418 For a beginning it was possible to meet the new fuel requirements by an appropriate admixture of aviation benzol.

Even after commencement of the main rearmament program the aircraft engines of the emergency armament phase remained in service, so that no reasons existed to insist on any improvement of the quality of aviation fuel. It was the development of the 20- and 30-liter class engines and their variants, with their improved power performances, and which provided the basis for the main phase of rearmament, as well as the BMW-801 and the jet engines which created a necessity for special types of aviation fuel.

The following special fuels were used in the types of aircraft stated:

Fuel	Octane Rating	Aircraft Engine Classes
A 3	80	As-10 and MR-500 classes
B 4	87-89	DB-601, 603, 605, 606, 610, BMW-132, BMW-801a, SAM 233, Jumo-211, 213, and 222, As-410 and 411
C 3	100	BMW-801 series
J 2		Medium fuel for jet engines
C-Stoff	Containing 50 percent B-Stoff fuel and 50 percent methanol for engines of Me-163 aircraft.	

The procurement of limited quantities of Diesel oil

419 was also necessary for Ju-86 aircraft using Jumo 205 engines. The types of Diesel oil thus required were DN 1, and later K 1.

The GM 1 fuel used as a booster charge for short bursts of extra speed consisted of an admixture of methanol and water

The development of the B 4 lead treated gasoline with its octane rating of approximately 87 became necessary because it was found that an admixture of more than 60 percent benzol with normal fuel did not further improve the knock resistance of engines.

Type B 4 fuel was used in the majority of the engines installed in front line aircraft. This fuel necessitated the import and the manufacture in Germany of tetra-ethyl-lead. fluid and ethyl-di-bromide, the latter to burn out the residues left by the tetra-ethyl-lead.

As the war proceeded the necessity developed for further improvement of engine performances. This was possible with Type C3 fuel, the production of which depended on the production of iso-octane, which came from the Leuna Chemical works.

The J 2 fuel needed for jet power units had to be taken from the intermediate processes of the ditillisation of synthetic fuels. There was thus no possibility to find a

420 substitute base, which would have been highly desirable in general respects because of the shortage of all types of fuels. Experiments with Rumanian asphaltic crude oil were still in process when the war ended.

Plans for the expanded Reichswehr[1] provided for the activation of eight squadrons in about 1933, and so far as quantities were concerned their supply encountered no difficulties. It was only after 1933 that the comprehensive aviation training program, the gradual increase in the number of activated units, and the preparations against the eventuality of a mobilization made studies necessary to ascertain the possibility of meeting requirements and to insure that the rapidly mounting consumption would be met.

Investigations in 1933-34 into the producing capabilities of installations within Germany manufacturing synthetic fuels showed that these were in no way sufficient to meet the needs for the mobilization plans established for 1934. In view of the critical international situation at the time, the exposed military position of Germany, and the existing treaties between various of Germany's neighboring states, this made comprehensive measures necessary to insure the availability of adequate supplies for mobilization preparations. This

1. Germany's post-World War I 100 000-man Army.

421 meant that, to meet requirements, reserve stocks had to be built up by means of increased imports of foreign fuels and the necessary components, supported by simultaneous expansion of the synthetic fuels producing industries within Germany.

Because of the stage reached at the time in the synthetic fuels production industries, it was not to be expected that appreciable supplies of aviation fuel could be made available from these sources in the years following 1933, so that the only possibility to insure adequate supplies for implementation of the mobilization plans was by means of expedited and increased purchases from foreign suppliers. This, in turn, presupposed the availability of large bulk storage facilities.[1]

In calculating the storage space thus required it was not sufficient to take into account the supplies needed for air units in the event of a mobilization; in addition consideration had to be given to the possibility that Germany might be completely isolated from foreign sources of supply.

The Aviation Fuels Section of the Technical Office thus had to concentrate primarily on the construction of bulk fuel storage facilities. This was a subject on which no experience or examples were available, particularly since consideration had to be given from the outset to the matter of protecting these installations against air attack.

1. See "Bericht Oberst-Ingenieur Heydenreich."

422 Compared with the buildin projects currently in process for the rearmament programs, the fuel storage installations had to be large enough to meet future expansions. Furthermore consideration had to be given to the requirements for quick reception and quick deliveries, and therefore to the necessity for favorable transportation facilities, in order to insure quick supplies to the troops in the event of mobilization.

Other factors which had to be taken into consideration in selecting sites for large bulk fuel storage installations were the existing possibilities for camouflage, transportation facilities, the risks of sabotage and [illegible] so forth, all of which factors were checked by air reconnaissance while ground reconnoitering served to check the results of the air reconnaissance and to study the geological conditions.

423 Specificatoons also had to be established for the compositions of the fuels, since they would presumably be held in stock for anything between two and three years.

In addition to aviation fuels, provisions also had to be made for the storage of lubricants, and later also for tetra-ethyl-lead supplies.

Construction of the bulk storage installations commenced at a time when it was impossible to estimate or predict future fuel developments or the number of air units to be

423 activated, but plans nevertheless from the outset provided for the possibility to expand them considerably if necessary.

Laboratories at each storage installation provided the possibility to analyse and test each shipment of fuel prior to intake and, after it was drawn from the installations, prior to its dispatch to troops, also to to admix the necessary components when required.

The bulk storage tanks used for the purpose had a diameter of 33 feet (10 meters) and a length of between 130 and 150 feet and a cubic content of approximately 88 275 cubic feet (2 500 cubic meters). They were arranged in batteries of ten linked together by pipelines underground. The tanks themselves were placed approximately 50 feet (15 meters) under ground covered successively by a layer of specially hard concrete between 3.94 and 5.91 inches (10-15 centimeters reinforced with wire netting; a layer of earth of approximately 29.55 inches (75 centimeters), an impact deflection layer of heavy rocks of between 11.8 and 17.7 inches (30-45

424 centimeters) and a top layer of earth. This gave them ample protection against bombing.

In actual fact none of the bulk fuel storage depots was seriously damaged, although they came under heavy bombing attacks. In a bombing attack against one of these fuel bulk storage depots near Neuburg on the Donau, only one out of

424 the forty tanks was damaged and set on fire.

The first such bulk fuel storage depots established had a capacity of 2471700 cubic feet (70 000 cubic meters) plus 353 100 cubic feet (10 000 cubic meters) for aircraft engine lubricating oil. The storage capacity was increased later to 3 531 000 cubic feet and 635 580 cubic feet (18 000 cubic meters),respectively. Work was so expedited on this project that the first of these depots was ready to receive fuel in mid-May 1935. This must be considered as an exceptional performance, both in actual labor and in organization, on the part of all official agencies, the construction firms, and the Fuels Section of the Technical Office. In appraising this performance consideration must be given to the necessary preliminary preparations, the reconnoitering to be done, the clarification of the geological conditions, the designing work--which initially caused very serious difficulties, and the work which went into determining the most proper arrangement for the intercommunication pipeline systems, the most favorable approach and departure transportation routes, the establishment of laboratories with their testing facilities, the research work involved in determining the essential specifications to insure the keeping qualities of the fuels to be stored, and the measures taken to keep

425. the stored fuels free from impurities.

425 An Economic (or Industrial) Research Association (Wirtschaftliche Forschungs-Gesellschaft), generally known as the Wifo and formed especially for the purpose, assumed responsibility for supervision of the construction work and settled accounts with the engineering firms employed, as well as for the operation and administration of the finished installations. The Association was controlled by the Plenipotentiary General for the Wartime Economy.

Apart from technical equipment, the availability of fuel supplies for training and operational purposes was the most important condition for operability of the Air Force, so that the Aviation Fuels Section formed specifically for the purpose within the Technical Office initially had to handle the problem of fuels supply storage without any consideration for the needs of other users.

Later, the Military Economy Staff of the Joint Military High Command assumed responsibility for all fuels bulk storage measures, including the supplies of aviation fuels. At the

426 same time the Aviation Fuels Section of the Technical Office, after a new subdivision of its functions, became the Mineral-Oils Economy Branch of the Four Years Plan Authority established in 1936.

The mission of the new branch was to handle the execution of all construction work for mineral oils--including large

426 bulk storage tanks, for bulk storage operations, and for the procurement and transportation of mineral oils.

The above measures coordinated the responsibilities in the most urgently important field of fuel supplies with the other missions and responsibilities of the Four Years Plan Authority.

However, the shortage of iron which soon resulted from the innumerable public building projects in process necessarily had adverse repercussions in the field of aviation fuel supplies. In order to reestablish direct influence by the Air Force Command on the supply of aviation fuels, however, the more important fuctions in this field of responsibilities were transferred back to the Reich Air Ministry. In this field the Four Years Plan Authority remained responsible only for all bulk storage tank construction, which also had to serve for all military supplies of fuel for surface vehicles, and for the execution of constructional work in connection with mineral oils.

427 Because of the financing problems involved, the Reich Ministry for Economy also had to participate in the constructional activities for mineral oils, so that four top level authorities were now involved, namely,

the Four Years Plan Authority
the Joint Military High Command (Oberkommando der Wehrmacht

427 The Reich Air Ministry
the Reich Ministry for Economy.

The fact that nothing had been done to clearly define the missions and responsibilities of the various authorities involved, and this applied particularly to the subdivision of responsibilities between the Four Years Plan Authority and the Military Economy Staff of the Joint Military High Command, necessarily hampered the progress of work.

By 1 January 1942 bulk storage facilities with a holding capacity of 28 601 100 cubic feet (810 000 cubic meters) were ready and in operation, the larger share of the space being for aviation fuels.

The quantities thus held in storage were distributed throughout Germany in ten depots, namely,

Location	Fuel Storage Space	Lubricant Storage Space
	Cubic Feet[1]	Cubic Feet[1]
Derben	35 310 (1 000)[1]	635 580 (18 000)[1]
Nienburg	3 531 000 (100000)	
Stassfurt	7 062 000 (200000)	
Muenchen-Gaubing	3 884 100 (110000)	194 205 (5 500)
Neugurg/Donau	3 531 000 (100000)	151 833 (4 300)
Hitzacker/Elbe	3 531 000 (100000)	194 205 (5 500)
Galtgarben	3 531 000 (100000)	194 205 (5 500)
Juditten, Eastern Prussia		45 903 (1 300)
Niedersachswerfen		776 620 (22000).

The followin, bulk storage depots were under

[1] Cubic meter content given in parentheses.

428 construction at the time:

Location	Fuel Storage Space (cubic feet)[1]	Lubricant Storage Space (cubic feet)[1]
[illegible]		
Farbe, near Bremen	10 593 000 (300 000)	
Uebbs, Austria	7 062 000 (200 000)	
Niedersachswerfen		351 300 (10 000)

Plans were in preparation for expansion of the depots at

Derben, Munich, Neuburg/Donau, Hitzacker, Niedersachswerfen.

The Stassfurt depot represented an experiment at fuel storage in a mine shaft. Owing to the difficulties encountered in providing protection against weather conditions and the considerably higher expenditures involved, however, no further use was made of mine shafts for the purpose.

Besides Stassfurt, another depot differed from the general system. This was the Niedersachswerfen depot, where aviation lubricants were stored in drums inside [illegible] tunnels. The tunnels were level with the outside terrain, which greatly facilitated transportation to and from the depot, since rail cars could be moved into the tunnels. Owing to

429 the favorable premises available in the tunnels and the excellent protection they provided against air attack, the Niedersachswerfen depot later came into use for the

429 construction of V-2 missiles and Me-262 jet aircraft.

The mineral oils produced in Germany played no important role in meeting the requirements of the Air Force in the 1937-1937 period. The output at the time was only between five and six hundred thousand tons per annum and the raw gasoline content was relatively low.

Fuels to meet the current needs of the steadily growing German Air Force and to build up reserves could therefore initially come only from imports. The suppliers in question were as follows:

Fuel Suppliers:

The Shell Company, the German-American Petroleum Company, and the Olex Company.

Suppliers of Aviation Lubricant Oils:

The German-American Petroleum Company, the German Vacuum Oil Company, and the Shell Company.

The German Air Force thus had to depend initially on purchases from foreign countries for its supplies of both fuels and lubricants.

Because of price and other considerations, and in order not to be completely dependent on the monopoly exercised by the three firms mentioned above, the German Air Force after a while succeeded in obtaining supplies from also from smaller firms after these firms had proved that they could meet delivery conditions.

450 The whole fuel supply situation was complicated by the necessity to use tetra-ethyl-lead-fluid (Bleitetraaetylfluid). There was no possibility to obtain sufficient currency to stockpile large supplies, so that one of the most pressingly urgent requirements was to establish an installation within Germany for the production of tetra-ethyl-lead-fluid. After lengthy negotiations between the IG Farben Corporation and the American Ethyl gas Corporation an agreement was finally reached to establish such a factory in Germany using the experience of the American corporation. This factory was established at Doeberitz in 1936-37.[1] However the output of the factory was inadequate to meet the needs of the German Air Force in the event of mobilization and to build up reserve supplies appropriate to the gasoline stocks held. The output in 1937 was barely sufficient to lead-treat XXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX (verbleien) 40 percent of the gasoline supplies then held in storage.[2]

This lag in the production of tetra-ethyl-lead-fluid was due partly to the business interests of the IG Farben Corporation, which desired to introduce its own product,

1. In his 1949 lecture General von Seidel states that it was only with difficults and against opposition by Milch and Udet that such a factory was established shortly before the war, after purchase of the patent right abroad, and thus make Germany independent of imports. It is necessary to establish here that the Doeberitz factory was established already in 1936-37 after lengthy and difficult negotiations between the IG Farben and the American Ethyl Gas Corporation.
2. See Report by Oberstingenieur Heydenreich, p. 66.

431 Bleikarbonyl, in place of tetra-ethyl-lead-fluid. However, this admixture resulted in engines misfiring, and therefore had to be rejected.

Since only part of the lead supplies needed for the production of tetra-ethyl.lead-fluid was available and severe penalties were threatened if the official allocations were exceeded, Goering in 1938 ordered the construction of a second factory to produce the fluid. In addition, as much as possible was to be imported from the United States until the new factory was completed.

The new factory had an output three times that of the first and was situated near Nachterstadt. Once it commenced producing the requirements of the Air Force in the event of mobilization could be met.

The planned supplementary purchases of tetra-ethyl-lead from the United States was delayed for a long time, and deliveries only arrived in September 1938, a period of exceptionally serious political crisis. What influence the critical international situation had on the delayed deliveries would require further research.

As previously mentioned ethyl-di-bromide, which made up approximately 45 percent of the whole final product, was necessary to take care of the residues left by tetra-ethyl-lead in the aircraft engine cylinders after combustion.

432 The ethyl-di-bromide came from a works of the IG Farben Corporation situated in Oppau in a seriously exposed powition.

A syndicate of which Germany, Holland, Belgium and Luxemburg and France were members furnished the supplies of bromide needed for these purposes. Deliveries constituted no problems.

Since the availability of aviation fuel supplies for peacetime needs and to meet the requirements in the eventuality of mobilization depended almost exclusively on imports, and in consideration of the fact that the possibility of Germany being cut off from foreign supplies in the eventuality of a mobilization, so that the quantity of stockpiled reserve supplies would dictate the duration of any German conduct of air warfare, the natural aim of all concerned was to make Germany as independent as possible of imported fuels by increased German production. Another factor here was that German foreign assets were not nearly adequate to insure sufficient imports to build up the required reserves.

The Leuna Works at Halle had endeavored to produce usable synthetic aviation gasoline, and the establishment of a subsidiary aromatizing installation at the expense of the Reich Air Ministry had brought these endeavors to a successful conclusion. With support from the Military Economy Staff of the Joint Military High Command two other works

432 using the IG Farben high pressure process were under construction even before this, namely Werk Boehlen near Leipzig and a works near Magdeburg. Both of these commenced operations as early as in 1937 with a combined monthly output of 80-100 000 tons. To control these works the Brabag (abbreviation of Braunkohlen-Benzin Aktien Gesellschaft--Lignite-Gasoline Company, Limited) was founded in Berlin as the holding company.

Another works using the Fischer-Tropsch process was established at Ruhland, Niederlausitz, but only for the production of gasoline for surface vehicles.

By October 1944 the following hydrogenation works were established and part of their production was aviation fuel:

Poelitz, Gelsenberg, Leuna, Bruex, Scholven, Wesseling, Boehlen, Moosbirbaum, Oppau, Magdeburg, Blechhammer, Schkoppau, and Huels.

The construction of these works was subject to the same difficulties and delays encountered in other armaments construction projects.

In view of the high importance of the availability of aviation fuels, Goering had therefore ordered in 1941 that building construction projects for the fuels and synthetic rubber manufacturing industries were to be given preference over the submarine construction program, which had been

433 awarded the highest priority, known as the SS-Dringlichkeits-stufe. However, the Military Economy Staff and the Armaments Office of the Joint Military High Command revoked this order.[1]

Aviation fuel imports from the end of 1939 on came from Rumania (8-9000 tons monthla) and Galicia (precise quantities unknown), and during the war from Poland and Russia.

Besides the production of synthetic fuels, the Four

434 Years Plan Authority did everything possible to increase the German output of natural mineral oils. Up to 1937 mineral oils produced in Germany could not be used for aviation purposes because of their poor quality, and the oil-drilling operations ordered by Goering in 1937 to find a product suitable for conversion to aviation gasoline brought little success.

Owing to the increasingly serious tension in international affairs in 1938, foreign powers seriously curtailed fuel exports to Germany, for which reason the Technical Office called for measures to accelerate a step up of German production.[2]

With the beginning of the war foreign deliveries naturally ceased, with the exception of supplies coming from Rumania, which continued to deliver 6-9 000 tons of aviation

1. See "Vortragsnotiz GL-Chef-Ing. 5. 3. 1941 fuer Goering beim Hitler."
2. See "Schreiben Chef des Techn.Amtes im Luftfahrtministerium vom 10.1.1939 (1063)."

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fuels,[1] which level appears to have remained constant until Rumania was occupied by Russian troops in August 1944.[2]

The supplementary 100 000 tons of aviation fuel coming from Russia can be considered as compensating for the lost imports from other sources, although the quality of the Russian fuel was only conditionally up to the German standards for quality. However, the Technical Office made allowances in this case, so that it can be assumed that the Russian deliveries were made available to the Air Force.[3]

The aviation fuel supplies captured in occupied territories, and particularly the 200 000 tons found in France, can also be considered as foreign imports.

Later in the war deliveries also came from the newly discovered deposits in Hungary and Austria. It has not been possible to ascertain what share of these deliveries was suitable for aviation or what share was allocated to the Air Force.

It has not yet been possible to verify information available on the aviation fuels output by German hydrogenation works or on when deliveries commenced and the increases achieved. Monthly deliveries prior to the war are estimated at approximately 20 000 tons.[4]

1. See "Entwicklung der Flugbetriebsstofflage der deutschen Luftwaffe Gen. d. St.Abt. vom 25. 5.1945.
2. See Letter "Planungsamt Az. 195 Nr. 9991/42 v.13.7.1943".
3. See "Entwicklung der--Continued on p. 538

435 This output increased gradually, as follows:

1941 to between 50 000 and 87 000 tons per month
1942 " " 178 200 " 120 000 " " "
1943 " " 160 000 " 186 000 " " "

Dr. Krauch, Plenipotentiary for the Chemical Industires expressed hopes that it would be possible, from the technical viewpoint, to increas the output of aviation fuels to an overall total of 307 000 tons monthly after expansion of the existing and establishment of new hydrogenation plants and after conversion of the installations at Boehlen, Magdeburg, and Z Zeitz to produce aviation fuels instead of gasoline for surface vehicles, but in actual fact this target was not even

436 nearly approached.

In 1944 output increased at the most to 180 000 in January and was maintained at approximately this figure until April. In May the figure dropped to 155 900 tons and in September to 5 300 as a result of the damage done by Allied air attacks.

The damage done by bombs to the hydrogenation plants had a decisive impact on supplies for the German Air Force. It was therefore a matter of paramount importance to take measures which would enable the various factories to resume production on as large a scale as possible. The Geilenberg

Footnote 3, p. 537--Continued: ".....Flugbetriebsstofflage der deutschen Luftwaffe Gen. Q. 6. Abt. v. 25. 5.1945 u. RdL u. ObdL GL 5 Az Nr. 5519/40 I A v. 18. 5. 1940, Schr. and OKW Wehrwirtschaftsstab (470)."

Footnote 4, p. 537: See "Entwicklung der Flugbetriebsstoffluge der deutschen Luftwaffe Gen.Q.6.Abt. 25.5.1945."

436 project was launched for this purpose and furnished practically unlimited powers of authority with the mission of repairing as speedily as possible the damaged hydrogenation installations.

Through a ruthless exploitation of all means available, this project succeeded in restoring production, but the success achieved in this work was cancelled out again very shortly by renewed air attacks.

As the Allied air offensives proceeded repair operations assumed such proportions that it was no longer possible to put the installations back into operations in cases where factories were very badly damaged, so that the output from such factories was completely lost.

437 Although a man power force of 200 000 was employed for the purpose, all efforts to restore the output of aviation fuels to anything like former maximum performances failed.[1] Production totalled 16 400 in late November, and 23 400 tons in December only to decreas in 1945 to 1 600 tons followed by a complete cessation in April of that year.

