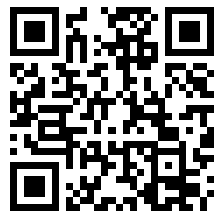

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**HISTORY OF
THE SECOND WORLD WAR
UNITED KINGDOM MILITARY SERIES**

Edited by SIR JAMES BUTLER

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THE
STRATEGIC AIR OFFENSIVE
AGAINST GERMANY

1939—1945

Volume IV

Annexes and Appendices

BY

SIR CHARLES WEBSTER

K.C.M.G., F.B.A., D.LITT.

AND

NOBLE FRANKLAND

D.F.C., M.A., D.PHIL.

LONDON: 1961

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Price £2 2s. 0d. net

Printed in Great Britain under the authority of Her Majesty's Stationery Office
by Butler & Tanner Ltd., Frome and London

57-11-
-31-61
S.C. 8207

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SECTION I

Annexes

ANNEX I

The Principal Radar Aids to Navigation and Bomb Aiming

Gee, Oboe, H2S, and G-H

DURING the Second World War no radar device was evolved which, for long-range flights, formed a complete substitute for dead-reckoning navigation. Nor was any radar method of blind bombing as accurate as visual aiming when the target could clearly be seen. But as an aid to dead-reckoning navigation and as a means of bomb aiming when the target was obscured, radar was fundamental to the success of Bomber Command.

Dead-reckoning navigation was the process by which two vectors, the course and airspeed of the aircraft and the direction and speed of the wind, were computed in order to produce a third vector, the track and ground speed of the aircraft. The first vector was simply a matter of co-operation between the pilot, who steered, and the navigator, who plotted.¹ The second was to a large extent unpredictable and, of course, it varied with height as well as with changing meteorological conditions. The third vector was the vital one, for upon it depended the actual path of the aircraft over the ground. Thus, the principal problem in air navigation was the calculation of the wind vector, and, because it constantly changed, the frequent calculation of it.

There were a number of ways in which the wind vector could be calculated, but the only practicable method for long-range night flying was by a comparison of the air position, that is the position produced by the course and airspeed vector or, in other words, the position which the aircraft would have reached in conditions of zero wind, with the ground position, that is the geographical position of the aircraft. Thus, dead-reckoning navigation, which began on the basis of the meteorological forecast of the wind, could accurately continue only on that of reliable observations of the ground position or upon the process known as taking a fix.

The value of fixing, as should now be clear, was that it enabled the navigator to calculate the wind and, therefore, the course which the pilot ought to steer in order to make good the required track. Since, however,

¹ This, however, was not an entirely simple proposition, especially at night. Pilots could not hold heavy aircraft constantly on precise headings and their attempts to do so were often vitiated by the need to take evasive action during which magnetic compasses tended to swing aimlessly and gyro compasses often toppled. Moreover, instruments did not give true readings. Air Speed Indicators had to be corrected for position error, temperature and altitude, altimeters for barometric pressure, magnetic compasses for variation caused by the magnetic field of the earth, and for deviation caused by that of the aircraft, and gyro compasses for wander caused by the spin of the earth. Navigators had to work fast in somewhat cramped and poorly lighted conditions. They also had to draw straight lines on vibrating surfaces.

Bomber Command aimed, at any rate from 1942 onwards, at a high degree of concentration both on the route and at the target, it was necessary not only to keep on the right track but also on the prearranged time schedule. Wind finding, therefore, had to be constant and as up to date as possible, which meant that fixing had to be regular, accurate and, because an aircraft can travel several miles off track in a few minutes, quick. At the beginning of the war there was no method of doing this and there was for that reason no systematic dead-reckoning navigation in Bomber Command. What is surprising about the years before 1942 is not that so many crews failed to find their targets, but that more of them did not fail to find England on their return.

There were, of course, several methods of taking fixes. Map-reading was the most elementary, but in Bomber Command it was seldom a practicable proposition because crews flying at altitude in the darkness, and often in cloud as well, seldom caught a recognisable glimpse of the ground. Astro-navigation was another possibility, but the stars were often obscured by cloud, and, even if they were not, sighting them from a wallowing and, perhaps, evading aircraft was not only a lengthy but a highly skilled process which seldom produced an accurate fix. Finally there was radio direction finding, which was also a lengthy, highly skilled and generally inaccurate business. Thus, until the introduction of radar, there was in Bomber Command no regular and reliable method of taking fixes.

Radar, which for convenience is generally taken to include *Gee*,¹ did in the form of the latter and of *H2S*, though only under certain conditions, provide such a method, and it became the backbone of dead-reckoning navigation in Bomber Command. But radar, especially in the form of *Oboe* and *G-H*, also had an important bearing upon the problem of bomb aiming. When the target could not be clearly sighted and even more so when it could not be sighted at all, radar blind bombing provided an almost infinitely superior method of attack to the old system of bombing at the expected time of arrival over the target. Without radar, the bulk of Bomber Command crews would have continued to fail to find the target area, and on many occasions those that did would have been unable to hit the target.

The *Gee* System

The *Gee* system consisted in the reception by equipment in the aircraft of pulse transmissions from three ground stations situated on a base line of approximately two hundred miles in length. One of these transmitters was known as the 'A' or 'Master' station and the other two were called the 'B' and 'C' or 'Slave' stations. Each 'Slave' transmission was locked to a 'Master' transmission and the differences in the time taken by the 'A' and 'B' and the 'A' and 'C' signals to reach the aircraft were measured and displayed on a cathode-ray tube on the navigator's table in the air-

¹ Radar is a term which can be applied with strict accuracy to devices like *H2S* and *Oboe* which exploited a radio echo. *Gee*, which depended upon the direct transmission and reception of radio pulses was, therefore, not really a radar device.

craft. From them, the aircraft could be located on two position lines known as *Gee* co-ordinates and the ground position of the aircraft coincided with the point at which these co-ordinates, which were printed as a grid on special *Gee* charts, intersected.¹ The co-ordinates could be obtained by a competent navigator in less than a minute.

The accuracy of a *Gee* fix varied from less than half a mile to about five miles and depended upon the skill of the navigator, upon whether the aircraft was in an area where the *Gee* grid intersected acutely or obtusely and upon the range of the aircraft from the transmitters. The range of *Gee* itself varied with conditions from three to four hundred miles, but in general, the rule was that the greater was the range the less was the accuracy.²

Gee was thus an admirable aid to dead-reckoning navigation, for it provided a reasonably accurate and regular means of fixing the ground position. Over short distances it could also be used as a homing device. In this event, the *Gee* co-ordinates of the place it was desired to reach were set up on the cathode-ray tube and the aircraft was then steered in such a way as to bring the pulses into line. Originally it was hoped that this would offer a means of blind bombing but, in practice, as was shown by the 1942 attacks on Essen, *Gee* was not, at that range, sufficiently accurate for the purpose. Nevertheless, over England on the return flight, *Gee* was generally used for homing to base, which meant that aircraft could come home on prearranged co-ordinates without fear of getting lost and with a much reduced risk while losing height of running into hills or other aircraft.

LIMITATIONS AND DISADVANTAGES OF GEE

The principal limitation of *Gee* was its lack of range, to which reference has already been made. Over Germany, it was seldom of any use to the east of the Ruhr. In addition it was, as has also been mentioned, not accurate enough for effective blind bombing. The principal disadvantage of the system was its extreme