Immediately after the Allies opened the air offensive against hydrogenation works, systematic preparations commenced for the establishment of underground hydrogenation works with an initial capacity of 5 000 tons in February 1945 to increase to a monthly output of 60 000 tons by the

1. Appendix 27.

437 summer of the same year. However, this project encountered serious serious difficulties in the personnel, materials, and transportation fields, and the target was not achieved. The end of the war also put an end to the postponed plans to commence output in May 1945 and increase production to approximately 45 000 tons monthly by the end of the year.

The production of the J-2 type fuel needed for the He-262 and Ar-234 types of aircraft admittedly made significant simplifications possible in hydrogenation processes, but, as previously mentioned, the production of these fuels remained contingent on the operability of the hydrogenation works. In spite of their low quality, it was therefore not possible to produce these fuels in any appreciable quantities. Plans
438 provided for a monthly output of 50 000 tons by mid-1945 and of 120 000 tons by 1946, but air attacks also frustrated these plans.[1]

As previously mentioned, efforts were then made to produce jet fuels from asphaltic crude oils received from Rumania, but the occupation of Rumania by Russian troops prevented realization of these plans.[2]

Circumstances were similar in the production of C-Stoff fuels for the Me-163 type rocket planes. This fuel consisted of 50 percent B-Stoff fuel and 50 percent methanol. Air at-

For Footnotes see 540.

438 attacks destroyed the only installations for the production of these components at the Rasche Works, Ludwigshafen, and at the Badische Analin und Sodafabriken, Leverkusen, so that these aircraft could not longer be used.[1]

Both Reich Minister Speer and Field Marshal Milch repeatedly submitted urgent requests to Hitler to provide better protection for the hydrogenation works, but adequate protection was not provided because of the commitment of all available forces at the fronts.[2] In spite of detailed reports predicting a very small production by the hydrogenation works from October 1944 on as the result of air attacks which were to be expected, it proved impossible to secure better pro-

439 tection for these works.[3]

At the beginning of the war aviation fuel reserves, stockpiled mostly from imports, totalled roughly 400 000 tons.[4] By means of imports from Rumania--although these were small, and from Russia, plus the supplies captured in France, and in spite of the consumption in the Polish campaign--on which no figures are available, this reserve increased to 600 000 tons in 1940. This equalled the

1. Report by Minister Speer to Hitler on 5 October 1944.
2. See "Entwicklung der Flugzeugbetriebsstofflage der deutschen Luftwaffe Gen.Q.6.Abt. vom 25. 5. 1945."
3. See Excerpts from 1979 Lecture by Generl von Speidel, at the time Chief of Luftwaffe Supply and Administration.
4. See "Besprechungsnotiz Nr. 7/42 geh.Kdos.ueber Besprechung Goering-General von Seidel am 8. 1. 1942."

Footnote
For Footnotes see p. 541a
For Footnotes to p. 540see p. 541a.

Footnote 1, p. 540: See "Gl.-Besprechung am 24. 2. 1944."

Footnote 2, p. 540: See "Entwicklung der Betriebsstofflage der deutschen Luftwaffe vom 25. 5. 1945."

Footnote 1, p. 541: See Letter "Chef des Techn. Amtes im Luftfahrtministerium vom 10. 11.39/1063;"See Letter Milch, 23 June 1943, Gst No. 321/43 geh.Kdos.

Footnote 2, p. 541: Ibid

Footnote 3, p. 541: From Report by Reich Minister Speer to Hitler on 5 October 1944.

Footnote 4, p. 541. See "Entwicklung der Flugbetriebsstoff-Lage der deutschen Luftwaffe Gen. Q. 6. AB-4, vom 25.5.1945.

439 requirements stated by the Chief of Air Force Supply and Administration at the beginning of the war.[1]

Apart from the quantities still imported, all fuel used from this reserve had to be replaced exclusively from German production. Since the German synthetic fuels producing industry was still in the initial stages it was not able to replace the quantities consumed in 1940which totalled an average of 74 500 tons monthly or in 1941, when the average monthly consumption was 106 500 tons. What further complicated matters was that, in addition to supplies for the German Air Force and German industries, deliveries also had to be made to Italy and Finland.[2]

440 For the above reasons it was to be assumed that fuel reserve stocks would total only 231 000 tons on 1 February 1942. Of this total only 40 percent was available directly to the Air Force General Staff, while roughly 60 percent, or approximately 153 900 tons, was in depots in the various theaters of operations.[3]

Although German production in 1941 increased to about 80 000 tons monthly, Goering ordered measures to secure an even more economical use of fuels than before.[4]

In addition to restrictions on air travel, these measures even reduced the quantities allocated for training purpose and for the industries. Another measure which must

440 be considered as an attempt to prevent further reduction of the reserves is the order previously mentioned in this study to convert hydrogenation works currently producing gasoline for surface vehicles to the production of aviation fuel. This measure was to be carried out on 1 March 1942 and involved the following

Poelitz Hydrogenation Works, monthly output				12 000	tons
Magdeburg	"	"	"	7 500	"
Zeitz	"	"	"	7 500	"
Leuna	"	"	"	4 500	"

giving a total of 31 500 tons monthly.[1]

However, consumption increased sharply in the summer of 1942, because of increased air operations, to 134 000 tons in July and 146 000 tons in August,[2] while production in the same two months totalled only 112 000 and 131 000 tons. Consumption continued to rise in 1942, reaching 160 000 tons monthly, so that there was a threat that the supply situation for the Air Force would become exceedingly difficult.

1. See "Besprechungsnotiz Nr. 7/42 geh.Kds. ueber Besprechung Goering-General von Seidel am 8. 1. 1942."
2. See Letter GL AM Az 85 Nr. 2242/42 geh.Kds. 11.11.1942.

Footnote 1, p. 542: See Excerpts from 1949 Lecture by General von Seidel, at the time Chief of Air Force Supply and Administration.
Footnote 2, p. 542: See "Besprechungsnotiz Nr. 7/42 geh.Kds. ueber Besprechung Goering-General von Seidel, 8. 1. 1942."
Footnote 3, p. 542: Ibid
Footnote 4, p. 542: Ibid.

401 At the beginning of 1942 reserve stocks fell to 160 000 tons.[1] The severe economizing measures thereupon introduced, which in particular affected aviation training and severe cuts in all allocations with the exception of those for units in action, combined with reduced air operations in the winter of 1942, made a slow increase in reserves held possible, showing a total of 540 000 tons in May 1944.[2]

Of this amount only 420 000 tons were available to the Air Force General Staff. The remaining 120 000 tons were earmarked as a reserve available to the Joint Military High Command and to be held at the disposal of that headquarters.

Although German production in the first five months of 1942 increased to a monthly average of approximately 163000 tons, heavy consumption, amounting in some months to as much as 190 000 tons, made it necessary to even cut supplies for field units to 120000 tons monthly.[3]

Careful and complete control over all aviation activities in general had thus become necessary. The prohibition of air travel already in force was extended to include official trips not essential for the conduct of the war. Air transportation was to be replaced by other means of transport.[4]

1. See "Entwicklung der Flugbetriebsstofflage der deutschen Luftwaffe Gen Q. 6. Abt. v. 25. 5. 1945."
2. See "Flugbetriebsstofflage in Deutschland 1939-44."
3. See "Betriebsstoffzuweisung aus Befehlssammlung Koller vom 30. 6. 1944 und 1. 7. 1944 (657)."
4. See "Betriebsstofflage - Auszuege aus Go-Politik und Luftkriegsfuehrung (Studie 8. Abt.) F 79 (217)."

442 After the Allied air offensive commenced in June 1944 German fuel production dropped steadily till the low figure of 5 300 tons was reached in September. This fact and the heavy consumption at the fighting fronts, which in one month reached a peak figure of 190 000 tons, plus the loss of Rumanian supplies, resulted in a rapid decrease in reserve stocks from August on in spite of strict application of allocations and in spite of the restriction of air action to missions by fighters, fighter-bombers, reconnaissance planes, ground support units, and transport planes. All bomber aircraft were grounded and training was at a complete standstill.

Production dropped still further in March [redacted] to 1 600 tons, so that reserve stocks fell to a low of 25 000 tons plus a Joint Military High Command reserve of 5 000 tons, compared with the consumption of 20 775 for the month. All efforts failed to eke out the available supplies by means of severe rationing until the new underground installations commenced production.

In the case of the industries, the Technical Office had at an early stage taken measures to economize in aviation fuel in view of the difficult fuel situation expected to develop in the event of mobilization. One of these measures was a reduction in the time required for deliveries.

442

Calculations in January 1941 showed industrial consumption of fuel to have averaged 10 000 tons monthly in the past.[1]

An order from Field Marshal Milch to reduce fuel consumption admittedly resulted in a reduced consumption per unit of manufacture, but the increased output of aircraft and aircraft engines in the first half of 1942 nevertheless raised industrial consumption of fuels to between 13 000 and 13 800 tons per month.[2]

In spite of a new measure further reducing the duration and number of delivery test flights, another increase in aircraft and aircraft engine output again increased fuel requirements to 15 000 tons monthly.

Implementation of plans by the Air Force General Staff to reduce fuel allocations to the industries to between 6 000 and 7 000 tons monthly thus would have created the risk that it might not have been possible to deliver completed aircraft, or that factory trial and delivery test flights would have had to be reduced to a point where the safety of the aircraft would have been compromised. In actual fact it became necessary to halt all air activities periodically, particularly in September 1942, when the Ju-87 aircraft were being delivered.[3]

1. See "Besprechungsnotiz Nr.7/42 geh Kds.v.8.1.1942 ueber Besprechung Goering-General von Seidel.
2. See "GL-Besprechung vom 1.9.1942.
3. Ibid.

443 The economizing measures naturally created difficulties in the matter of delivery flights to the front.

One result of the still further deteriorating fuel supply situation was that factory engine trial runs had to be carried out with an electric drive, and that time for such runs was still further reduced.

Aviation fuel requirements had been computed and stated from time to time on the basis of the currently valid mobilization plans of the Air Force General Staff. The stated monthly requirement in the summer of 1939 was 200 000 tons. Because of the increased number of units in service this stated requirement increased by 1942 to 220 000 and in 1943 to 350 000 tons per month.[1]

Comparison with reserve stocks and production figures for the times involved shows that none of these requirements were met.

All figures found in the sources available at writing on the subject of imports, production and consumption have been compiled to form the table included with this study as Appendix 26. The same information is presented as a graph in Appendix 27.

Since no figures are available on consumption in 1939, and since the individual fingure for production and consumption do not furnish a true picture of the quantities actually

444 produced and actually used in any one of the years involved, it is not possible to use these overall totals for any comparison with the available stocks at any given time. The serious decrease in stocks in 1944 in spite of the small consumption and the small production is undoubtedly due to built up supplies lost in the various theaters of operations.

The presentation given in Appendixes 26 and 27 thus can only be regarded as a picture of developments in general, in which no consideration has been given to the unknown intermediate elements.

Further and very copious research would be necessary to make possible the compilation of comparative charts approximating actual facts.

TANK RAIL CARS

Up to 1940 the volume of aviation fuel to be stored as reserve supplies mounted steadily. This created serious problems of transportation, particularly for the State-owned railroad system, which not only had to carry the fuel to the bulk storage depots but also to the individual units. Inquiries addressed to the railroad authorities revealed that only 1 500 tank rail cars were available for the transportation of gasoline and furthermore that these were the

Footnote 1, p. 547: See "Betriebsstoffläger in Deutschland 1939-44 (G 18)."

445 property of private firms or tank car hiring contractors.

Furthermore, the necessity to add tetry-ethyl-lead-fluid to aviation fuels because of increasing engine performances meant that this fluid also had to be transported. This necessitated better quality tank rail cars than normal, particularly because it was of paramount importance to insure that the cars would not develop leaks in the event of collision or derailment in view of the fact that the fluid was so highly poisonous.

For the above reasons the Technical Office by the end of 1942 procured 5 200 tank rail cars out of the 9 000 called for by the Air Force General Staff. It has not been possible to ascertain whether the full number was procured later in the war.

REPAIR SERVICES

While the purpose of the various production programs was to provide the material essentials for execution of the Air Force General Staff plans for unit activation or unit requirements, the mission of the military repair hangars and industrial repair workshops was to maintain the units technically operable in the highest possible degree and to insure good technical conditions at the schools.

In subdividing the repair mission arising from

446 combat unit and training activities, the ruling factors had to be requirements in personnel, working procedures, and organization.

The continuous rotation of servicing personnel with the troops, the equipment available to the military repair hangars in the form of tooling machines and other installations on a scale appropriate to the technical capabilities of the personnel involved, and the need to avoid burdening the troops with too large organizations involved in repair installations automatically limited the scope of repair activities of ~~MAIN~~ field unit repair hangars. Besides current 447 maintenance their mission thus included such activities as servicing, check-ups, partial overhaulings, and minor repairs which could be done without special installations and tools.

Thorough overhaulings and difficult repairs the rational performance of which required a large expenditure of workshop equipment, installations, gages, special tools, and a comprehensive workshop organization besides personnel with a thorough knowledge of the manufacturing processes thus had to be assigned to industrial repair workshops.

The establishment of State-owned repair shops was avoided in order to bring industrial initiative into play by having the repair shops under private management and in order to establish close contact between the manufacturing firms

447 and the repair workshops they maintained.

Within an organizational setup of this type it was easier to secure a more speedy transfer of the experience gained during manufacture to the repair shops, a more speedy execution of modifications, and manufacture of spare parts, and to insure ready exchangeability of spare parts, than would have been possible in a State owned organization, where regulations would often have hampered personal initiative.

The high importance of the required industrial repair organization for the maintenance of the operability of aircraft and other equipment was confirmed by the creation of

448 special Repair Services Sub-Sections (Reparatur-Referate) within the various procurement branches and sections of the Technical Office. These sub-sections expanded commensurate with their missions to four full sections when they were assigned the additional duties of handling reconstruction, reequipment, and spare parts manufacture.

Since it appeared an advantage to secure uniform direction of the entire repair industry, all repair services sections within the Technical Office were consolidated in 1938 to for a Repair Services Branch. In a very short while, however, the separation of the individual repair service sections from the appropriate procurement subdivisions produced very adverse results.

448 Planning for the procurement of the spare parts units needed by the repair shops, for the timely availability of the necessary installations, appliances, and special tools for repair work purposes had to be handled by the procurement subdivisions, and the processing of alterations and so forth called for very close cooperation within these subdivisions. The disadvantages of the new system thus soon became evident and the newly created Repair Services Branch, the establishment of which was possibly due to personal ambitions, was deactivated after a short while and the sections returned to the procurement subdivisions.

It was not possible from 1933 on to construct factories and repair workshops side by side and at one and the same time. For this reason the parent factories were required to establish repair departments so as to establish a proper cycle from the outset , namely for all items of equipment coming from the factory new, going through the ordnance offices, to the troops, then back to the Repair Services Branch, and back to the ordnance offices for return to the troops. Another function of the factory repair departments was to give the factories an opportunity to gather experience on the soundness of individual parts and units of the various items of equipment, on wear and tear, on the making of the necessary replacement parts, and on points to be used in compiling instructions

449 concerning repair work for the independently operating repair shops and unit repair hangars to be established later. The experience thus gained was also valuable for application in the manufacture of new equipment.

Another purpose of the measure was to gather experience which would be useful in putting together reserve spare parts units.

However, the parent factories were so fully occupied with the task of establishing the necessary manufacturing facilitiesthat the additional requirement stated by the Technical Office in respect to the repair services did not receive proper consideration. The steadily increasing demands of the Air Force General Staff compelled the factories to use their entire facilities for [redacted] manufacture.of new series.

Furthermore, repair operations require an entirely different works organization from that of factories, so that industrial firms showed little inclination to meet this requirement of the Technical Office.

450 These circumstances resulted in an exceedingly large accumulation of aircraft and aircraft engines requiring repair or overhauling at the factories engaged in serial production. This, in turn could have placed the build up of the Air Force, the operability of units, and execution of the training program in jeopardy.

450 For the above reasons it became necessary to concentrate particular attention on planning for new independently operating repair shops.

Owing to their significance within the whole complex of armaments, the locality and the local sites for such repair shops had to be selected in accordance with the same principles as those applying to sites for factories to manufacture by serial production methods. This applied also to the air attack protection requirements to be observed, and to preparations against the eventuality of mobilization.

Furthermore, in order to keep communications and transport routes between the repair works and the field units and schools as short as possible, they were distributed by provinces (Luftgaue).

Their installation and working requirements were thus dependent on the individual units and schools situated within the provinces, or rather on the aircraft and engine types used in those units and schools. This meant that they were also subject to all changes taking place in the equipment of these units and schools.

Insofar as time considerations made it necessary to use premises outside the boundaries of "interior Germany" for the establishment of repair workshops, these could not be included in the mobilization plans.

451 As was the case for industries engaged in new production, the mobilization plans provided the basis for the assignment of repairs to specific types to each repair shop. In addition to their repair work, these shops had the responsibility of insuring that when ~~XXXXXXXXXXXXXXXXX~~ serial production of a type ceased in the parent factory, the aircraft or other equipment of this type in service with troops would be maintained operable.

In contrast with the factories engaged in new production, the repair works thus had tasks not enumerated in the mobilization plans and required only for peacetime operations.

As a precaution against the loss of repair works, facilities for the repair and overhauling of each model were provided as a rule in at ~~XXX~~ least two separate works.

One main repair workshop was established for each type which mobilization plans provided would be in use. This main workshop was responsible for the manufacture of spare parts and repair possibilities for its particular type if it went out of serial production. To keep the workshop occupied, it was assigned repair and basic overhauling responsibilities for another type otherwise handled by some other main workshop. This meant that each workshop engaged in the repair and basic overhauling of at least two types.

Since it had become necessary in the speedy build up

451 of the Air Force, and particularly for training purposes, to make use of all available aircraft types existing in the

452 sports and commercial aviation schools, in the German Lufthansa Airways, and so forth, the number of various types of aircraft in service with the Air Force up to 1937 totalled 49.

Facilities had to be provided for all of these 49 types of aircraft in use. The result was that each repair workshop had to handle repairs for as many as up to ten types of aircraft. In 1937 there were 26 independently operating repair workshops, including those of the Lufthansa Airways, and including and ten repair departments in factories manufacturing by the serial production system. This number increased to 35 by 1940, including the repair workshops of the Lufthansa Airways and six repair departments within factories.

Under such conditions it was impossible to achieve rationalized work processes, particularly since a large number of the workshops were still under construction and lacked the necessary outfits for their mission.

Another complicating factor was that the volume of repair work and basic overhauling work fluctuated widely, so that it was practically impossible to make any dispositions in advance.

1. Appendix 28.

452 The increased air activities during the summer months, followed by the autumn maneuvers, had admittedly created normal employment conditions for the repair workshopsfor a large part of the year, but the volume of work had to be expected to decrease in the spring on a scale which even made the release of personnel and shorter working times necessary.

453 The inadequate number of engines available also had adverse results. A survey in 1937, for example, revealed that 23 percent of the aircraft currently in repair workshops were there because no engines were available to render them fit for return to units or schools. Only the following percentages were in the workshops awaiting other replacement parts:

13.2 percent awaiting spare parts
7.8 " " instruments
2.3 " " propellors
1.4 " " radiators.
52.3 " held back in the repair shops for various reasons.[1]

The number of independently operating engine repair workshops at the time was 13, to which must also be added the repair departments of factories manufacturing engines under serial production methods.[2] +

1. See Procurement Reports (Beschaffungsmeldungen) 1937.
2. Appendix 29.
+ It is not possible to determine from the German text whether the 26"selbstaendige Reparaturwerke" on p. 452 (original pagenation p. 412) of the German text include the ten "Reparaturabteilungen von Serienwerken).

453 In the matter of aircraft and engine repair under mobilization conditions, the subject of mobile repair workshops had been taken under study long before the war. The outcome of the investigations made was the decision that mobile workshops would only be able to handle basic overhauling jobs, repair damage caused by weapons fire, and to carry out repairs for which permanent installations would not be necessary. Larger repairs would have to be done in workshops located in the zone of interior.

Matters were more complicated so far as engines were involved, since engine repairs were more dependent on the availability of tooling machines and test benches than aircraft repairs.

During the war the long distances from the fronts to workshops in Germany, and the excessive burden placed on the whole transportation system, which made it impossible to move damaged aircraft from the front areas to Germany on the necessary scale, necessitated implementation of the plans prepared for mobilization in this field by the organization of field repair shops.

The sites for such workshops were to be so selected that they would serve to support the individual air fleets and could receive damaged aircraft or engines by the shortest routes.

454 The fact that such field or forward repair workshops would have to operate with a minimum of equipment and installations necessitated the employment of fully qualified personnel. Such personnel with the necessary specialized experience could be procured in the required numbers only from the aircraft industry, in each case from the factory producing the type of aircraft or engine to be repaired by a workshop.

For this reason it appeared more practicable to attach the field repair shops to the appropriate factories and place them under functional and organizational control by the factories. In each case the appropriate air district command assumed responsibility for the operational control and administration, and logistical support.

Within the Procurement Department of the Technical Office, the appropriate Field Repair Services Chiefs (Front-reparatur-Chefs) were responsible for the uniform planning of all field repair workshops, for their siting, and their installations to handle the various types of aircraft, engines, and other equipment. Owing to the various specific problems involved, these Field Repair Services Chiefs had to cooperate very closely with the appropriate procurement branches.

Field repair workshops were established in practically all theaters of operations, namely, in France, Belgium,

455 Holland, Norway, Russia, Poland, Rumania, Greece, Yugoslavia, and Italy.

The field repair workshops intended for Africa was not established because of the German withdrawal from there.

It has not been possible from the records available at writing to establish the location of the various field repair workshops, a subject which would require further research.

Field engine repair shops were established in existing workshops in Poland, in Brussels, Antwerp, Paris, Le Mans, Belgrade, Athens, and Zaporozhe.[1]

Things were far more difficult in the matter of repairs to various items of equipment. Some of these items, such as instruments, required very complicated testing installations, so that the field repair workshops were able to handle only repairs which had nothing to do with the functioning of the item involved.

Having more complete and better equipment, in particular so far as testing installations were concerned, the repair workshops in Germany were able to expand their functions and were able to carry out the necessary testing of instruments and so forth and even remedy minor defects. The workshops of the Lufthansa Airways in particular had equipment for such purposes.

All other repairs in this field had to be left to

1. See Report by Oberbaubingenieur a.D. Meyer, p. 21.

456 Aircraft and engines which were beyond repair were delivered to specially equipped dismantling workshops, which sorted out the usable parts or items of equipment, and forwarded the rest of the materials, properly sorted out, to appropriate factories in Germany for reuse. Workshops of this type were also established in all occupied territories.

457 The mission of the industrial repair workshops was to insure the most economical execution of repair jobs possible, to insure proper execution of the work to protect the safety of aircraft crews, and to insure spare parts production after a model went out of serial production, besides taking every possible measure to economize in materials.

Germany's position in respect to raw materials supplies made it necessary to carry out repairs even when they did not appear worth while from the economic point of view.

The general rule was that an item should be repaired if it was up to 40 percent damaged. In the case of particularly important aircraft or items of equipment this limit was even exceeded. For this reason it was a responsibility of each repair workshop to examine each damaged part and determine from the viewpoint of materials economy, with the greatest possible regard for economic operations, whether it was worth repair, and to carry out necessary repairs within the shortest possible time. This served the dual purpose of

459 insuring that aircraft and equipment would not be withheld from the troops too long.

Construction Supervisors, as representatives of the Technical Office, were co-responsible for the execution of repairs.

When the repair workshops first went into operation regulations required that before starting on a repair job the shop concerned was to forward a condition report and

458 a cost tender to the Technical Office, where the appropriate branch or section would decide whether the article involved should be repaired or scrapped. Very soon, however, the volume of work this involved made it necessary to transfer to the construction supervisors the responsibility of deciding whether the damage was more than 40 percent of the new article.

The only data available for planning the peacetime staffing of repair workshops was information from the procurement programs and the assumed number of hours of flight in schools and field units. Although the procurement programs were subject to frequent alterations, they did at least provide some sort of a basis for calculations. During the first few years no reliable information was available on actual flight operations.

Things were more difficult in the case of engines.

458 Here the procurement programs could only serve as a vague guide in the assignment of specific engine models to specific engine repair shops. Workload calculations had to be based almost exclusively on the number of basic overhauling jobs anticipated, since there was no way to estimate the number of breakages and other damages which might occur. For this reason it was first necessary, in cooperation with the Development Branch and the developing firm, to establish the authorized number of hours an engine could be in operation between two basic overhaulings. The figures which could be calculated on this basis fluctuated within very wide limits,

459 however, because they depended on the current status of development and the purpose for which an engine was intended.

At a later stage accurate records were maintained on the actual number of flight hours in schools and units. This enabled the Supply Office to furnish some idea of the number of basic overhauling jobs to be anticipated in the coming months, and this could serve the Technical Office as a basis for future planning. However, the predictions thus calculated in many cases did not correspond to actual circumstances, since no allowance could be made for weather conditions, special exercises, or other plans. This frequently created difficulties in the repair shops due to an overload or too small a load of work.

459 Another difficulty in repair operations was the procurement of replacement parts. As previously mentioned all plans for serial production provided for the manufacture of spare parts, an item included in the manufacturing contracts. However, because of the constant increases in the programs and the pressure on firms to fulfill them, the firms almost invariably used the spare parts in the manufacture of new aircraft. Furthermore, the manufacture of the spare parts was usually left until late in the series, and at times appreciable quantities of spare parts only became available after

460 a model was out of production. The consequence was that aircraft and engines awaiting repair accumulated in the various repair shops. This finally caused disruption of the established cycle and delayed supplies to the troops.

This situation was only remedied after contracts were worded to specify definite quantities of spare parts kits or units to be manufactured as part of the program and to specify the deadline for their delivery .

Initially, the execution of aircraft repairs was handled by job numbers, the system being that all parts of the same job number were reassembled after repair. This system had the disadvantage that it delayed work. At times an otherwise completed aircraft had to be held back because one single part was not available. However, the system of stock checking in force made this system necessary.

460 The disadvantages resulting from aircraft being held in repair shops too long and of the consequent necessity to deliver new aircraft to units to make up for the resultant shortages finally led to a relaxation of the system. From then on the hull of the tail (Rumpf) was given a job number. All other parts, such as the wing assemblies, middle pieces, outer parts of the wing assemblies, tail empennage, the engines, and fixed installations were treated as individual parts for repair independently of their job number.

Both methods of repair operation called for a large expenditure of labor by skilled personnel, in contrast with the manufacture of new aircraft by the belt assembly or integrated processes systems. The lack of skilled personnel caused by inductions for military service and the expansion of the aircraft industry during the war finally led to the development of a system permitting the large scale use of semi-skilled and unskilled labor.

After a thorough analysis and breakdown of the various work processes, similar to the system in use for serial production, the most favorable solution proved to be as wide a decentralization as possible of aircraft repair work, with a simultaneous concentration or centralization of the manufacturing processes.

For repair purposes, the complete aircraft was broken

461 down into its main construction units, and a central repair workshop was employed for each such unit, such as the power unit, the tail empennage, the wing unit middle piece, outer parts of the wing unit.

Quite apart from the fact that this system made the employment of semi-skilled and unskilled personnel possible, it resulted in an extraordinary saving in man power hours, and made the installation of assembly lines possible.

Under this system the number of unskilled personnel employed, for example on the repair of He-111 aircraft, mounted from 15 to 40 percent, that of foreign personnel from 18 to 43 percent of the total number employed. Also in the case of the He-111 the number of repair jobs completed increased by 11 percent in 1943 over 1942 performances. The man-power hours expenditure was reduced, and the time planes were under repair dropped by 50 percent. The man power expenditure per aircraft repaired sank from 13 000 to 9 850.[1] Similar results were obtained in the repair of other types of aircraft.

This application of serial production methods to repair operations presupposed the availability of the same installations and gages as those used in the manufacture of new aircraft to insure exchangeability of parts between aircraft coming from serial production and those coming from repair.

1. See "Tätigkeitsbericht des Arbeitsausschusses F6a 1942-43."

462 In constructing the installations, gages, and so forth needed for a new model going into serial production, an extra set was construted at the same time for each intended repair shop, so that this requirement caused no difficulties. Furthermore, the necessary skilled and leading personnel in the repair workshops were given a course of training through employment in the serial production processes and also in the processes involved in all modifications introduced. This insured that the responsible main repair shop for any one aircraft ~~XXXXXXXXX~~ model would be able to manufacture any spare parts needed after the model went out of serial production.

In the case of engines, matters were more difficult. The repair branches of the manufactruing firms, which existed up to about 1939-40 were able to rely largely on the machinery

463 used in serial production. To have equipped the engine repair shops with the changing types of special tooling machines needed for each new engine model would have been too costly. When a new engine model came into service, the continued use of the model it replaced made it impossible to turn in engines of the old model to the repair workshops, as was the case with aircraft. The manufacture by a repair workshop, of spare parts needed for the repair of an engine model no longer in serial production was thus not possible. When serial production of an engine model ceased, spare parts therefore had to be available in such

463 large amounts that adequate supplies for the repair shops within Germany and for the field and unit repair shops would be available. This restricted the work of the engine repair shops largely to the exchange of damaged parts, smallscale retooling of parts, and the stripping and reassembling of engines, and test-bench tests.

The units of spare parts needed for basic overhauling were held at the repair shops in Government storage and issued to the firm as required.

Retooling jobs in the repair shops were approved subject to the conditions that no changes were to be made which would prevent future use of standard spare parts from the normal units of spare parts supplies. For example, to rebore a cylinder was permissible only if the corresponding oversize pistons and piston rings were available.

464 Just as was the case with aircraft fuselages, cannibalizing of engines was dependent on the ratio of the cost of repairs to the cost of a new engine. Another deciding factor here was the number of aircraft in service using the ~~XXXX~~ model of engine involved.

In addition to the above arrangements, individual works were engaged to repair engine accessories, such as cylinders, magnetos, carburettors, injection pumps, fire control equipment, and aircraft propellors.

464 The inadequate experience data available for the planning of repair capacities during the first few years undoubtedly led to the creation of too large capacities for peacetime purposes. It was therefore not possible to guarantee employment for all repair shops simultaneously. This applied in the case of aircraft as well as engine repair shops. In some cases this resulted in serious difficulties. During the war, however, the excess capacities available proved an advantage.

Unfortunately, few records are available at writing on the volume of work turned out by the aircraft and engine repair workshops. In contrast with engines the number of aircraft repaired was always lower than the number manufactured. Using the few figures available from records for calculations it appears that repaired aircraft totalled between 40 and 80 percent of the numbers manufactured, while the number of engines repaired, in contrast, totalled 1.25 the number coming out of serial production. This large difference was due to the number of hours in operation approved between overhauls. Some of the newer types of engines, for example needed an overhauling after every forty to fifty hours in operation.

The number of engines overhauled monthly on an average was

465 50-70 in 1935
800-1000 in 1939
6000-8000 in 1942-43
12000 in 1944-45.[1]

Field (or forward) repair workshops accounted for roughly 40 percent of these performances.

SPARE PARTS AND ALTERATIONS

1. Spare Parts. Apart from the necessity for proper supplies of new aircraft, engines, and equipment, the operability of field units and the execution of training programs in accordance with plans depended largely on the prompt delivery of appropriate quantities of spare parts.

Unless it was cannibalized, the time an item could remain in the cycle of Industry-Ordnance Offices-Troops-Unit or Field Workshop-Ordnance Offices-Troops depended on personnel considerations and otherwise exclusively on the supply of spare parts.

466 Unit repair hangars could only carry out partial overhauls and minor repairsif they had adequate supplies of spare parts, and the spare parts available also determined the time requirements for basic overhauling and major repairs in the industrial repair shops.

Delays in the manufacture of spare parts resulted inescapably in the disuse of aircraft, engines, and items of

1. See Report by Oberstabsingenieur a.D. Meyer, p. 24.

466 equipment due for an overhauling or needing repair.

The preparation and execution of Air Force General Staff programs thus presupposed, in addition to new production programs, careful planning for, and the timely manufacture of, spare parts. For this reason the Technical Office gave very special consideration to this subject in planning its production programs.

However, the difficulties encountered in this field were far more serious than those encountered in the execution of programs for the serial production of aircraft and engines, and so forth, since the volume of spare parts which would be needed and time for their delivery depended on factors which were in part contradictory and were subject to changes.

The logical solution would have seemed to only place aircraft, engines, and items of equipment in service after the necessary repair workshop personnel had received adequate training and if adequate supplies of spare parts were available. This, however, presupposed detailed experience on the wear and tear to which the individual parts would be subject in operation.

In cases where units or schools received new models of aircraft or items of equipment this experience was not available. Adequate experience on the wear and tear of individual parts could not be accumulated during the short duration of

467 pre-delivery testing. Two alternative solutions were thus possible. The one was, whenever a new model went into serial production, to include in the contract the manufacture of spare parts in specified quantities, accepting the risk of unnecessary expenditures if certain parts were not needed later. The other alternative was to intentionally furnish the troops inadequate supplies of spare parts in order to gather experience while the aircraft were in service.

In consideration for the optimum exploitation of the funds available, the latter solution appeared the more favorable, particularly since it was to be assumed that any parts not used would not be usable in later serial production, because the models for which they were intended were not yet completely out of the development stages. Such parts would thus have been reduced to the value of scrap material.

The risk that aircraft would fall into disuse after a relatively short time in service was thus accepted, but care had to be exercised to insure that such aircraft were not cannibalized by the troops.

468 However, even when experience became available on spare parts requirements after an appreciably long time of service in units, the volume and value of this experience remained subject to constantly changing factors, since consideration had to be given to new development results and the changing

468 purposes for which the aircraft were used. The fact that the continuing development work necessitated restriction to the production of only small series of aircraft here had a very adverse impact on the spare parts situation.

The size and composition of spare parts supply units was also influenced largely by the training status of ground servicing and repair hangar personnel. In view of the rapid build up of the Air Force a uniform training status of such personnel could not be expected. Consideration therefore had to be given to the probability that inadequately trained ground servicing personnel would tend to use more spare parts and do less actual repair work, while more thoroughly trained personnel would use the repair facilities available at the repair and maintenance hangars. The composition and size of spare parts supply units thus had to correspond to these circumstances.

As explained, the continuing development of aircraft models necessitated precautionary planning for spare parts. In addition it was essential to give consideration to the time a model would probably remain in service--when it was likely to be replaced by a newly developed model, in order to avoid unnecessary expenditures in work, materials, manpower, and funds.

469 The volume of spare parts to be provided also depended

469 on the operational plans of the Air Force General Staff, for example, in respect to supplies for tactical air fields and bases for special operations.

As described in the chapter on the repair services, the assumption of responsibility by each main repair shop for the manufacture of spare parts for its specific type or types of aircraft once these types went out of serial production insured the supply of spare parts to units and schools. In all cases there was no possibility for the original manufacturing firms to continue producing spare parts for the models no longer in current production, since their manufacturing facilities were exploited to the utmost in producing a new model. One uncertain factor in planning for and manufacturing these spare parts in the repair shops was that there was no way to predict how long the models in question would remain in service. In some cases models were taken out of service at very short notice, in other cases they came into full use again because of some failure in the new model. Owing to the long lapse between the production and the use of spare parts, difficulties were therefore to be expected in this field.

Apart from troop units and schools, the main repair workshop handling the manufacture of spare parts for an aircraft model also had to take care of the needs of other

469 repair shops handling the same model. Rational repair work by the conveyor belt or integrated processes systems made completely different demands on the composition and size of spare parts supply units than the needs for troop units, since they had to be computed by the standards applicable in manufacturing processes.

Circumstances were more complicated in the case of spare parts for engines. The tooling machinery used in the original factory for the production of engine parts for an engine type no longer in production remained in use for the production of parts for the new model, so that they could not be transferred to the repair workshops. Contrary to the aircraft repair shops, engine repair shops thus could not be used for the manufacture of spare parts. For this reason each factory manufacturing a series of engines was required at the same time to manufacture a quantity of spare parts calculated to meet future needs of the troops and the repair shops after the engine went out of serial production.

Planning for and the manufacturing of spare parts were thus complicated by a number of factors due to widely diverging requirements. Some of these factors were as follows: frequent alterations and modifications in a model while it was in serial production, rendered necessary by new development results; the final size of any series of one model;

470 the differing training standards of servicing personnel with the troop units; the fact that it was not always possible to estimate how long specific models would remain in use by troops units and schools; the unknown and unpredictable requirements of tactical air bases; short notice action by the Air Force General Staff or by the Technical Office to halt a series currently in production; and the requirement to

471 furnish spare parts to the industrial repair workshops. This complicated situation was still further complicated by the requirements for mobilization preparations, which had to be met concurrently with the peacetime needs.

Normal wear and tear determines the peacetime requirements in spare parts, and spare parts kits or units had to include the necessary appliances and special tools, so far as these could be used for only one specific model, while the spare parts themselves had to meet the requirement of easy and quick exchangeability.

In contrast with the peacetime requirements, calculation of the wartime requirements in spare parts had to take into consideration the parts which could be damaged by weapons fire. The spare parts supply kits or units designed for aircraft models and engine models in use at the front therefore had to include primarily entire construction units, such as outer surfaces, tail assemblies, complete engines, under-

471 undercarriages, and so forth.

Furthermore, it was to be assumed that under mobilization conditions personnel would not be selected as carefully as otherwise and that the training periods would be shorter. The composition of spare parts kits therefore had to be adapted to compensate for increased wear and tear and increased breakages.

472 Weapons fire damage, and the fact that training under mobilization conditions would be carried out without any regard for problems of economy, both of these factors would contribute to considerably shorten the life of aircraft. Therefore, replacement calculations had to be based less on wear and tear losses than on the replacement of entire construction units instead of individual parts, or on the replacement of entire aircraft, engines, and equipment outfits. This in peacetime turn meant that the replacement or spare parts kits, which were calculated to replace parts damaged through wear and tear, would for the greater part be unsuitable under mobilization conditions.

In the case of spare parts kits procured against the eventuality of mobilization extreme care therefore had to be exercised to insure that any surplus was used in the manufacture of new aircraft before the model involved went out of serial production. However, there was no possibility to

472 predict mobilization so far ahead that the time available for arrangements would correspond to the time a model would be in serial production, while it was possible that the construction units stockpiled as spare parts no longer corresponded to modified units used in a later part of the series involved. The risk therefore had to be accepted that a large percentage of the stockpiled spare construction units and individual parts would become unusable and have to be scrapped.

It was a responsibility of the Supply Office and the Technical Office to make the proper decisions in these matters with proper regard for the current international situation.

In execution, the spare parts procurement programs both before and during the war failed to meet the various, and sometimes conflicting, requirements. During the first stages of the Air Force build up the Technical Office, because of its complete lack of experience on the subject, had endeavored to determine the quantitative requirements in cooperation with the industry, and to include these requirements in its procurement programs. From the outset approximately 25 percent of the available producing capacity was reserved for this purpose in all calculations. This measure proved only partly effective, however, since the categoric insistence of the Air Force General Staff that the constantly expanding programs should be met made it inescapably necessary to use

473 in the current series items manufactured originally for stock-piling as a spare parts reserve. One thing which compelled the industries to do this was the fact that they were unable to expand their manufacturing capacities fast enough to keep pace with the growing demands of the Air Force General Staff.

For the above reasons, spare parts for a model newly placed in serial production were almost always only delivered after the usual initial difficulties had been removed. The specified deliveries with the twelvth and thirtysixth aircraft of a series were never made in full.

The seriously critical shortage of spare parts in troop units and in the ordnance depots due to these circumstances was made even more serious when new models went into production. In most cases a modxl went into serial production at a stage when only the first phases of its tests were completed. This made subsequent, and sometimes quite substantial, modifications necessary, which resulted in delayed deliveries of both aircraft and spare parts from serial production. It was only natural, furthermore, that servicing personnel had not adequate experience in the servicing of a newly introduced model, so that the operability of units was bound to suffer.

These circumstances finally made it compulsory to integrate in detail the manufacture of spare parts with the

474 appropriate procurement programs. Practice had shown that it was not possible to maintain a precise check of deliveries consisting of innumerable detailed items. The new arrangement was based on the size and itemized content of spare parts kits, for which special procurement programs were compiled parallel with the programs for the procurement of new aircraft.

Experience data from the first years of the Air Force build up served as a basis in determining the itemized contents (or the composition) of the spare parts kits. According to content the kits were classified as T-1, T-2, and N spare parts kits, and Class 1 and Class 2 equipment and tools kits.

The T-1 and T-2 spare parts kits contained the spare parts supplied to squadrons and larger units as Table of Equipment supplies for a period of approximately four weeks. The T-1 kit contained wear and tear parts plus servicing accessories; the T-2 kit contained the parts needed for the repair of minor damages which could be handled by the troop units.

475 The N kits were designed for delivery to the resupply depots, and were to serve as a mobilization reserve and as supplementary to the T-1 and T-2 kits.[1] In addition, the N kit included complete construction units, such as wings and

1. See Letters Oberstabsingenieur a.D. Abel, 14 April and 2 July 1958.

475 tail empennages designed to serve the needs of two to three groups for a period of four to six weeks. The Class 1 and Class 2 equipment and special tools kits were delivered in numbers commensurate with the number of fuselages delivered, and their size was established for each type involved.[1]

This method of specifying the contents of the kits and the number and time of their delivery improved the spare parts supply situation of troop units and the various supply depots, but although the itemized content of the kits was revised from time to time in the light of new experience, all efforts to completely remedy difficulties in this field failed.

The manufacturing firms continued to offer various excuses for short deliveries of spare parts kits, such as the necessity to introduce modifications, unavoidable delays, laterdeliveries from their sub-contractors, materials supply and personnel difficulties, but in most cases the short deliveries were due to their having used the spare parts to meet their deadlines for the delivery of complete aircraft or engines, particularly since the delivery of engines was the basis for financial settlements.[2]

476 The experience of the Air Force units committed in ac-

1. See "Bericht Oberstabs-Ing. a.D. Belter ueber grundsaetzliche Betrachtungen zum Beschaffungsgang," pp. 14, ff.
2. See "Besprechung Oberstabs-Ing. a. D. Diedrichs mit den Dornier-Metallbauten v. 22. 5. 1937."

476 action during the Sudetenland crisis of 1938 confirmed how untenable the position was in the matter of spare parts. Quite apart from the lack of reserve engines, the fuselage and engine spare parts available for the new aircraft models in service would in no way have been adequate to meet the demands of warfare for longer than four months at the utmost. In numerous cases firms had exceeded their delivery deadlines. Furthermore, when there was a sudden increase in the wear and tear of sensitive parts, it proved impossible within a short time to create a reserve. Current deliveries from the industries had been inadequate to keep all aircraft in service operable.[1]

Besides having to specify the contents and size of spare parts kits and the number of kits to be delivered, attending to their procurement and planning for their manufacture, and insuring that deadlines were met, the Technical Office because of the conversion of aircraft repair work to integrated processes production methods also had to keep the industrial repair workshops supplied with spare parts, had to allocate the work by contracts, and had to supervise the execution of work in accordance with those contracts.

The whole complex of spare parts supplies had thus assumed such proportions that the staff available to the Tech-

1. See "Erfahrungsbericht ueber die Aufstellung der Luftwaffenverbaende im Januar 1939", Chef des Technischen Luftzeugwesens Nr. 3365/38 geh. Kdos. vom 5. 11. 1938.

476 Technical Office was too small to cope with it. Furthermore, the mission of the Technical Office, as a technical branch of the High Command, was not to direct the fulfillment of contracts in all details. Furthermore, the situation in this field had become exceedingly complicated in 1939, since the large number of specific aircraft models and their variants simultaneously in service, and the consequently small series of each produced, created such confusing circumstances that it was no longer possible to gain accurate insight.

The organizational setup in the Office of the Chief of Air Force Special Supply and Procurement Service was such that development projects always received preference, and automatically, less attention was paid to the subject of serial production. This may have contributed in some measure to the confusing situation, but the greatly increased demands made on the Office and its organization were entirely disproportionate to the staff available to handle them.

For these reasons, the whole complex of spare parts supplies was turned over to a newly established concern, the Gesellschaft fuer Luftfahrtbedarf m. b. H. (Aviation Requirements Company, Ltd) operating out side of the Office of the Chief of Air Force Special Supply and Procurement Service as a subsidiary of the Bank der Deutschen Luftfahrt (Aero-Bank).

The most important missions of the new concern were

477 to procure the spare parts kits for the troop units in accordance with instructions from the Technical Office, to supervise the execution of spare parts manufacturing contracts in accordance with specified deadlines, and to furnish XXXXX individual spare parts and spare construction units to the repair industries.

This last mission included:

478 Registration of the spare parts stocks available in depots

Storage and administration of spare parts stocks

Deliveries to the repair workshops

Computation of spare parts requirements on the basis of parts actually used by the repair works

Planning and execution of relocation of depots when necessary.

In addition to the above, the concern assumed responsibility for the administration of Government funds, etc., for the repair industry and the cataloging of all such funds and property, for repeat orders for ~~xxxxx~~ spare parts and the allocation of the contracts involved, and the disposal of surplus stocks and captured stocks.

Establishment of the new concern also made it possible to clarify the financial circumstances in the repair works. Since each of these works handled at least two models and in most cases more, their funds were inadequate to maintain the necessary stocks of spare parts required in their repair operations. The new concern now assumed responsi-

478 responsibility for the maintenance and administration of such stocks. This relieved the strain on the workshops and made more rationalized operations possible. In addition, it avoided the difficulties which in the past had developed with the Office for Industrial Economy when accounting for stocks of spare parts for aircraft and engine models no longer in service.

The Aviation Requirements Company compiled and maintained current a catalogue of all spare parts stocks held by the various repair workshops and placed all necessary requisitions to maintain these stocks at proper levels. Success was thus achieved in obtaining a survey of the stocks available, but the reduction of the large stocks in existence which the Technical Office had expected did not materialize.

The value of the spare parts under contract for manufacture alone totalled 1 900 000 000 Marks in 1940, and this figure was entirely disproportionate to the number of aircraft in existence.[1]

The large number of individual models and their variants in existence, which must be estimated at 200, the short time the individual models remained in service, and the small series manufactured in each case made a completely satisfactory control of all spare parts and reliable estimates for

1. See Letter "Staatssekretaer der Luftfahrt und Generalinspekteur der Luftwaffe Gst Nr. 954/41 Geh. Kdo. vom 4. 9. 1941 an GL."

their manufacture impossible. The establishment of the new concern thus did not insure satisfactory supplies of spare parts to the various repair workshops in spite of the fact that it resulted in largely increased stocks.

As part of the policy of transferring responsibility for important technical functions to the industry in 1942, most of the technical functions of the Aviation Requirements Company passed to the various Main and Special Committees. However, this brought about a dissipation of effort, since the various special committees handling spare parts among their other fuctions acted independently of each other. This
480 organizational change thus brought no improvement.

Investigations by the Technical Office revealed that some of the innumerable agencies now in control were scrapping certain spare parts which at the same time were being manufactured under instructions from some of the other agencies.[1]

New plans therefore had to be made to obtain a better control over the production of spare parts. The outcome was the adoption of recommendations by Special Working Committee F-3-a[2] under Director Kalkert. These recommendations provided for better control by means of a Spare Parts Disposition Index to compute and establish the parts to be stocked for

1. See "[illegible] v. 31. 7.1944," p. 24 of Excerpts.
2. See "Zwei. Teilbericht des Arbeitsausschusses F-3-a I942-I943 vom 2. 1. 1944."

480 military and industrial requirements with the object of compiling spare parts stock catalogue. The latter was to serve as a catalog, its sheets being used as a specimen for report sheets on stocks held and stock movements, and at the same time as a standard form for requirements reports from the repair industry. It was thus to serve those responsible for planning in the Working Committee as working data in computing the spare parts requirements of the repair workshops.

Unfortunately, the new system was only introduced in 1944 and the war ended before experience could show how effective it was. However, it did presuppose the availability of experience with the aircraft and engine models involved. When new models were introduced, the data provided by the system could serve only as a rough guide.

481 In summarizing it can be said that it is essential to insist from the outset of aviation activities on the timely supply of adequate supplies of the proper assortments of spare parts as a fundamental requirement for the maintenance of troops at the highest possible degree of operability. This principle did not receive the proper attention in Germany, neither during the build up of the German Air Force, nor during the war.

In spite of repeated warnings by the Technical Office the pressure caused by the demands of the Air Force General

481 Staff made it necessary to use in the production of increasing numbers of new aircraft the parts intended as reserve supplies.

The commitment of identical aircraft models in the widely separated theaters of operationsand the diversified purposes for which they were used, plus the necessity to introduce minor and major modifications and alterations while a model was in serial production, created such difficult conditions in the field of spare parts supplies that it was not possible to satisfy the needs of the troops and the repair industries and services.

These circumstances not only reduced troop unit operability but also had an adverse impact on industrial output. The manufacture of large quantities of spare parts which were not used and had to be scrapped later tied down manufacturing capacities which were thus lost for the production of new aircraft. In like manner the man power hours and materials thus used were wasted.

482 For all these reasons the efforts to remedy these difficulties by means of organizational changes weredoomed to failure from the very outset.

2. Modifications and Changes. The necessity to build up an air force practically from the very foundations and, because of Germany's military and political position, at the

482 same time to give it aircraft and other equipment at least equal with or if possible superior to that of the air forces in adjacent countries, logically entailed the disadvantage that modifications to aircraft and equipment would become necessary while they were in production or even after their delivery to the troops.

The German air force command knowingly accepted this disadvantage. The system of placing newly developed aircraft, engines, and other equipment in service before they were completely tested produced certain advantages, among them a measure of superiority over other air forces. As long as it was expected that Germany would not become involved in any major war, these advantages outweighed the disadvantages accruing from the necessity to carry out later changes, delays in execution of procurement programs, tactical reverses in combat, and difficulties in supplying spare parts to front line units.

Since most of the models used for the first phase of the main rearmament program had already been thoroughly tested before 1933, the changes which became necessary during their serial production did not cause any seriously noticeable disadvantages. Such alterations were usually merely a correction of errors detected in the construction data.

This changed with introduction of the models adopted for the second phase of the rearmament program. Practically

485 all of these had been developed after 1933, and some of them were delivered to the troops already approximately three years after development commenced. Since they had not been completely tested before going into serial production it was essential, as pointed out previously in this study, to incorporate the experience gained while the series was still in manufacture.

The volume of work involved in the minor and major modifications becoming necessary because of the continuing development of aircraft, engines, and items of equipment gradually assumed such proportions that the necessity arose to subdivide the procurement programs into small series.

This method could be considered justifiable under peacetime conditions, but the number of alterations to be carried out should have been radically limited as soon as it appeared possible that the units might have to carry out operations under mobilization conditions. Germany's geographical position and economic situation called for a maximum and uninterrupted exploitation of all materials, personnel, and manufacturing potentials available. The Air Force General Staff, the Technical Office, and the Chief of Air Force Special Supply and Procurement Service therefore had all three at an early stage introduced measures to insure an orderly

434 handling of all recommended changes commensurate with their importance.

The basis for these measures was provided by an Alterations Processing Plan (Aenderungsgang)[1] drafted by the Technical Office, which regulated the flow of alterations requests from all channels through the various stages of examination, testing, and approval, the methods for establishing priorities, stating the nature of the change and the work involved, and procurement of the necessary materials for the alteration.

The time at which the change was to be introduced was regulated by priority classes. Alterations awarded Priority Zero involved vitally important changes and therefore had to be introduced immediately. Until they were incorporated, the equipment involved was withheld from service.

Priority 1 meant that the change was to be introduced as soon as the necessary parts became available. Priority 2 changes were to be made at specified times, for example when an aircraft came in for a partial overhauling, a basic overhauling, or for repairs.

434 All other recommended changes, after approval, were to be introduced if a new series went into production.

1. See Report "Der Reichsminister der Luftfahrt und Oberbefehlshaber der Luftwaffe, Generalluftzeugmeister GL 6 Nr. 1885/41 vom 4. 7. 1941," and "Der Reichsminister der Luftfahrt und Oberbefehlshaber der Luftwaffe St-GL Nr. 1664/42 (C/TT) vom 14. 7. 1942."

485 The parts rendered necessary by instructions concerning the introduction of an alteration or of alterations were forwarded to field units and other appropriate points as alteration kits through normal supply channels. Any confusion as to the execution of the work involved, and any misunderstanding by the field units, schools, etc., were avoided by the fact that the priority class, as Priority 1 or Priority 2 was only issued after the necessary parts for exchange became available.

An Alterations Commission (Aenderungskommission) consisting of members from Branches 2 and 6 of the Air Force General Staff, the Technical Office, the appropriate inspectorates, and the Supply Office decided on all alterations which could not endanger the lives of aircraft crews. This commission was responsible for the proper introduction or the prevention of alterations.

These measures did reduce the number of alteration requests from the various channels, but the time was usually too short for the timely introduction of approved alterations while a series was still under production. The burden of carrying out the changes therefore fell on the field units, but these were not equipped to carry out such work.[1]

486 The commitment of Air Force units in various theaters

1. Excerpts from "Besprechung Goering am 18.3.1941 in Den Haag."

486 of operations usually necessitated reconstruction work of a greater or lesser degree. At times this work of reconstruction was quite comprehensive. Since the troop unit repair hangars or workshops were not equipped to handle such work, and since the aircraft to be reconstructed could not be returned to the original manufacturing firm or the regular repair workshops for the purpose without serious interference with their current operations, Transit Depots (Schleusen) were established for each air fleet.

The mission of the Transit Depots was to carry out the various alterations previously referred to; to carry out any reconstruction work to adapt aircraft for other climatic conditions when a unit was transferred from North to South, or East to West, or vice versa; to carry out any special work they might be order to do by the air fleets; and to requisition aircraft for purposes other than those they had been employed at in the past.

The introduction of modifications not incorporated by the manufacturing firms presupposed the maintenance of records for each aircraft and each engine in service. This record had to show the structural condition and serve as a working basis for the Transit Depot.

This measure avoided the necessity for the exceedingly time-consuming and laborious process of dismantling and

detail examination to determine construction details of each aircraft. However, much effort had to be expended at the manufacturing firms before the service records for aircraft were properly maintained.

The establishment of transit depots proved a factor of special significance in providing support for night fighter operations,[1] and for the Second Air Fleet in Italy.

Since it took three weeks to properly adapt an aircraft for night fighter operations, and since a workshop could only handle one aircraft at a time, the Guetersloh and Werl Transit Depots were designated for this specific purpose.

Since it was impossible during winter or bad weather to transfer fighter aircraft by air to Italy without seriously endangering crew and aircraft, the Muenchen-Riem Transit Depot was designated to support such movements and to adapt all aircraft for commitment in Italy.

The purpose of introducing changes in accordance with the three established priority classes; of incorporating experience gained through development and testing activities while a newly adopted model or variants of an existing model were under serial production; and of carrying out the reconstruction work necessary for the various theaters of operations or to adapt aircraft for purposes other than those they had originally been intended for, was to insure the

1. See "GL.Besprechung beim RM am 8. 2. 1941.

487 supply of aircraft of the highest possible degree of operational value to the troops . In the interests of the conduct of the war as a whole it was of the utmost importance to implement all measures serving this purpose as speedily as possible.

488 That the volume of work caused by the alterations and reconstruction for this purpose assumed such proportions that one could in reality no longer speak of normal serial production, which was replaced rather by continuously changing improvizations, was not due to technical difficulties or faulty planning, but exclusively to the constantly changing dispositions made by the higher command.

Efforts to meet these changes by means of special projects perforce lessened the normal manufacturing performances because of the drain on valuable leading personnel and materials.

It is possible that it might have been feasible to reduce the number of changes and reconstructions necessitated by the fluctuating operational objectives, but this would not have brought about any basic improvement.

Apart from what has just been said, the volume of changes and modifications was strongly influenced by the commands committed in the theaters of operations, whose desires for changes were expressed in alteration requests from the

488 various arms inspectorates, although these were fully aware of the effects of such measures because of their contacts with the Office of The Chief of Air Force Special Supply and Procurement Service. In this action they were apparently following instructions from Goering, who considered that direct con-

489 sideration must be given to experience gained in actual operations at the front, and that direct contact must be maintained with the front line units.

Almost all such requests were based exclusively on the personal opinions of individual field commanders endeavoring, independently one from the other, to influence the development of aircraft. This caused seriously contradicting views which enabled the firms to do much as they wished and play off one authority against the other, which became particularly evident during development of the Me-210 and He-177 aircraft.[1]

The powers of authority given by Goering to front line officers was obviously due to Goering's ignorance of technological matters and his distrust of technological personnel, and particularly of engineer personnel, who had to base their designs and other work on what was technologically feasible, which usually did not coincide with Goering's concepts.

1. See Report by General-Major Grabmann a.D.; Report by Diplom Ingenieur Utecht, responsible for supervision of the He-177, who writes as follows: "It was somewhat strange how some of the alterations were caused. From the end of 1942 on, for example, front line officers appeared at intervals, with authority from Goering, at the factory and decided on changes allegedly based on the latest combat experience. On principle, each of these officers undid what the one before had done. The outcome was that the firm could not handle all the alterations and within a few months became completely confused."

489 The officers thus empowered by Goering necessarily were completely unaware of the directives given by the Technical Office or of the latest technological principles involved.

490 Unfortunately, it is not possible to establish from the records available at writing how many individual alterations were introduced in the individual models of aircraft. It can be assumed, however, that their numbers ran into thousands in the case of each model manufactured.

Those insisting on introdiction of the alterations requested by front line commands failed to realize that the alteration of one part always necessitated alterations to the adjacent part or parts. In some cases, a relatively minor change necessitated comprehensive reconstruction of a complete assembly unit.

It is also no longer possible to establish the amount of labor and material expended on the unknown number of changes made. It is definite, however, that when an aircraft was under serial production these expenditures caused serious disruptions and a considerable wastage of materials, and thus seriously reduced output.

CONSTRUCTION SUPERVISION AND DELIVERY ACCEPTANCE PROCEDURES

In accepting delivery of normal products of industry, the spirit of competition between the various industrial

490 manufacturers of such products provides adequate guarantee for the quality and priceworthiness. Unless general safety is involved, special tests of such products are not necessary and not usual practice.

491 Products required to meet established safety standards or which have to meet other special requirements are subject to inspection regulations for the enforcement and supervision of which industrial organs, such as the various industrial societies established for the purpose or official authorities are responsible.

In the case of general machinery, the established standards require that each part must be able to withstand five times the stress and strain to which it might become exposed, so that here calculations and proper functioning provide adequate proofs.

Matters are more difficult in the field of aircraft construction. In contrast with all other industrial products, it is only possible here, because of the performance:dead weight ratio required, to reckon with a safety factor of 2,or 1.8 in the case of the maximum strains and stresses.

This necessitated a far more comprehensive and thorough testing of all manufacturing materials used in aircraft construction, since flaws in the materials used would constitute a grave risk for the aircraft crews no matter how

491 carefully and accurately the construction data may have been calculated.

To have tested the materials and the individual parts at the point where the final assembly took place would have required too large an expenditure in highly valuable skilled man power, and furthermore would have or supposed large and complicated and costly installations for the purpose. Furthermore, detection of flaws in a material at this point would have come too late to avert the heavy transportation costs and possibly of effort expended in manufacturing parts.

The outcome of the desire to avoid these disadvantages was that thought was given to testing the materials at the source, the materials manufacturing installations. The advantage here would be that faulty material could be detected at an early stage and, if necessary, excluded from further use in manufacturing processes.

For example, an analysis of each charge going into an oven or retort at the original raw materials works insured that the basic products used for the material were sound and insured that the material furnished for finished and semi-finished parts would be sound. At the final assembly point it was then only necessary to inspect and test samples at random, which secured much faster processing.

The obvious advantages of such a system influenced the technical office in 1934 to recommend to the Federal

492 Association of Aviation Industries (Reichsverband der Luftfahrt industrie) that it should established its own testing and approving organization at the points of materials production.[1]

This transfer of responsibility for raw materials and semi-finished products to the industries also served to relieve the burden, both in respect to personnel and work considerations, considerably for the Technical Office.

The materials approving organization of the Association of Aviation Industries included primarily all firms participating in supplies of steel, light metals, plywoods, and fa-

493 brics of their own manufacture to almost 600 firms of the aviation and subsidiary industries.

The introduction of this materials testing and approving system naturally encountered resistance during the initial stages from both the raw materials producers and the factories of the aviation industries. The former feared that their experience might be leaked to competing firms, the latter distrusted the activities of the approving organization and feared adverse repercussions on their output.

The advantages of the system became obvious at a xxxx relatively early stage, however, and resulted in full recognition and full support for the approving organization.

1. See Report Diplom-Ingenieur Weitzmann of the Reichsverband der deutschen Luftfahrtindustrie.

493 Up to the outbreak of the war the German aviation industries could thus rely on a materials approving organization which gave them valuable support in the execution of their expanding mission and saved them valuable personnel.

The approving engineers stationed at the various raw materials producing works were organized regionally under 4 regional chiefs, one chief for each class of raw material involved. All regional chiefs for any specific class of material, such as iron, aluminum, etc., were controlled by a branch chief, in turn responsible to the director of the entire organization. Besides his responsibility for the technical and administrative supervision of the whole organization the mission of the director was to maintain contact with

494 the Technical Office of the Reich Air Ministry; the accepting organs of the Army, Navy, and Air Force; the firm of Germanische-Lloyd; the German Bureau of Standards, and the various associations of the manufacturing industries.

The number of testing and approving engineers stationed with 300 basic materials producing works mounted by 1943 to 200.

When the volume of work increased to such proportions that the number of additional approving engineers could not be procured because of the general shortage of engineer personnel, the directors of manufacturing materials branches in

494 reliable basic materials works necessarily had to be required to accept responsibility within the scope of the program to transfer as many responsibilities as possible to the industries This released the engineer personnel of the testing and approving organization to perform other missions for the aviation industries besides their remaining mission of supervision. They were employed now primarily in special missions for the engine manufacturing industries, for example, to test and approve castings. Later, they were responsible for the approval for acceptance of the materials and castings used in the manufacture of V-2 weapons, acting under instructions of military authorities. In the occupied territories they were able to render valuable services as advisors to the armaments detachments in addition to their own responsibilities.

The activities of these engineers of the materials testing and approving organization simplified considerably the task of testing materials in factories of the aviation industries. These could now restrict themselves to manufacturing materials research, to sample tests, and to measures to detect in time any possibility of mistaken shipments.

495 The systematic accumulation of all results achieved by the materials testing approving personnel provided reliable insight into the actual features of the various materials.

The organization was not bound by any official regulations and could

495 regulations and could readily adapt to any changes in the composition of manufacturing materials made necessary by materials shortages and could determine the results of these changes, since the regulations governing their activities were based on private agreements between the users, producers, the accepting organizations, and the Air Force Technical Office.

The results gained through the high frequency with which tests were repeated furnished a valuable source of information for a continuing improvement of aircraft manufacturing materials and delivery conditions.

Statistics were maintained on complaints and showed, for example, that of the various steels tested 0.9 percent were faulty in the first few years. In 1940 this percentage dropped steeply to only 0.15 percent and remained at this level until the end of the war. Most of complaints received were due to external damage, to mistakes made during transportation, or to faults which only became evident during processing of the material involved.

496 According to all the evidence available it appears that no accidents were provenly due to faulty manufacturing materials.

In summarizing it can be said that while the testing and approving organization of the Federal Association of

496 Aviation Industries remained in existence, and particularly during the war, it proved extraordinarily valuable. In contrast with conditions in the case of the Army and the Navy, it greatly simplified working procedures in the Technical Office.

The experience data accumulated by this method was applied in the manufacturing and processing of aviation materials, and the delivery conditions compiled at the time today still serve as the basis for delivery contracts.

Transfer of the responsibility for manufacturing raw and semi-processed materials to the testing and approving organization made it possible to restrict the activities of the construction supervisors appointed by the Technical Office and/or the Office of the Chief of Air Force Special Supply and Procurement Service to supervision of the factories manufacturing or assembling the finished article in the production of aircraft, engines and equipment.[1]

The responsibilities of the Construction Supervisors were formulated in a "Service Regulations for Construction Supervisors of the Reich Air Ministry (Dienstanweisung fuer die Bauaufsichten des Reichsluft-Ministeriums) the 1 August 1940 version of which established these responsibilities and regulated the various phases as follows:

As direct representatives of the Reich Air Ministry

1. See Report Oberst-Ingenieur a.D. Waldemar Zyretzky.

497

tthe Construction Supervisors are appointed at installations of the armament industries with responsibility for all technical matters in the execution of contracts. Their activities therefore are not restricted to supervision of the construction of equipment ordered by the Government and to the acceptance of such equipment, but include the following missions:

To advise the technical subdivisions of the Reich Air Ministry on all development problems;

To advise the firms on all problems involved in the execution of Reich Air Ministry contracts;

To carry out sample tests;

To handle approved acceptances;

To handle approvals;

To report the completion and deliveryof equipment and its acceptance by other authorities of the Air Force;

To cooperate in

The incorporation of alterations during serial production;

Supervision;

The authorization and appointment of factory staff members to accept Government equipment;

The maintenance of records on the whereabouts of scrap and used oils;

497 The administration of Government-owned equipment;

The storage and issue of weapons and ~~XXXXXXXXXX~~ammunition;

The pre-examination of requests for manufacturing materials supplies;

The preexamination and indorsing of invoices for the Reich Air Ministry;

Supervision of delivery programs and reports on the procurement situation;

498 Supervision and approval of repair work;

Advice and support to manufacturing firms in all matters of procurement and construction projects;

Dispatch of mechanics, riggers, etc., for off-post assignments and indorsement of their invoices;

The issue of military bills of lading;

Supervision of construction and approval and acceptance of aviation products for civilian and export purposes by authority of the Aircraft Inspection Bureau (Pruefstelle fuer Luftfahrzeuge).

Within this whole complex of missions, main emphasis was on precautionary action supporting the Technical Office by recognizing and reporting in advance any difficulties to be expected in the execution of procurement programs. This mission was highly important during the build up of the aviation industry, but even far more so immediately prior to and during the war. In view of the lack of man power, materials, and tooling machinery, difficulties arising from inadequate

498 cooperation within the various cartels would have interfered with manufacturing and caused serious delays in the delivery programs unless timely action was taken by the Technical Office.

Besides this, it was necessary to detect and resort to the Technical Office if any of the firms management were following the interests of their own firms if the possibility existed that this was liable to harm the programs in any way. Everything which had a bearing on manufacturing activities had to be watched closely, arbitrary changes by the firms had to be prevented, and deviations from the specifications had to be examined and approved or disapproved.

The proper performance of the responsibilities assigned to construction supervisors presupposed not only thorough vocational qualifications but also personal experience in the technical processes and problems of manufacturing, ability at negotiating, and a strong character, all of which were needed to enable the construction supervisor to develop a personal opinion on the technological status and the processes and happenings within the firms involved.

Even in 1933 there was already a great shortage in qualified aviation engineers, so that it was exceedingly difficult to find suitably qualified personnel for these posts, and the situation was far worse, in this respect, during the war.

499 The only possible solution was to train new personnel with assistance from those already in such positions for a number of years. However, new personnel had to be found who had a thorough knowledge of aircraft and engine construction.

Organizationally and functionally, the construction supervisors and approving and accepting engineers were consolidated under the Central Construction Supervision Branch under the Technical Office. This branch was organized in subdivisions for aircraft and ~~ENGINEERING~~ engine construction.

RADIO AND NAVIGATIONAL EQUIPMENT; GENERAL EQUIPMENT; AIRCRAFT WEAPONS AND AMMUNITION; BOMBS AND OTHER AIR DROP AMMUNITION; TORPEDOES AND GUIDED MISSILES; GROUND EQUIPMENT

The constantly expanding programs, the employment of new and the expansion of existing factories during the war, and the increasing number of separate installations of the individual firms caused by the decentralization of manufacturing processes seriously increased the burden on personnel of the construction supervising system. Although their numbers were increasedthey were no longer able to cope with this load of work, and the only solution was to train and use appropriate master artisan personnel as testers.

The expansion of manufacturing activities to factories in the occupied territories of France, Poland, Belgium, Holland

500 Denmark, Norway, Czechoslovakia, Russia, Greece, and Yugoslavia meant that construction supervisors had to be assigned also to these foreign factories. In fact, the need was even greater for them in such factories, on the one hand because these factories had to support the various German air fleets, and on the other hand because of the risk of sabotage.

This naturally decreased the number of construction supervisors available in German firms, so that finally it became necessary to transfer responsibility for testing to factory control personnel, as had been done in the case of the approving and accepting organization of the Association for Aviation Requirements.

501 Another purpose of this measure was to employ the construction supervisors in a larger measure to determine the difficulties arising in connection with the execution of programs caused by the deteriorating military situation.

In transferring testing responsibility to the factory control personnel, the Technical Office had to accept certain risks, since these personnel were employees of the firms concerned and were thus completely dependent on the firm management, to whom they were responsible.

However, a system was devised to furnish them temporary official testing licenses, after they themselves had been carefully tested, and this withdrew them from control by their

501 managements and placed them under very strict laws so far as their testing responsibilities were concerned. This was necessary because in cases of doubt they would have had to decide either against their firms or against the construction supervisors, to whom they were also subordinate.

This measure proved exceptionally sound. The firms were now compelled to pay even more attention than before to the quality and good workmanship of their products in order to avoid having their own factory personnel reject parts. The construction supervisors could thus restrict themselves to sample tests, or spot tests.

502 Later in the war the Technical Office found itself compelled to go even further in this system of relieving the construction supervisors by using reliable specialists to test the products of their own factories, or their own work. Although this was equivalent with recognition of the performances of individual personnel, it was only an emergency measure symptomatic of the extraordinary difficulties existing in the personnel field.

The decentralization of factory operations in regionally separated installations had created confusing circumstances for the individual construction supervisors in the execution of their mission of supervision and of insuring uniform processes. The individual construction supervisors in the va-

503 various installations of a manufacturing firm were therefore placed under a chief construction supervisor stationed at the parent factory, who controlled and supported them.

In spite of all organizational and personnel difficulties it can be said in summarizing that the system of employing construction supervisors, used by the Technical Office in contrast with the organizational set up in the case of the Army and the Navy, proved sound in every way. It reduced personnel expenditures to roughly one-tenth of the Army requirements.

The appointment of specialized engineer personnel to most of the positions, and particularly to positions of control, placed men with a detailed knowledge of and experience in the necessary fields in control and thus provided a guarantee for the delivery of sound aircraft and equipment, which met all technical specifications, to the troops.

The simultaneous appointment of the chief construction supervisors as field agents of the Technical Office to watch over and report on everything connected with the execution of contracts and to detect and report anticipated difficulties, in many cases enabled the Technical Office to remove obstacles before any harm was done.

The measures taken to secure the highest possible status of constant operability of field units by insuring that construction uints and parts were readily exchangeable, without

503 any regard for the manufacturing firm, namely, regardless of whether the aircraft or part was manufactured by the factory which had developed the model or by a firm manufacturing it under contract, imposed exceptionally high standards of precision in the various installations and gages used. The construction supervisors made periodical tests by exchanging parts from aircraft manufactured by different firms, but of the same model, but this did not appear an adequate guarantee for general exchangeability of all parts throughout a series and in the case of replacement parts manufactured by the repair workshops. The gages and other processing and checking appliances used in the various installations were naturally subject to wear and tear, and there was always the risk

504 that differences would become so great from a certain stage on that the parts coming from different installations would no longer be exchangeable.

This would have jeopardized the operability of combat units, and in order to avoid anything of this sort happening the construction supervisors from time to time checked and compared measurements in all installations against the measurements of master gages in their possession, which were identical with the original master gages, etc.

Because of the high importance of the gages, etc., used in acceptance inspections and of the original gages, etc.

504 and of insuring that the manufactured article would be fit for use, the necessity arose to have a centralized agency responsible for the handling of all such matters. For this purpose the Aircraft Procurement Branch of the Technical Office immediately before rearmament commenced established a Gages Testing Station (Lehrenpruefstelle).[1] Because of the instruments, installations, and so forth required, and for familiarization purposes, the necessary staff first worked at the Gages Testing Station of the Army and then commenced operations in premises at Berlin-Adlershof as a field agency of the Technical Office.

505 The mission of the new field agency was to exert an influence on the construction of gages and similar appliances in line with uniform principles, making use of the experience gained in mutual cooperation, and to control their manufacture. The designing and manufacture of the gages and other appliances was carried out in all cases by the industries themselves. Another mission of the Testing Station was to train personnel for acceptance activities.

The station had modernly equipped premises, with proper air conditioning installations and all gages and other measuring instruments needed, plus XXXXXXXXX mechanical workshops to make particularly important original gages and testing instruments and appliances.

1. See Report by Oberstabs-Ingenieur a.D. Mai.

505 In performing their missions they had to maintain very close contact with the individual development and procurement Branches of the Technical Office, in order to be able to take the necessary measures in time for decisions made concerning models to be placed in serial production, current series to be taken out of production, and alterations to be introduced while a model was in production if these could in any way influence the exchangeability of parts. Furthermore, they had to supervise execution of the appropriate measures in the factories and insure the proper and complete posting of the service history of the various gages and other measuring and testing devices.

Commensurate with the increasing size of the programs to be executed, the number of gages, etc., to be tested monthly increased from approximately 100 in 1935 to 13 000 per month

506 in 1941.

This extraordinarily large increase was due in part to the fact that during the first years of its existence the Testing Station was only able to handle a part of the instruments concerned. In accordance with its growing testing capacities, the staff of the Testing Station mounted from two in 1935 to 200 in 1941.

As a third factor, in addition to the approving and accepting organization of the Association of German Aviation

506 Industries and the system of construction supervisors of the Technical Office, the Gages Testing Station while it operated made a highly important contribution under exceptionally difficult conditions during the war towards insuring the exchangeability of spare parts for aircraft and aircraft equipment and thus towards maintaining the aircraft in service in an operable condition.

SUMMARY

The following factors had a decisive influence on the Procurement programs of the German Air Force:

The reduced stated requirements of the Air Force General Staff because of the reduced military budget for 1937;

Continuation of the peacetime civilian economy during the first two years of warfare;

The failure to place the armaments industries on a mobilization footing;

507 The unfavorable position of the Air Force supporting industries in the sequence of prioritieswithin the whole armaments production complex;

The delayed production of certain important types of aircraft, engines, and equipment;

Difficulties encountered in the development of certain types of aircraft;

Faulty decisions made by the highest levels of command;

In a lesser degree damages sustained by the industrial

507 industries and transportation facilities as a result of bombing attacks.

The interruption of armaments production expansion, which was just beginning to gather momentum, and failure to exploit possibilities which would have resulted from a declaration of mobilization for the economy alone had already caused a serious drop in armaments output and thereby seriously reduced the operability of the combat forces. The unfavorable priorities awarded to the Air Force procurement programs as a whole aggravated matters by delaying development projects and creating additional difficulties in the serial production of air armaments, which delayed the equipment of the troops with newly developed aircraft and equipment and thereby further weakened their striking power.

The delayed production of the He-177 aircraft by a few years caused the lack of the so urgently needed air support for submarine warfare.

The delayed development of the Me-262 jet aircraft, due to Hitler's order to halt all development work, plus the faulty decision to reconstruct the model as a fast bomber, prevented the timely use of this model which could at least have produced better results in the German home air defenses.

508 The impact of other factors on manufacturing activities and on the industrial output require closer study before the

503 influence of armaments procurement on the conduct of air warfare can be clarified. These factors include the difficulties encountered in the development and procurement of engines, general equipment, radio and radar equipment, aircraft weapons and bombs, repair service and spare parts supplies, air torpedoes and guided missiles, and in the fields of materials supplies and man power. The fact that sources are still lacking has made it impossible to treat these subjects here.

APPENDIX 22
Outline Map of Germany

INDUSTRIAL PLANS FOR 1934
(Aircraft Factories)

(I-VII) Concerns manufacturing bomber aircraft

Concerns developing bomber aircraft

Firms producing fighter aircraft

Firms producing reconnaissance and twin-engine fighter aircraft

Firms producing training aircraft

------ Approximate borders of territory designated as "Inner Germany" of the "German Interior."

Scale 1:4 000 000

Appendix 24a
Graph

ARMY LONG-RANGE RECONNAISSANCE AIRCRAFT

Legend.

_____ Authorized strength

------ Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by Chief of Air Force Supply and Administration

\+ At this point the Air Force took over all long-range air reconnaissance.

Appendix 24b
Graph

NIGHT FIGHTER AIRCRAFT

Legend.

_____ Authorized Strength

\- - - - - - - - - - Actual strength (in aircraft)

. . . . . Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Bis 2. Nov. 1940 keine Nachtjaeger

Up to 2 November 1940 no night-fighter aircraft

APPENDIX 24c
Graph

ARMY CLOSE-RANGE RECONNAISSANCE AIRCRAFT
(later Transferred to Air Force)

Legend.

———— Authorized strength

---------- Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration.

AIR FORCE LONG-RANGE RECONNAISSANCE AIRCRAFT

Appendix 24d
Graph

Legend.

_____ Authorized strength

\- - - - - - - - - - Actual strength (in aircraft)

. . . . . Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Bis 28. Sept. 1940 einschl. Div. Fuehrungsketten

The figures given up to 28 September 1940 include divisional headquarters flights

Appendix 24e
Graph

BOMBER AIRCRAFT

Legend.

_ _ _ _ _ Authorized strength

_____ Actual strength (in Aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Appendix 241
Graph

DAYTIME TWIN-ENGINE FIGHTER AIRCRAFT

_____ Authorized strength

---------- Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

NIGHT TWIN-ENGINE FIGHTER AIRCRAFT +

Designated as "Zerstoerer [Nacht]" from 2 November 1940 to 28 December 1940. Then designated "Nachtjaeger" (Night fighter under which title more details will be found.

Appendix 24
Graph

DIVE-BOMBER AIRCRAFT

Legend.

_____ Authorized strength

---------- Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Reconstructed to serve as ground attack aircraft from 30 September 1943 (see graph for Ground Attack Aircraft)

Appendix 24 h
Graph

GROUND ATTACK AIRCRAFT

Legend.

_____ Authorized strength

---------- Actual strength (in aircraft)

.....v..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Anfang 1940 Aufloesung der Schlachtstaffel

Early 1940 deactivation of the ground-attack squadrons

Ab 30.Sept 1943 umgewandelte Stukaverbaende

From 30 September 1943 on converted dive-bomber units

Appendix 24 i
Graph

FIGHTER AIRCRAFT

Legend.

_____ Authorized strength

---------- Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters — Tables prepared by the Chief of Air Force Supply and Administration

Appendix 24 k
Graph

GROUND-ATTACK AIRCRAFT

Legend.

_____ Authorized strength

---------- Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Anfang 1940 Aufloesung der Schlachtstaffel. Ab 30. Sept. 1943 umgewandelte Stukaverbaende

Early 1940: Ground-attack squadrons deactivated. The figures from 30 September 1943 on are for dive-bomber units converted for use as ground attack aircraft.

Anlage 21 I

FIGHTER AIRCRAFT

Legend.

_____ Authorized strength

---------- Actual strength (in aircraft)

..... Actual strength (in aircraft crews)

Quelle: Tabellen des Generalquartiermeisters

Source: Tables prepared by the Chief of Air Force Supply and Administration

Appendix 25
Graph

MONTHLY AIRCRAFT DELIVERIES

1 January 1934-1 May 1945

Legend.

Scale — 2 millimeters equals 10 aircraft delivered

Stueckzahl — Number of airrraft delivered

Gesamtzahl Nah- und Fernaufklaerer — Combined total of close and long-range reconnaissance planes delivered

Jagdflugzeuge — Fighter aircraft

Sturzkampfflugzeuge — Dive-Bomber aircraft

Aufklaerer — Reconnaissance planes

Transport — Transport aircraft

Seeflugzeuge — Naval aircraft

Schulflugzeuge A — Training aircraft Class A

Schulflugzeuge B — Training aircraft Class B

Aufklaerungsflugzeuge — Reconnaissance planes

Mittlere Kampfflugzeuge — Medium bomber aircraft

Verbindungs Flzge. — Liaison planes

Sonstige Flzge. — Other aircraft types

Schwere Kampfflugzeuge — Heavy bomber aircraft--not operable

Jagd-Flugzeuge zugleich Nahaufklaerer und Jagdbomber, Schlacht-Flugzeuge — Fighter aircraft, served also as close reconnaissance, fighter-bomber, and ground attack units

Sturzkampf-Flugzeuge zugleich Fernaufklaerer, Schnellkampfflugzeuge, Panzerflugzeuge — Dive-Bomber aircraft, served simultaneously as long-range reconnaissance, fast bomber, and AT planes

Graph

Mittlere Kampfflugzeuge, zugleich Fernaufklärer,- Nachtjagd,-Zerstörer, u. Schnellkampfflugzeuge	Medium bomber aircraft, served also as long-range reconnaissance, night and daytime twin-engine fighter, and fast bomber aircraft
Schwere Kampfflugzeuge	Heavy bomber aircraft
Schulflugzeuge A u. B-u. sonstige	Training Class A and B Training and other aircraft types
Strahljagd Me-262 (im Umbau als Jabo)	Me-262 jet fighter aircraft (under reconstruction as fighter-bomber aircraft)
Strahljagdflugzeug He-162	He-162 Jet fighter aircraft

COMPARATIVE TABLE OF AVIATION FUEL REQUIREMENTS (STATED); PRODUCTION; IMPORTY, RESERVE STOCKS; and CONSUMPTION FOR THE YEARS 1938-1945

(In tons per month)

	1938	1939	1940	1941	1942	1943	1944	1945
Stated Requirements		200000[1]		120000[2]	135000[2] Aug-Oct 220000[1+2] (End)	350000 (End)[1+2]		
Imports		6000-9000[1]	100000 form Russia Quality questionable 200000 captured France, Holland, Belgium	13000[6] captured Russia			3500[12] (July)	
German Production	6000[11]	20000[1]		60000[2] 50000[2] 87000[4] (Nov)	120000[1+2] 112000[5] (July) 131000[5] (Aug) 87200[3] (expect.) 102030[9] (July)	160000[1+2] 186000[2] Expected: 320000	Beginning 180000[2] 159500[7] (Jan) 163200[7] (Feb) 180100[7] (Mar) 175100[6] (Apr) 155900[7+6] (May) 53300[7+6] (Jun) 30200[8+7] (Jul) 12500[7+6] (Aug) 5300[7+6] (Sep) 16400[7+6] (Oct) 35400[7+6] (Nov) 20400 (Dec)	16000[2]

Continued on page 633

Continued:

	1938	1939	1940	1941	1942	1943	1944	1945
Reserve Stocks		400000[1] (Sep)	600000[1+2] (End of year)	Badly reduced, 600000 254000 (Dec)	(Jan)[4] 254000 (Jun)[1+5] 164000 (Aug) 144000 (Feb)[3] expected: 231000		(May)[2] 540000 July assumed 213000	(Mar)[2] 30000
Consumption			74500[3] Average	Average[3] 106500 Peak, in[3] July 141120 (Dec)[4] 73113 Aug-Sep 126000 (Dec)[3] 75000	Peak[1+2] 160000 (Jul)[5] 134000 (Aug)[5] 146000 (Jan estimate)[3] 80000	Peak[1+2] 170000	190000[6] (April) 165000 Consumption restricted to 120000 monthly	20775[2]

Remarks. 1941: 153 900 tons, or 60 percent of total reserve stocks, held in depots in various theaters of operations. Only 105 000 tons available to Air Force High Command.[2]

1942: Difficulties resulting from Program 21 Ue. Additional requirements stated subsequently: 1 Sep 42 196 000 tons monthly; 1 Apr 43 250 000 tons monthly; 1 Jan 44 296 000 tons monthly. Of the total reserve of 200 000 tons, 198 000 tons in field depots.[13]

For Footnotes see page 634

Footnotes:

1. See "Betriebsstoffl[illegible] 1939-40 (A 18)."
2. See "Entwicklung der Betriebsstoffl[illegible] der deutschen Luftwaffe Gen. St. d. Abt. 25. 5. 1945."
3. See "Besprechungsnotiz 7/42 Vermerk vom 8. I. 1942."
4. See " Beschaffungsplanung v. Dez. 1940 GL/AM."
5. See "GL/A - M Az 85 Nr. 2242/42 Rch.Kdos. II. 11. 42." Memorandum
6. See Speer on Hydrogenation (Hydrier-Denkschrift Speer) 28 July 1944.
7. See "A 433 Flugkrafterzeugung Januar-Dez. 1944 nach GB Chemie."
8. See Excerpt from Daily Report, Chief AF Operations Staff (Tagesmeldung Chef Lw. Führungsstab Ia Nr. 4532/44 geh. Kdos. 26. Ausfertigung vom 1. 7. 1944).
9. See Letter Planning Office --Planungsamt As 195 Nr. 3907/42 geh. (GL/A-M 1/II) vom 15. 7. 1942.
10. See "Flugbetriebsstoffbedarf ab 1. 6. 1939 bei GL als Mobbedarf angefordert fuer gesamte Luftwaffe (357)."
11. See Excerpts from Report Notes (Vortragsnotiz des Amtes GL v. 15. 12. 1938 (391)."
12. See Excerpts from Report by Chief, AF Operations Staff (Bericht des Chefs des Luftwaffenführungsstabes vom XXXXIX 5.7.1944. Ziffer 5 c.), Par. 6, c.
13. See Chief of AF Spec Sup and Procurement Serv Conference 24 May 42 (1171) (GL-Besprechung v. 24. 5. 1942 (1171)).

Appendix 27.
Graph

AVIATION FUEL PRODUCTION, STATED REQUIREMENTS, CONSUMPTION, and RESERVES, 1938-1945.

Legend.

1. 1000 t.	in thousand tons
1. Mittel	on an average
vermutliche Einfuhr aus Rumaenien	estimated imports from Rumania
_____	Production
-:-.-.-.-.-	Stated Requirements
//////////	Consumption
.....	Available supplies.

Appendix 28

GERMAN AIR FORCE

TYPES OF AIRCRAFT MANUFACTURED
1933-1945

Sequence	Aircraft Type	Models
1.	Reconnaissance	He-45, He-46, He-126, FW-189, Do-215, BV-141
2.	Fighter	Ar-64, Ar-65, Ar-68, He-51, Me-109 Fw-190, Me-163, Me-262, Ta-152, He-162
3.	Dive-Bomber, Twin-Engine Fighter	He-50, Ju-87, Hs-123, Me-110, Me-210, Me-410, Ta-154, Hs-130, Hs-129, He-219
4.	Medium & Heavy Bombers	Ju-86, Ju-89, Ju-189, Ju-388, Do-11, Do-23, Do-17, Do-217, Do-335, He-111, He-177, Ar-234, Pot-63, Ca-313
5.	Transport	Ju-52, Ju-252, Ju-352, Ju-90, Ju-290, FW-200, Ar-232, Me-321, Me-323, Go-242, Go-244, DFS-230
6.	Naval	He-38, He-42, He-59, He-60, He-114, He-115, Ar-196, Ar-199, Do-J, Do-18, Do-24, BV-138, BV-222, BV-238, BV-250,
7.	Training, Class A	Kl-25, Kl-26, Kl-31, Kl-32, Kl-35, Kl-151, He-72, Si-202, Ar-396, Fw-44, Bue-131, Bue-133, Bue-181
8.	Training, Class B	W-33, W-34, Fw-56, Fw-57, Fw-58, Ar-66, Ar-76, Ar-96, Ar-199, Go-145, Al-75, Al-101, Al-102, Bl-177, D-520, C-445, JM-82
9.	Liaison	Fi-156, Fi-256, C-30, Fi-282, Fa-223, Fa-330
10.	Other	He-70, He-100, Me-108, Fh-104, Si-204.

Appendix 29

GERMAN AIR FORCE

Aircraft Repair Shops in 1937

Work Shop	Models Handled
Ago, Oschersleben	He-51, Ar-65, He-123
Arado, Brandenburg	Ar-68, Ar-76
Arado, Warnemuende	He-70
Bachmann, Ribnitz+	He-59, He-60, Do-Wal
Badisch-Pfaelzische+ Reparatur Werft	Kl-25
BFW, Augsburg	He-45, Bf-108, Bf-109
Flughof, Basser+	He-72, Ar-66, Fw-44, Fw-56, Go-145
Brinker, Eisenwerk+	He-46, He-51, Ju-52, Ju-86, Do-17
BFW Fuerth +	He-45, He-46, He-50, Ar-66, 145
Reparatur-Werk, Braunschweig+	He-72, Ar-76, FW-44, FW-56
Buecker, Rangsdorf	FW-44, Bue-131
DLH,[1] Staaken+	He-70, He-111, W-34, Ju-52, Ju-160
DLH, Boeblingen+	W-34, Ju-52
DLH, Travemuende+	W-34, Ju-52
DLH, Koenigsberg +	Ju-52
DLH, Schkeuditz+	He-111, W-33, W,34, Ju-52
Reparaturwerk, Erfurt	He-45, He-111, Ju-52, Do-23
Erla, Leipzig	He-51, Ar-65
Esenlaub, Duesseldorf+	He-72, Bue-131, Kl-25, Kl-26
Fieseler, Kassel	F-5-R
Fo-Wu-Albatross+	He-46, W-33, W-34, FW-40, Fw-54, FW-47, L-82, L-101, G-30
Friedrich, Straussberg+	He-72, Bue-131
Gerner, Frankfurt+	He-70, Kl-25, Kl-32, He-123
Gothaer Waggon Fabrik	He-50, Ju-160
Hansen, Muenster+	He-45, He-51, Ar-65, Ar-68, F-13, W-34, Ju-52
Reparaturwerk, Heiligenbeil+	He-70
Heinkel, Rostock	He-46

Henschel, Schoenefeld+	W-33, W-34, He-123
Junkers, Dessau	Ju-86
Junkers, Leipzig+	W-34, W-33, Ju-52, Ju-86, Ju-87
Flugzeugbau, Kiel+	He-42, He-51, W-33, W-34
Klemm, Boeblingen+	He-111, Ar-65, Fw-44, Kl-25, Kl-31, Kl-36
Land- und Seeleicht-bau+	He-72, Ar-66, Fw-5[illegible], Hs-123
Peschke, Minden+	Fw-44, Go-145
Flugwerke, Saarpfalz+	Ar-66
Schwade, Erfurt+	Fw-44, Go-145
Weser Flugzeugbau	W-33, W-34, Ju-52

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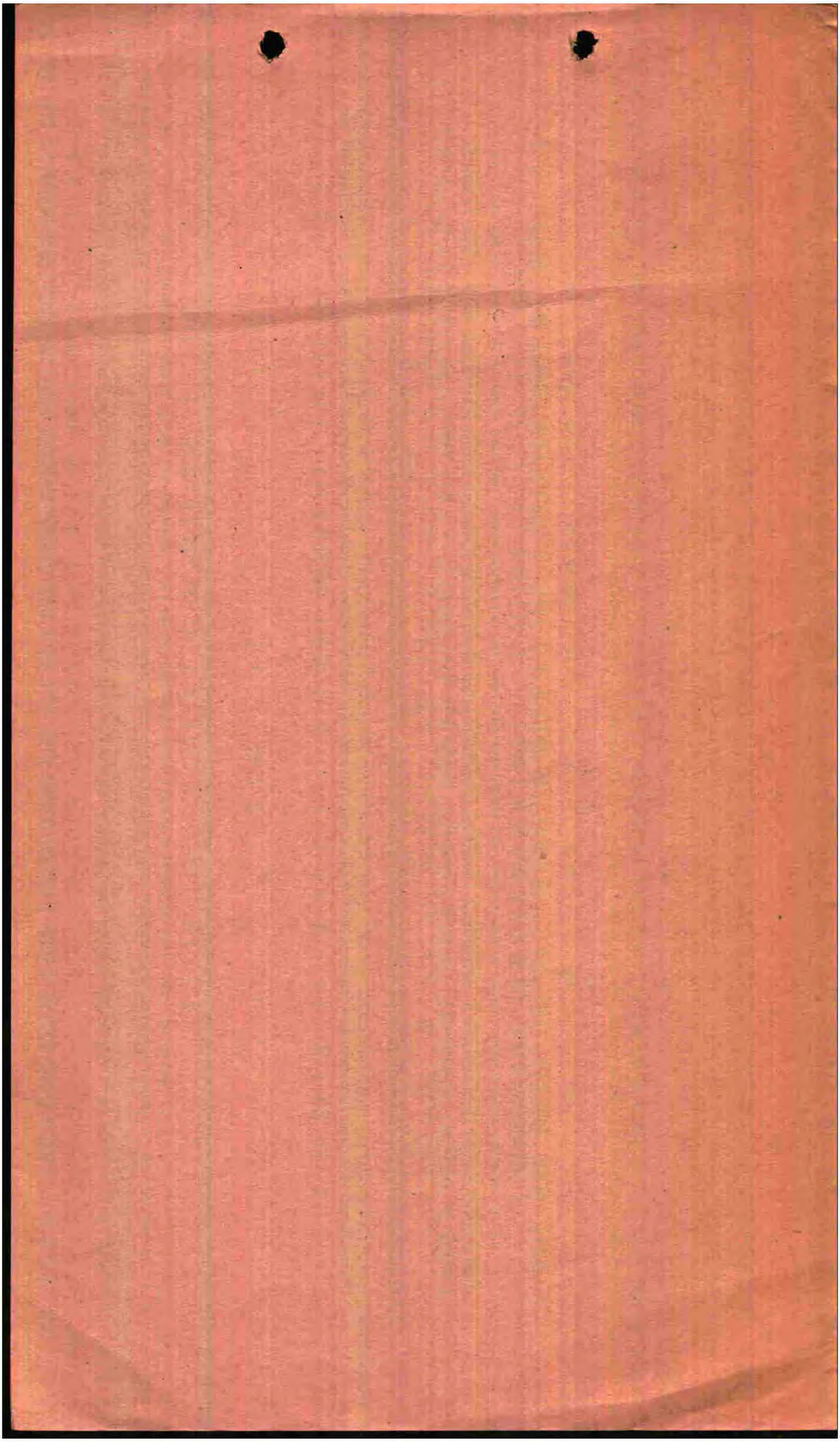
1. German Lufthansa Airways (Deutsche Lufthansa)

+ Independently operating industrial repair workshops.

ENGINE REPAIR WORKSHOPS

Repair Shop	Locality	Types of Engines Repaired
Hanns Haeussler	Munich	All types
Helmut Hestler	Eilenburg	Argus
Industriewerke	Heiligenbeil	All types
Motorenreparatur-werke	Varel	All BMW types
Kloeckner-Humboldt-Deutz	Hamburg	Bramo
Kaminski	Hameln	BMW
Franke,	Bremen	BMW-DB
Wumag	Goerlitz	BMW-DB
Famo	Breslau	Junkers
Buessing	Braunschweig	Junkers
Austro-Fiat	Vienna	Junkers-DB
Two factories in	Prague (1939)	



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APPENDIX 2

Study No. 170

PROCUREMENT IN THE GERMAN AIR FORCE

by

Hertel
German Air Force Engineer Corps (Retired)

PART III: Summary

Paragraphs 1-3

Further paragraphs to follow

III. SUMMARY.

1. Influence of Command System Organization on Planning and Procurement. The nine aircraft manufacturing firms in existence in Germany in 1933, with a total factory area of only 7,500 square meters, were incapable of meeting the requirements of an air rearmament even on a small scale.

Neither the factory space, which averaged less than 1,000 square meters per firm and thus represented the capabilities of a very small factory, nor the financial resources, which were lacking in the case of each firm, could have served as a sound basis for any rearmament.

The establishment of a new air force ordered in 1933 therefore presupposed a planning and reestablishment program for the aviation industry starting from rock bottom. With few exceptions, planning for this reestablishment could therefore proceed without regard for already existing factories, which called for a considerably greater reestablishment performance than was the case with the Army or the Navy. These latter could still rely on the firms authorized under the Treaty of Versailles to manufacture military requirements.

The assigned mission not only required that a status of armament parity with the other two military branches was to be achieved within the shortest possible space of time but, in view of the extremely unfavorable political and military

situation in which Germany found herself at the time, that the build-up of an aviation industry of high capability was to be completed as speedily as possible to anticipate the eventuality of intervention by any foreign power.

The first measures taken included an examination of the feasibility of provisionally arming the available sports aircraft as a temporary precautionaly defense measure against the eventuality of an attack by Poland, and steps to increase the output in sports types of aircraft already in production for purposes of training. Then, in work lasting a number of days and night, it was possible to formulate the basic plan for the industrial build up to meet the first phase target.

The practical measures thereupon introduced also served to provide a basis on which the Air Force General staff could establish the necessary training schools and units.

The Government in power at the time gave full support to the immediate commencement of work for the build up, an important consideration here being the widespread unemployment in Germany.

Goerings's powerful political position as Minister of Aviation and Commander in Chief of the Air Force gave further vigorous support in the accelerated execution of the necessary work.

A further factor promoting progress of the work was

the organizational set up of the Air Force Technical Office. Although the formal organization of this Office corresponded to that of the Army Ordnance Office, from which it had originated, the nature of its missions and the procedures adopted in their execution were fundamentally different. In each of the two offices branches of equal status admittely existed to handle the subjects of research, development, proving, and procurement. In the Air Force Technical Office, however, the working methods and procedures of those branches were directed towards achieving the set target of providing for the units to be activated aircraft and other equipment of the highest achievable technological standards within the shortest possible space of time. In these efforts it relied on the experience of the engineer personnel responsible for the various fields of activity within the Office and therefore adapted itself primarily to the working methods and procedures customary in industry.

However, the set target could only be achieved by an organization functioning as free as possible of bureaucratic hindrances and which, apart from providing clearly defined specifications and insuring the prerequisites for industrial activity, could leave the execution of assigned projects as largely as possible to the initiative of industry.

For these reasons the parties with which the Technical

Office entered into contracts were in the majority of cases only the producers of a final article, who were responsible for the final assembly and therefore also for the work done by sub-contractors

This avoided the attention to which the Technical Office would have had to give to administrative principles and the delays which would have resulted therefrom as well as the confusion of responsibilities which would have arisen if contracts had been awarded directly to such sub-contractors.

There were thus no important bureaucratic obstacles to hinder the accelerated realization of the plans compiled by the Technical Office for the build up on the basis of current mobilization plans or for the execution of the various programs. Within a very short time it was possible to translate into industrial activity the plans which the Technical Office prepared on the basis of planning by the Air Force General Staff. In this way it was possible speedily to exploit the manpower reserves available because of the widespread unemployment as well as the suppliers and sub-suppliers of raw materials, and semi-finished products, all of whom were suffering from a lack of manufacturing contracts, on a large scale to initiate and complete and increase current programs. Over and beyond this, these factors contributed to make it possible

4 to expand the factories on a scale exceeding normal require-
ments for current production in order to meet the needs of the
Technical Office and of preparations against the eventuality
of a mobilization.

5 Although during the first years of the rearmament program
political pressures were such that no difficulties existed in
making the contractual arrangements essential for the technical
steps which had to be taken, the danger existed that contro-
versies between the Technical Office and the Administrative
Office of the Air Ministry concerning spheres of responsibility
might have caused delays in fulfilling the various programs.
A transfer of all matters concerning the financial support of
the industries concerned together with the handling of the fi-
nancial aspects of contracts to the Technical Office and the
consequent centralization of responsibilities in one single
Office established clear lines of responsibility in this field
which was the most important in the whole subject of rearmament.

The programs established by the Technical Office now
provided legally binding foundations for the initiation of all
necessary measures by the industries. Only later were these
measures formulated in the regulation-like contracts or formal
contract letters awarded by the Industrial Control Department
(Amtsgruppe Industriewirtschaft) of the Technical Office and
later by the Industrial Control Office of the Chief of AF

5 Special Supply & Procurement Service

The advantage of this method, also for the Industrial Control Department, was that the formulation of contracts was not subject to time pressure and that in the meanwhile the firms concerned could carry out the investigations and negotiations necessitated in most cases for the speedy build up, while the financial requirements of the industry were met by advance payments.

The factory expansion and manufacturing contracts awarded to the industries increased from 1933 on in a measure which would have fully occupied all technical and administrative capabilities of the industry to meet both quantitative and time requirements.

As previously mentioned, the factories existing in 1933 would in no way have been adequate to meet requirements and since the expansion of these few factories on the necessary scale would have been impossible for reasons of space, labor and transportation requirements, the necessity logically evolved to establish independent factories, XXXXXXXXXXXXXXX which could manufacture under licence the items previously produced by the designing and developing firms.

Within the already existing firms handling development this gave rise to anxiety concerning ~~later~~ future competition by copying firms if the volume of contracts should at any time

6 seriously decreasing.

This jeopardized cooperation between the developing and the copying firms and the plan to have both manufacture separately identical series of items. Recognition of these complications at patent licensing conferences directed by the Technical Office created the compelling necessity for measures to be taken within the industry to secure the exchange of patents between the developing firms and, in each case, a

7 number of copying firms. The latter when exploiting patents registered by the developing firms by establishing a ratents Pool with ramifications throughout the aviation industry, the conclusion of contracts to manufacture patented items under license, and by insuring later transfer of to the developing firms of responsibility for the serial production of the various types, including manufacturing activities in the copying factories.

The latter arrangement above had become necessary because of the considerably increased volume of contracts, compared with 1933, in order to take some of the burden off the Technical Office and at the same time served to insure fullest exploitation of the capacity of the participating firms.

This cartel system formed within the aircraft industry at the instance of the Technical Office was taken over later by the Ministry of Armaments and War Production and applied

throughout the industries serving military ~~purposes~~armament purposes.

The technical measures initiated by the Technical Office and the Chief of AF Special Supply and Procurement Service, together with those of the Industrial Control Office in the field of economics had an exceptionally favorable influence on the speedy commencement of the industrial build up and on the execution of serial production programs as long as air armament matter remained under the authority of the Chief of AF Special Supply and Procurement Service.

The necessity for systematic direction in the expansion of existing and the establishment of new factories with a view to preparations for industrial mobilization, and the need to avert faulty investment, called for wide experience on the part of the engineer personnel of the Technical Office. The latter need together with the need for supervision of the progress made in the expansion and in manufacturing activities provided the opportunity, with participation by industrial circles, to investigate speedily on the basis of planning by the Air Force General Staff what impact such plans would have in the technical-manufacturing field and to what extent those plans could be realized, and to make the results of such investigations available to the General Staff. The advantage here for the General Staff was that it could make important decisions

8 at very short notice.

In addition, this system served to accelerate considerably the initiation of newly established programs, since there was no need for time-consuming investigations within the industries and the need for redesigning and re-adaptation of manufacturing specifications which might otherwise have arisen could be avoided.

The system proved exceptionally valuable during the war, since it was possible, when necessary because of changing military situations, to introduce measures immediately without first having to consult industrial circles.

The rearmament program suffered a setback in 1938 due to the reorganization of the Technical Office, or rather the Chief of AF Special Supply and Procurement under General Udet and the rearrangement in functional branches. The dual position of General Udet as Chief of AF Special Supply and Procurement and Chief of the Technical Office and the resultant direct control over a number of individual branches, besides the two Offices, necessarily led to confusion and at times to a lack of leadership.

9 Symptomatic of these conditions, among other occurrences, was the fact that 20 industrial programs were issued during the 1938-1941 period compared with only 9 in the 1933-1937 period. Although other factors also contributed towards the establishment of these 20 new programs,

9 the circumstances which led to the frequent changes were in a large measure due to the tendency of General Udet to give preference to development activities and intentionally neglect serial production problems, which tendency was the basic cause for the whole reorganization which had taken place.

The number of programs decreased immediately after Field-Marshal Milch in 1941 assumed control of the Office of the Chief of AF Special Supply and Procurement and after reintroduction of the former organizational setup.

It can be considered basically as an established fact that the type of organization in the Technical Office as it existed under General Wimmer and ~~xxxxx~~ of the Office of the Chief of AF Special Supply and Procurement Service as it existed under Field Marshal Milch as well as the working methods of the department under this Office provided a basis sound in every way for implementation of the program of industrial rearmament, with the support of which, and given properly planned targets, it would have been possible to achieve optimum industrial performances and an economic exploitation of the vailable facilities.

However, the organizational set up at the highest levels of command constituted an important obstacle in the way of a pruposeful and optimum exploitation of the industrial potential available.

In practice, each branch of the military, the Army, the Navy, and the Air Force, formulated and executed its armament programs separately, independently of the other two military branches, and without any higher level coordinating control. Nothing had been done to coordinate the construction and procurement programs of the three military branches.

However, the lack of a higher level coordinating agency did not make itself felt as long as the materials and manpower potentials remained adequate to meet the requirements of both military armaments and the civilian economy. The difficulties which would necessarily arise whenever this condition ceased to exist were all the greater. This occurred in 1937, when Hitler ordered an incisive reduction of the armament program because of a shortage of steel.

Although the tendency then obviously still existed to adhere to the previously established objectives and only change deadlines for their achievement in order to comply with Hitler's decision, in many cases plans had to be changed and building and manufacturing projects had to be halted, the failure to complete which perforce had exceptionally unfavorable and possibly even decisive repercussions after the outbreak of war.

It should have been the mission of the OKW (Joint Military High Command) to coordinate the armament programs of the three military branches, but it did not have the command authority

over the tree branches which this would have required. The mission of its Military Economy Staff, later upgraded to Office status, was exclusively to maintain statistics on the manufacturing capabilities of industrial concerns of importance in the event of a mobilization, to regulate the allocation of work to them in the event of mobilization--in order to prevent overlapping of the manufacturing allocations made by the individual military branches, and to control the requirements from the Ministry of Economy for the peace-time programs. It had no influence whatever over the Air Force build up of industry or the emplementation of the Air Force armament programs.

Consolidation of all armament projects of all three branches of the military in a single office undoubtedly would have been the best form of organization, but in view of current political conditions and in view of the accelerated commencement of rearmament, the establishment of a new office of this kind would have caused intolerable delays. Furthermore, a measure of this kind could hardly have been put into effect because of the personal position held by Goering as Commander in Chief of the Air Force.

Just as was the case with implementation of the programs of the three military branches, civilian requirements and requirements for the implementation of the Government and of the National Socialist Party (in particular the Four Year Plan) projects

11 as well as the Autobahn (Superhighways) Corporation, etc., were handled in each case separately and independently of other needs.

The Reich Defense Council and, as a working committee, the Reich Defense Committee had admittedly been established as early as in 1935 with the mission of coordinating military rearmament requirements with the requirements of the civilian economy. However, the controversial views held concerning the spheres of authority of the Plenipotentiary for Military Economy and on the one hand and of the OKW on the other prevented effectiveness of this measure, particularly since no solution of this problem could be reached even after years. When the war commenced the necessary preparatory measures had not yet been taken in the civilian field. The position of a Plenipotentiary was thereupon abolished because of its failure.

Even after the difficulties encountered in executing the established programs, due in particular to the previously mentioned steel shortages in 1937, the proper conclusions were not drawn in the matter of organization. All programs continued independently of each other in process, although some were severely reduced.

The only factor then regulating the size of the armament programs of the individual military branches was the size of the raw materials allocations made by the OKW, but in point of quantity, these allocations from then on at no time were adequate to meet requirements.

12 The conditions described above continued even after estab-

lishment of the Munitions Ministry under Minister Dr. Todt. The

13 missions of this Ministry was to support the Army Ordnance Of-

fice in the production of ammunition, to influence progress of

the programs of the three military branches in manufacturing

technological matters, and to simplify cooperation of the

military technical offices with industry, or to adapt them to

the Air Force Technical Office.

After Dr. Todt's death in an air crash in 1941 and after

Minister Speer had taken over the Ministry, which later ~~xxxxxx~~

was expanded to become the Armaments and War Production Minis~~tr~~

istry, a decree issued by Hitler on 2 September 1943 admittedly

assigned to the new Ministry responsibility for the armament

programs of the Army and the Navy, but implementation of the

armament program of the Air Forcecontinued under the Chief of

AW Special Supply and Procurement.

It can be assumed that the deciding factor in this latter

arrangement was the position of Goering as Minister of Air

and Chief of the Four Year Plan, together with the fact that

the way in which the air armament had been carried out in the

past had given no cause for intervention by outside authoritie

The decree mentioned above transferred to the ~~Xxxxxxxx~~

Armaments and War Production Ministry control over all pro-

duction of the war economy including "the production and al-

allocation planningfor the entire war economy on the basis of planned requirements for the territories under German jurisdiction and founded on the raw materials resources available." This transferred to the Ministry the missions originally handled by the Military Economy Office of the OKW and later by the Four Year Plan Administration.

In practice, this meant that the Ministry controlled all production, extending from raw materials to the manufacture of finished products -- with the exception of air armaments.

However, industries producing sub-units required in the Air Force armament programs were also controlled by the Ministry the execution of these programs was also in every respect dependent upon the Ministry. The latter could thue withount any difficulty to give preference to the armament programs under his direct control at the e pense of the Air Force.

The missiom of the Central Planning Office, as an authority above all other offices, was admittedly to allocate basic raw materials and man power to the various sectors on the basis of data compiled by the Planning Office of the Armaments and War Production Ministry and to establish the level of output for the entire war industry, and thus also to determine priorities. However, Hitler usually made decisions of this kind himself.

In actual fact, the consolidation of practically the

14 entire economy under the Armament and War Production Ministry did not have a favorable impact on the planning and implementation of the Air Force armament programs. In spite of the steadily mounting intensity and frequency of air attacks over Germany, in particular against installations of the armament industries, and in spite of repeated requests by Field Marshal Milch, nothing was done to change the extremely disadvantageous position in the matter of Air Force armament activities.

The decisive cause here was undoubtedly the fact that Air Force Armaments were not included under the Armaments and War Production Ministry since the materials and manpower potentials available were barely adequate to meet the needs of the most urgent missions of that Ministry.

Another cause for the attitude of the Ministry to Air Force armaments may have been the antagonistic attitude of the National Socialist Party towards the military forces. Most of the key personnel in the Ministry came from Party organizations and desired to exclude the military from all armament functions and transfer those functions under Party authority. The Chief of the Technical Office of the Ministry, Sauer, pursued this course relentlessly.[1]

1. See repeated statements by Sauer at conferences of the Fighter Production Staff and the Armaments Staff in 1944 and 1945 inimical to the various military authorities.

15 Realization of the hopelessness of his efforts to secure a more favorable status for Air Force armaments and the extent of the damage done to industries serving the Air Force therefore influenced Field Marshal Milch in February 1944 to at last transfer responsibility for fighter aircraft production to a projected Fighter Production Staff, which in practice was under the Ministry.

Whereas it had been impossible in the past to obtain priorities appropriate to their especial importance for the conduct of the war for air armament manufacturing projects, with a few exceptions, the entire program of fighter aircraft production from then on was given precedence over all other armament projects as the most important field of endeavor. Shortly thereafter all other areas of Air Force armaments had perforce also to be transferred to the Armaments and War Production Ministry.

The fact that fighter aircraft production was awarded the highest priority, taking precedence in particular over mining, tank and submarine production, etc., only after transfer to the Armament and War Production Ministry although all authorities had admitted the necessity to protect industry by the earliest possible large-scale reinforcement of fighter forces justifies the assumption that the necessary measures were intentionally prevented by the Armaments and War Production Mi-

17 Ministry, and particularly by Sauer who, as Chief of the Ministry's Technical Office, controlled the final manufacturing processes, until then.

Since this decision, which was of paramount importance for the conduct of air warfare, was only made at a time when it was no longer possible to break the superiority of the British and American air forces, the Armaments and War Production Ministry is largely coresponsible for the destruction of the German cities and industries.

It must be admitted that the Fighter Production Staff, and later the Armaments Staff, of the Ministry did take measures, including the exploitation of all available means and the cancellation of other aircraft types, which actually increased the output of fighter aircraft from roughly 1,300 in March to almost 3,000 in November, with special emphasis on the Me-262 jet fighter, but owing to the time at which this occurred and owing to fuel shortages it was too late for these measures to have any influence on the course of the war.

Establishment of the Armaments and War Production Ministry must be considered as a provisional measure. As previously mentioned, a large percentage of the staff members came from Party offices, and since the expert knowledge of these personnel was completely inadequate, responsibility for the implementation of production programs shifted progressively to

17 industry, to the main and special industrial committees and cartels as independent organs of the industry.

Finally even Speer himself rejected the organizational pattern thus developed, particularly because it no longer allow-

18 ed proper control. During the final stage of the war it became necessary to transfer responsibility for the projects still current to a large number of special plenipotentiaries.

Prior to the assumption by the Armaments and War Production Ministry of responsibility for the armament projects of the Army and Navy, responsibility for the procurement of items and equipment used in identical or similar form by more than one military branch had been assigned to that branch using the largest quantities of the particular item involved, the purpose being to insure the most rational production possible. For this purpose, the appropriate supplies of raw materials were allocated pro rata to the participating military branches. This system of procurement applied particularly in the case of small arms, machine guns, radar instruments, air torpedos, motor vehicles, gunpowder, other explosives, normal fuels, antiaircraft and other artillery fire control equipment.

Although it must be admitted that in most cases the military branch responsible for a particular item did endeavor to insure supplies appropriate to requirements in spite of shortages in raw materials and plastics, it was found that in cases of

18 particularly acute shortage, the branches not in control of the production of the items involved had not received their fair share.

In the case of the Air Force, this applied in particular to ammunition, motor vehicles, weapons, and explosives. Furthermore, it was not possible for the military branches not controlling the production of a certain item to influence the final form of the model in question. Special requirements arising from the circumstances of air warfare, especially in the case of aircraft-mounted weapons, bombs, and air torpedos, did not receive adequate consideration.

These conditions had an adverse effect on the equipment of the troops.

In summarizing it can be stated that both the organization and the working procedures of the Technical Office and/or the Office of the Chief of AF Special Supply and Procurement Service on the whole were appropriate to the requirements to insure maximum capability in the field of air armament, but that the lack of a higher level agency with appropriate command authority to coordinate the armament programs of the three military branches, civilian requirements, and the construction programs of the Government and Party authorities had a decisively adverse effect on air armaments.

The attempt to overcome the difficulties, which

19 increased particularly during the war, in the field of armaments by means of constant organizational changes necessarily had to fail, since it is only possible to insure a properly regulated application of all measures introduced if supported by an organization existing at least as a framework during peace and expanded during war to meet increased needs.

20 1. The Influence of Technology and Manpower Policies on Planning and Procurement. On the basis of World War I experience the Fertigungs G.m.b.H. (Manufacturing Corporation Ltd.), as a field agency of tWeapons Proving Branch 8, had worked out guiding principles governing serial production, and these provided the basis for the serial production of aircraft developed up to 1933. These manufacturing principles had been so far tested on a number of aircraft types that they could be applied generally throughout the aircraft manufacturing industry when serial production commenced.

Their purpose was to introduce a uniform system in the breakdown of aircraft into elements and in the designation of individual parts and to develop the standard installations and gauges needed for serial production.

With this support factories manufacturing aircraft under licence were to be enabled to do so as independently as possible of the original developing firm and, in the interests of uninterrupted supply operations, the parts for each aircraft

were to be readily interchangable regardless of the firm by which they were manufactured.

Another target resulting from World War I experience was that of insuring the serial production of aircraft, engines, equipment, and ammunition as independently as possible of imports from foreign countries and for this purpose close research had been carried out for a large-scale use of substitutes for raw materials not available within Germany or in friendly countries.

The classification of materials to be used in the air armament as "Aircraft Manufacturing Materials (Flugwerkstoffe)", specification of the alloys to be used, and the limitation of types of materials to be used to roughly 40 percent of the formerly used types, namely

33 types of steel
12 types of non-ferrous metals
36 types of aluminum alloys

besides the previously mentioned purpose of rendering the industry as independent as possible of imports, served to rationalize the production of manufacturing materials and semi-finished products, simplify stockpiling and control, and insure greatly facilitated supply operations.

The same applies to measures limiting the number of certain finished parts to be used in the manufacture of aircraft, engines and items of equipment; as an example the number of roller bearing types to be used was reduced from 8,000 to 832.

21 As previously mentioned, this same purpose was served by an extensive system of standardization which, in addition to the existing German Industrial Standards (Deutsche Industrie Normen, usually abbreviated DIN), provided for the use of newly established Aviation- and Aviation-Equipment Standards.

This preparatory work, which had reached a preliminary stage of completion prior to the commencement of rearmament, provided an important basis for designing and developing factories which were to be expanded as well as for the factories to be newly established to manufacture under licence.

22 It enabled a speedy initiation of serial production of the aircraft models developed by 1933 within the first phase of the main rearmament program, namely, the following:

He-46 tactical reconnaissance planes
He-45 strategic reconnaissance planes
Arado-65 single-seater fighter planes
Do-11 and Do-23 bomber planes

besides the

He-51 naval single-seater fighter planes
He-60 naval tactical reconnaissance planes
He-50 naval dive-bomber planes
He-59 multi-purpose planes.

as well as the Do-Wal seaplane intended for strategic reconnaissance.

In structure the training aircraft to be put into serial production during the first years of rearmament to provide fa-

22 facilities for the training of aircraft crews admittedly did not correspond to the stated specifications for standardization, interchangability of parts, use of standardized construction parts or the use exclusively of authorized manufacturing materials, since they had been designed and developed on instructions from various users, namely, the German Aviation/Sports Society, the German Commercial Aviators School, etc., without any influence being exercised by the Weapons Proving Branch 8.

In order to secure the speediest possible activation of the first units, the disadvantage had to be accepted as unavoidable that as many as six different types of aircraft were in production simultaneously for initial training and as many as five for advanced training and that these various types were also 23 simultaneously in service in normal aviation operations.

The resultant increased expenditures for spare parts and repair facilities could be accepted since these types of aircraft were not intended for use in actual combat missions and since it was to be assumed that the disadvantages mentioned would be eliminated later by introduction of the standardized aircraft and engines developed under instructions from the Technical Office.

In the case of the first types of combat aircraft developed on the basis of the first tactical specifications in the first phase of the main armament program, the constructional

23 prerequisites thus existed for serial production complying with the requirements stated by the [redacted] Weapons Proving Branch 8 and by the later Air Force Technical Office, particularly since the proving of these types had to a large extent already been completed prior to commencement of the rearmament program.

This was an exceptional advantage for the aircraft manufacturing firms since, apart from possible errors in the construction data, no very considerable difficulties were to be expected due to any changes. The major industrial mission therefore was to expand existing and establish new factories and to develop the most rational methods of serial production possible, since no experience was available in the aircraft or other branches of industry on the subject of production belts and assembly lines Besides this, measures had to be introduced to familiarize and retrain personnel coming from other branches of industry, supervising personnel, and personnel to handle the problems of welfare and air raid protection, etc.

The procurement of specialized personnel played a particularly important role in view of the fact that, owing to the lack of experience in serial production methods, larger numbers of specialized personnel were required than was normally the case in production belt and assembly line operations. Another factor was that the few supervisory personnel available in 1933 were

fully occupied with preparatory planning and expansion missions and with measures to arrange for and initiate production in the factories manufacturing various models under licence from the original developing firms.

The relatively thorough testing of the types for the first phase of the main armament program prior to the initiation of serial production, the resultant small scope of modifications occurring during serial production, and the previously mentioned basic preparatory work done by Weapons Proving Branch 8 had an exceptionally favorable impact on the rapidly increasing expansion of the firms and on serial production activities. During that work a large volume of experience had been gathered for further development of working methods in serial production, for concurrent improved rational use of materials, reduction of labor expenditures and thereby for improved employment of manpower.

The demand that aircraft should be made available to the troops which were at least equal but if at all possible superior to those of possible enemy powers necessitated transition at an earlier date than anticipated to the aircraft types designed for the second phase of the main armament program, at a time when the testing of these types had not yet been completed. This in turn made it necessary while serial production was in process to introduce modifications based on the experience gained in the tests carried out.

25 The aircraft types for the second phase of the main armament program were as follows:

Fighter aircraft: Arado 68 and Me-109

Dive-bomber aircraft: Hs-123 and Ju-87

Tactical reconnaissance planes: Hs-126 and Fw-189

Dual-purpose bomber/strategic reconnaissance planes: He-111

The premature commencement of serial production necessarily had an adverse impact on rationalized manufacturing operations because of the necessity for a larger use of specialized personnel, interruptions in the established routine and consequently increased expenditures in labor and materials for both manufacturing installations and the article being manufactured.

Whereas in the case of the types placed in serial production in the first phase of the main armament program it had been possible in some cases to achieve an output exceeding that established for the firms in the program, output in the second phase perforce fell short, and in some cases seriously short,

26 of the target figures because of the increased expenditures of effort and materials due to the changes introduced.

In spite of these disadvantages, this system would have been acceptable during peace as long as mobilization missions were not to be expected and as long as it remained possible ~~to~~ at the same time to achieve the goal of equipping the units with the most up-to-date types.

26 At the latest on the outbreak of the war, however, it would have been essential, in view of the manpower difficulties to be expected because of personnel being drafted for military service, to insure as smooth and uninterrupted a process of serial production as possible in order to achieve maximum output.

Quite some time before the war already, an arrangement had been made to regulate the introduction of changes during a production series by establishing degrees of change and making timely provisions for their introduction in order at least to reduce adverse effects on output to a minimum. Under the favorable impression created by the favorable outcome of the 1939 and 1940 campaigns in Poland and France, however, emphasis remained on development rather than on serial production, which resulted in an increased necessity for consideration to be given to changes introduced while a model was in serial production.

Although later in the war, and particularly so after Field-Marshal Milch assumed responsibility as Chief of RLM Special Supply and Procurement Service, the objective was to reduce the
27 number and magnitude of changes introduced during production, efforts to this end were seriously hampered by the increased demands made by the General Staff requiring the suitability of aircraft for use in the various theaters of operations and for

27 a multiple of tactical purposes. This resulted in an increased number of variants of the individual aircraft models and items of equipment and a number of consequent delaying factors, such as the very small numbers of each variant in a production series, changes in the manufacturing installations for each variant, the necessity for more specialized personnel, and increased expenditures in labor, materials for the various gauges and other special installations required, as well as for the aircraft and items of equipment themselves.

Other resultant disadvantages included the need for more time spent in designing, which deprived new development projects of highly qualified engineer personnel, and considerably increased requirements in spare parts and repair facilities.

Another factor which undoubtedly contributed to the difficulties in serial production was the introduction of modifications through direct contact between the troops and the factories, unknown to the General Staff, and usually based exclusively on the personal views of individual air pilots, which were frequently contradictory.

It is impossible in retrospect to form an even approximate estimate of the loss in output caused both before but particularly during

28 the war caused by extensive changes and the constant readaptations of manufacturing processes. One direct results of these circumstances was the small percentage of effective strength

28 in the field units due to defects in the numerous differing spare part kits and the large number of variants of the individual aircraft models supplied.

The limited resources available for armaments in personnel and materials would have called for the production of as large series as possible of any one type in order, on the one hand, to simplify and facilitate ~~xxxxxxxxxxxxxx~~ spare part supply operations , on the other hand to secure optimum exploitation of the potentials available in manpower and materials, in order thereby to increase output considerably.

This logically would have made it impossible to meet all requirements fully in point of the usability of aircraft for a multiple of tactical purposes. However, this disadvantage could have been more than balanced by improvised measures and a considerably increased output and by the considerably increased ~~xxxx~~ effective unit strengths which could have been achieved particularly during the first half of the war. To what extent this could have changed the outcome of the war in the air would require more detailed study.

~~There can be no doubt that the fact that the aircraft types specified prior to the war to equip the units in general met all requirements, favored retention even during the war, of the system of placing in serial production aircraft, engines and items of equipment still under development and still in process of testing~~

The aircraft types specified prior to the war as unit e
euqipment had, in general met all requirements, and there can
be no doubt that this fact contributed towards the decision
to retain the system of putting into serial production air-
29 craft, engines, and items of equipment still under development
and still in process of testing although no final decision
had as yet been made as to their suitability for tactical
and general military use.

This made the failure of the newly developed He-177 4-
engine bomber and of the Me-210 twin-engine fighter an even
more serious and unexpected blow in the conduct of air war-
fare than would otherwise have been the case.

After the death of General Wever, first Chief of Staff
of the new German Air Force, the project started by him on
development of a long-range bomber had been discontinued and
this have special importance to development of the He-177.
Plans provided for this bomber to go into front service in
1941, but it was actually only ready for use as a bomber
three years later, in 1944.

Plans to equip the units with this new model in 1941
were undoubtedly too optimistic, but they were based on past
experience in the development of former models.

The extraordinarily long delay in this development was
largely due to the adoption of too great innovations on

recommendations from the firm of Heinkel. Besides the introduction of a new type of cooling system and the use of as yet untried materials, the main cause of failure was the use of a dual power unit, consisting of two parallel engines driving a single propeller.

The use of this power plant was admittedly due to specifications from the General Staff requiring ability to dive at an angle of 50°, but the mounting of the engines already showed serious defects which were only remedied at a late stage in spite of requirements stated by the Technical Office.

Matters were similar in point of flight properties and the functioning of the power units and construction elements.

Apart from the interruptions caused in serial production by difficulties encountered in the development stages, a hampering factor was the intervention by front line officers, who under authority from Goering ordered changes, most of which contradicted each other, and all of this hampered solution of the difficulties. These authorized officers had not first contacted the Technical Office, and were therefore not informed concerning the development principles followed by that Office. This circumstances, which led to contradictory instructions being given to the firm by various sources and thereby produced confusion in the designing stages undoubtedly contributed largely towards the faulty development.

30 On this subject Engineer Utech, a former staff member of the Rechlin Proving Station and supervisor of the He-177 development project reports as follows:

A peculiar feature is how some of these alterations were caused. Thus, particularly around the end of 1942, front line officers with authorization from the Reich Marshal (Goering) appeared at intervals of about four weeks at the manufacturing firm and decided on alterations allegedly based on the latest combat experience. A fundamental feature was that each of these cancelled out what the previous officer had decided, so that the firm was unable to keep pace with the numerous alterations and consequently became completely confused.

The numerous changes prevented a properly regulated manufacturing process. Time and again manufacturing work was interrupted, already manufactured parts had to be scrapped, modifications had to be made, installations and new gauges had to be readapted.

Another factor complicating the manufacture was that, since the firm of Heinkel was already too heavily occupied with other projects, the main series had been put into production in the factory of the firm of Arado. Inadequate contact between these two firms and incompleteness of the data furnished to the firm manufacturing under licence led

to

31 to annoyances which certainly in no way served to promote progress in the manufacture.

Failure of the Me-210 as a twin-engine fighter resulted in a further reduction of effective air strength. Since this was not a completely new development but rather merely

32 intended as an improvement on the old Me-110 no serious difficulties had been expected in putting it into serial production prematurely.

Owing to its inadequate flight and take-off performances ~~Goering~~ as well as repeated undercarriage fractures, Goering had cancelled the production of this model after a number of serious crashes. This resulted in a serious gap in aircraft production, since the Me-110 had already been taken out of serial production and months passed before the output from a newly started series could make itself effectively felt.

About 300 Me-210 planes had already been completed and material had already been cut for another 800. Although some of this material could be used for the newly developed Me-410, which was then put into serial construction, a considerable quantity of the material had to be scrapped. Furthermore, in addition to the labor already wasted, the sudden halt in production led to the waste of thousands of manpower hours.

32 The reasons for this surprising faulty development were, ~~similarxxxxxxxxxx~~ similarly to those given above for the He-177, were due to faulty designing; the responsibility rests with Udet, who as Chief of AF Special Supply and Procurement Service had given the basic instructions and with Professor Messerschmitt, who followed those designing instructions and made promises which did not conform to facts and which served as the basis in programming.

33 In this case again, the fact that group commanders, without the knowledge of the Technical Office, influenced Messerschmitt resulted in confusion within the firm and to alterations.

Instead of the deliveries of M-210 planes planned forstart in January 1941, it was June 1943 before the first deliveries of Me-410 planes reached the front line units.

As previously mentioned, the principle adhered to even during the war of meeting the demands of the General Staff aiming at improved performances or greater versatility of the aircraft and items of equipment concerned resulted in exceptionally serious losses in materials and manpower hours, since it necessarily implied splitting the manufacturing program up into a number of production series.

In mid-1934 there were 19 basic aircraft types simultaneously in production, of which 9 were combat types and 10 training types, the latter including two types just being taken out

33 of production. In mid-1938, in contrast, the basic types in production numbered 31, namely 15 combat types--three of them just placed in production, and 16 training and commercial types --3 just placed in production and 1 just being taken out of production. The corresponding figures for mid-1942 were: total 30, namely, 21 combat or tactical types--including 2 glider types, and 9 training and commercial types.

34 Since tactical types, particularly fighters, twin-engine fighters and bombers represented the majority of all aircraft in production, some of the types being produced simultaneously in 8 widely diverging variants, this resulted in a serious dissipation of effort in manufacturing. In these circumstances there could be no talk of rationalized serial production.

A subject requiring closer study in this connection is that of the simultaneous production of a number of basic types serving one and the same purpose and which contributed largely towards the difficulties in manufacturing activities.

At compilation of the procurement programs in accordance with the specifications of the General Staff, promises were received that the materials required for the purposes would be provided, but in actual practice these requirements were not met in a single case. The idea on which this method was based was that stocks possible still held by the manufacturing firms could be exploited, but actually it resulted regularly in a

waste of material which could have been used to better purpose with proper planning.

Faulty dispositions in this field assumed such proportions that in the end, in spite of the introduction of a system of rationing for materials, the allocations of steel were overdrawn by 8 million tons; more allocation certificates had been issued to industrial concerns than could be met from production.

Similar conditions existed in the field of aluminum supplies, showing a shortage of

6000 tons in 1941
14500 " " 1942
85000 " " 1943.

Unfortunately, it is not possible to determine from available records to what extent the materials substitute measures taken by the Substitute Materials Committee (Materialumstellungsausschuss) proved effective.

The result of these circumstances was that the plans prepared and the work taken in hand by industrial firms on the basis of supply certificates received were fallacious and had to be undertaken anew on a different supply basis.

In the matter of labor resources, the Technical Office and the Chief of AF Special Supply and Procurement Service had introduced comprehensive measures for the retraining of specialized and the training of unskilled German personnel, and later of foreign civilian labor and prisoners of war, so that

it was possible to increase the number of personnel employed in the armament industries from 3,500 in 1933 to 1,800,000 in 1945. However, in spite of the later appointment of Saukel as Plenipotentiary for Labor Control it was at no time after 1938 possible to meet the manpower requirements for execution of the various programs. Saukel's reports on his success in the field of labor procurement, which were not factual, served furthermore mislead the Reich Government concerning the actual labor situation.

In summarizing it can be stated that the directives established by Weapons Proving Branch 8 prior to 1933 to create conditions for smoothly functioning serial production, including manufacture by firms working under licence, provided a valuable basis for a commencement and continued operations in assembly line production by creating uniform regulations for the preparation of construction data and to insure interchangabality of parts regardless of the manufacturing firms, and by establishing standards, particularly for the materials to be used in manufacturing.

If they had been logically applied, the planning also done by The Air Force Technical Office for optimum exploitation of the available potentials in manufacturing materials and manpower, the measures taken to create the conditions

36 essential for such purposes insofar as these measures fell within the responsibility of the Office, and the detailed praparations for mobilization planning could have insured a maximum industrial output if manufacturing process had been allowed to proceed with a little interference as possible.

The system adhered to even during the war of introducing changes during serial production on a scale, caused by development and tactical specifications, far exceeding the limits of tolerance, the faulty development of the two aircraft types previously discussed, to gether with the inadequate supplies of manufacturing materials and their replacement by substitute materials caused constant readaptations during manufacturing processes on such a scale that it would be fallacious to speak of serial production at all.

The sweeping decentralization of industry particularly during the last phases of the war and due to enemy air attack against armament factories and communications facilities, and the distribution of manufacturing processes among factories with very small space and in some cases situated far apart, finally produced a situation in which industrial production had to rely exclusively on improvisations. That the industries nevertheless succeeded at least in bringing about a considerable in crease in the production of fighter aircraft is due to the devoted service of industrial

personnel and of the Technical Office.

3. The Influence of Basic Decisions by Command Authorities on Planning and Procurement. The mission assigned to the Air Force Technical Office in 1933 was to create within the shortest possible space of time the essential conditions for activation of an air force initially equal to and later superior to the air forces of other countries. The execution of this mission presupposed besides the development of aircraft types, engines, and items of equipment, a systematic build up of the aircraft manufacturing industry and the functioning of an interference-free, rational system of manufacturing.

The organization of the factories corresponded to their classification as fighter, bomber, or training aircraft factories for fuselages powered by air or liquid cooled engines. The preparatory work for serial manufacturing, which was on a relatively large scale compared with that required in other branches of industry, and the long duration of the manufacturing processes, particularly in the case of bomber aircraft, required planning well in advance in order to avoid faulty investments and in order to achieve a maximum exploitation of material investments and manpower.

The plans prepared in 1933 for industrial expansion

and procurement setting an initial target to be achieved by 1938 provides a suitable basis for the above, particularly in view of the fact that the previously mentioned principles for serial production had already been formulated and tested. In spite of very serious difficulties in the personnel field an expansion of the factories commensurate with current mobilization plans was achieved together with a steady increase in industrial output.

The output mounted in 1935 by 80 percent over 1934 figures and in 1936 by 60 percent over figures for 1935. In spite of the 1937 transition to new models and the resultant increased expenditure of effort a considerably increased output would also have been possible in that year if production had not been interrupted by Hitler's curtailment of the defence budget.

For this reason the total output figures for 1937 show an increase of only 9.5 percent over 1936, while in 1938 figures even showed a drop of 7.5 percent compared with 1937.

This seriously delayed transition to production of the types planned for the second phase of the main armament program, namely

Me- 109
Ju-87
Do-17 and
He-111

as well as ~~planned~~ projected output, both of which factors ne-

necessarily had an exceptionally adverse impact on the equipment of the air units.

Efforts were admittedly made to achieve the purpose of the budget reduction, which was to economize in materials, particularly steel, by a reduced production of the less important types, but the savings effected in this way were inadequate. Therefore, the production of even the most important types of front line aircraft could only be increased by 14 percent ~~xxxxxxx~~ in 1937 over the 1936 figure and in 1938 even dropped in 1938 by approximately 15 percent of the 1937 figures.

Assuming that the output could have been increased by only 50 percent in 1937 over 1936 and by 50 percent in 1938 over 1937, ~~d~~deliveries to front line units could have been at least 3,000 higher than they actually were, an added strength which could have had a decisive effect, particularly in the Air Battle for Britain.

As previously mentioned, current mobilizations plans in each phase provided the basis for industrial expansion, for the acquirement and preparation of the necessary manufacturing installations, and for the acquirement of the construction data and production facilities. The sequence of industrial mobilization was established and prepared in detail by the mobilization schedules for the individual factories and

had even been tried out in practice in a number of firms.

However, implementation of the mobilization in the event of a conflict presupposed a general mobilization of the national economy so that in a war it would be possible to exploit potentials not required for the general economy.

Contrary to expectations, Hitler did not proclaim a general mobilization of the national economy. The civilian economy, including the building construction projects of the Reich Government continued practically on a peacetime footing even after commencement of the war, without any appreciable reductions.

Important prerequisites for implementation of the mobilization schedules of the factories supporting the Air Force thus did not exist.

The reason for this can be assumed to have been a faulty appraisal of the political and military situation by Hitler caused by the favorable outcome of the 1939 and 1940 campaigns against Poland and France. The resultant and generally accepted view that the war would be of only short duration had influenced the Plenipotentiary General for Wartime Production to resist the exploitation of the industries serving civilian purposes for military purposes.

Although the output of the industries supporting the Air Force increased after the regulations imposing a limit on

41 industrial production had been cancelled and after the outbreak of the war, resulting in an output 40 percent higher in 1939 than in 1938, the growth percentage in 1940 over the 1939 figure sank to 33 percent, and in 1941 over the 1940 figure to 22 percent because of the absence of a general mobilization of the national economy and because of the priority given to the armament programs of the Army and Navy.

Another contributing cause must be assumed to have been the principle established by Goering, the Air Force General Staff, and in particular by General Udet that development projects were to take precedence over production.

The advantages of a numerically largest possible output were thus not exploited.

42 In order to compensate for Germany's anticipated numerical inferiority in air power, particularly after the USA became an active participant in the war, and in order to insure protection of German armament factories, Field Marshal Milch after assuming office as Chief of AF Special Supply and Procurement Services ordered the compilation of a plan study on the feasibility of manufacturing 6,000 fighter aircraft per month.

There can be no doubt that it would not have been possible to carry out this plan on the projected scale except at a serious disadvantage to the Army and Navy. It projected a shift of emphasis in industrial endeavour throughout the ar-

42 overall armament program to the production of fighter aircraft in order to have stronger defenses available and thereby protection for the homeland against the increasing air attacks which were to be expected. However, this plan, as well as all later requests that fighter aircraft production should be given the highest priority, was rejected by Hitler and Goering.

Neither Hitler nor Goering accepted as credible the figures on aircraft production, particularly in Britain and America, which were submitted regularly in comparison with figures on German output. Characteristic of the ruling attitude is the fact that a recommendation by Milch in 1942 to produce at least 1,000 fighter aircraft per month "...was rejected with laughter by Goering and the then Chief of the AF General Staff..." who required only 400 to 500 aircraft per month. This although the then Inspector of Fighter Forces, Galland, in a study on the subject had found that 4,000-5,000 aircraft were needed.[1]

43 Hitler went even furtherand demanded that the production of bombers should be given priority within the air armament program even at a time when the industries supporting the Air Force had already suffered severe damage, resulting in some cases in a complete loss of output.

Hitler's hopes for an early end of the war after conclusion of the campaigns in Poland and France had influenced

1. See Comments by General Koller on interrogation of Colonel von Brauchitsch.

Ans. 21 lbs. 7 ozs. rem. 7 ozs.

31) 364 lbs. 14 ozs. = 11 lbs. 12 ozs.
31
054
31
23
×16
138
230
368

368 + 14 = 382
31
072
62
10

Ans. 11 lbs. 12 ozs. rem. 10 ozs.

27) 364 lbs. 14 ozs. = 13 lbs. 8 ozs.
27
094
81
13
×16
78
130
208

208 + 14 = 222
216
006

Ans. 13 lbs. 8 ozs. rem. 6 ozs.

13 lbs 8 ozs × 7, 11, 9

21 lbs 7 ozs × 6
128 lbs 10 ozs

21 lbs 7 ozs × 6
128 10
16) 42 (2
32
10

11 lbs 12 ozs × 8
94 0

13 lbs. 8 ozs. × 7
94 8 ✓

13 lbs. 8 ozs. × 9
121 8 ✓

13 lbs. 8 ozs. × 11
148 8

13 × 11
13
13
143

him in 1941 to order all development projects stopped, a decision which interrupted ~~development work~~ or at least seriously delayed development work in several fields which would have been of decisive importance in the later conduct of the war. This applied, among other items, to the development of radar equipment, the He-177, Me-262, and Me-163-B aircraft types as well as the jet engines under development by the firms of Junkers and BMW.

Although engineers of the Technical Office endeavoured in particular to continue development of the Me-262 and of jet engines, this work suffered serious delays because of the lack of engineer personnel and other personnel and bacsuse of ~~the~~ the fact that Milch and Udet on the occasion of a visit to the Augsburg factory expressly confirmed the prohibition ~~to~~ to continue the development, ordering that preference should be given to the Me-209 and Me-410 projects.

In spite of the recognition given in 1943 to the importance of the Me-262 and jet engine projects, and although these projects were then included in the Air Force armaments program, production was still further delayed because of the low priority awarded to the air armament program as a whole.

The efforts made after the Me-262 was awarded the higgest priority in March 1944 and the ~~max~~ employment of all means available by the Fighter Production Staff to accelerate

production of these aircraft were frustrated by Hitler's decision that all Me-262 planes already completed and under construction were to be readapted as fighter-bombers. Although a total of 1,294 of these planes was completed by March 1945 only a small number went into combat service by the end of the war.

From the very start of the armament program considerable emphasis had been placed on promoting the development of radar equipment, so that the German Air Force had superiority in this field, which was the most important subject in the control of air units, until 1941. However, the order to stop development projects generally restricted continuation of work on projects the results of which could not be expected to be made available in the conduct of air warfare within a short while. Since this condition did not exist in respect to the research being done by the firm of Telefunken on the subject of the 5 to 10-centimeter wavebands at the beginning of the war, this work was halted or not continued with emphasis.

This work was only resumed after the British and American air forces were able to attack targets in Germany without regard for weather conditions with the aid of ultrashortwave equipment and had already to a great extent eliminated the German defenses.

45 Developments in the field of electronics were also hampered by the fact that, owing to the prohibition of amateur activities in this field for reasons of internal policies, the development of the instruments to be used required considerably greater efforts in point of structure and manufacturing processes than was the case in Britain and USA, so that it would be possible for personnel with little preliminary training to handle and service them. There can be no doubt that it would have been a great advantage, both in point of the technical requirements in manufacturing and in point of the use of the instruments in aircraft, if it had been possible to rely on xeperienced amateurs for the purpose.

It is ~~XIXX~~ to be assumed that the fact that the necessary conditions for the installation of ultarshortwave equipment did not exist in the aircraft in service also contributed towards the lack of emphasis on development in this field. Because of the great weight and size of the instruments at that stage of development in this field , the German twin-engine bomber aircraft were too small for their installation.

The lack of 4-engine aircraft thus also proved a serious disadvantage in this field, which was of such exceptional importance in the conduct of air warfare.

46 Since the performances of the 4-engine aircraft

46 developed by the firms of Junkers and Dornier in 1935 did not meet the specifications of the Air Force General Staff and because in consequence of the then prevalent views on the nature of any future view doubts existed concerning the possibility of using large bomber aircraft, further development of these two types was discontinued. As previously mentioned, it was 1937 before the Technical Office again received instructions to develop a 4-engine bomber capable of attacking at an angle of 50°. Because of the previously mentioned reasons, however, work on this project was also delayed almost until the end of the war.

Contradictory evidence is available on how the specification requiring the ability to attack at an angle of 50° was arrived at, so that it was not possible to elucidate this matter. Closer study would be necessary for this purpose.

The assumption that the campaign against Russia would come to an early end had influenced Hitler to prohibit the training of Russian prisoners of war. This measure had particularly adverse repercussions on the procurement programs and on production because, owing to the developments in the conflict which then followed it was not possible to effectuate the intended disbandment of fifty divisions and transfer the personnel thus released from military service to industry. The resultant discrepancy between production plans and

47 available manpower was only removed far later by the training given to Russian prisoners of war, which thus had after all become necessary. There is no possibility to determine in retrospect the loss in output due to the above circumstances, but they were indubitably extremely great.

Goering's political position had contributed towards giving the air armament program preponderance over the Army and Navy and had provided a strong impetus towards the implementation of that program within the industries. This did not adversely affect the manufacturing programs of the Army and Navy as long as adequate raw material and manpower resources were available to meet all requirements of the overall armament program and civilian needs.

Although the 1937 cut in the defence budget had affected all three military branches, the Air Force program still retained its position of priority.

In July 1939 this influenced the Commanders in Chief of the Army and Navy to persuade Hitler to from then on give preference to the armament projects of the Army and Navy, against the objections raised by Goering in view of the decisively important missions of air power in the war.

48 After the campaigns in Poland and France, emphasis in armaments admittedly again shifted in favor of the Air Force, but only a few months later preparations for Operation Sea

48 Lion (the intended invasion of Britain) took precedence over all other projects. Production in support of the Air Force thus dropped to fifth place on the priority list and this fatefully unfavorable condition for the conduct of air warfare continued, in spite of numerous complaints by Goering and particularly by Milch, until the Fighter Production Staff was formed in March 1944. All that could be achieved during this whole period was to obtain temporary priority rulings listing particularly difficult bottleneck projects as top priority armament projects.

Symptomatic of the predudiced position of the Air Force armament programs is the decision made by Hitler on 14 January 1942 that the Air Force program was to be carried out within the scope of the raw materials allocation.

As previously mentioned the classification of the Air Force programs as fifth on the priority list made allocations of materials and manpower appropriate to requirements impossible, both the specifications given by the Air Force General Staff to the Chief of AF Special Supply and Procurement Services and the current industrial programs were subject to continuous changes, which resulted in considerable wastages in materials and manpower hours. Together with the factors previously mentioned, this classification contributed largely to prevent rationalized manufacturing and

49 and an optimum exploitation of the existing potentials, finally creating conditions in which manufacturing activities to a great extent assumed the characteristics of improvisations.

The decision of March 1944 to place at least fighter aircraft production in the top priority category was indubitably made under the stark impression of the results of Allied air attacks against the Air Force supporting industries and against cities, but it came too late. At this stage it was no longer possible to break the superiority of the Allied air forces or to prevent further decisively important destruction, particularly of coal hydrating works and the communications system.

Facts also reveal that changes in priority classifications often occurred so quickly that the industries were unable to make the necessary adaptations within the required time.

Appendix

In many cases priority classifications were changed before the previous classifications had even taken effect.

Besides shortages in materials and manpower and the adaptations and changes necessitated by supplementary specifications of higher level commands, short deadline projects also did much to prevent rationalized production.

This applied above all to measures concerning the

49 the purposes for which aircraft and engines were to be adapted.

Aircraft, engines, and items of equipment were designed for specified uses in the areas of Central Europe and the corresponding climatic conditions. They were in no way designed for use of the operations of forces in Soviet Russia of Africa. By means of comprehensive special industrial projects projects the necessary additional work was done, all other projects being postponed for the purpose. However, this necessitated the withdrawal of highly qualified skilled and supervisory personnel from their normal manufacturing functions. In addition, the necessity arose to have factory teams for dispatch to the field units in order to repair damages caused there by inappropriate preparation and training for special conditions, and these teams were also lost to normal manufacturing activities. This happened particularly during the first stages of the campaigns in Africa and Soviet Russia and applied in particular to aircraft, engines and ground equipment.

The faulty basic decisions made by the highest levels of command leading to the unfavorable developments in the conduct of the war were for the most part due to a faulty appraisal of the material and manpower potentials available to the Allies and a considerable overestimate of German power potentials.

However, those decisions were also largely due to personal views and personal influences.

Any attempt to finally clarify the reasons leading to the faulty decisions made already prior to, but in particular during, the war, would require mor detailed research, which would exceed the scope of this present study. Nevertheless, it does seem necessary to draw attention to certain events which had a direct influence on procurement activities.

The unfavorable development of air armaments, which fell short of Goering's expectations but was caused primarily by the previously discussed high level command decisions resulted in Goering's largely negative attitude towards technology, which finally led him to blame technology for the inability of the Air Force units to execute their assigned missions. These views of Goering found vent in the court-martial trial, by his orders, of a brigadier general and two engineers in general rank of the AF Special Supply and Procurement Service, atrial which produced no results in spite of his repeated orders for a retrial, and in his orders to replace a large number of the specialized technological personnel of the Service by officers, most of whom had no technological training.

There can be no doubt that ~~his wrong views on~~

51 in his wrong views on technological subjects he was influenced by the inadequate and sometimes false information given to him by his technical officer, an inexperienced young General Staff Corps captain, and ~~thxx~~ by the fact that he gave more consideration to the views of front line officers on technical subjects than to the voews of the expert engineering personnel of the Technical Office. It is to be assumed that in making his decisions Hitler was partly influenced

52 by Goering's wishful thinking, which was not commensurate with facts, in matters of technology.

Another factor contributing towards Hitler's faulty views was the previously mentioned affirmation given by Professor Messerschmitt that the Me-262 could carry bombs, which led to the fateful decision to reequip as fighter-bombers all Me-262 planes already completed or under construction.

It must also be assumed that other persons, with insight into only a part of the subject, influenced Hitler and Goering to adopt views not in conformity with facts. Under this heading must be included the efforts of the heads of various firms to circumvent the Technical Office in obtaining advantages for their own firms.

The preference given to development projects, also during the war, which coincided with the personal views of

52 General Udet and Udet's aversion to properly regulated routine--which found expression in the confusing organization introduced by him in the Office of the Chief of AF Special Supply and Procurement Service--have already been discussed in Chapter II, 3, above.

The fact that air armament remained so low on the priority list was indubitably due in part to the anti-military attitude of the National Socialist Party, an attitude upheld by Office Chief Saur as long as Air Force armaments were not included within the scope of his Office. The fact that the fighter production program was only awarded appropriate priority when it was already too late was due primarily to this attitude.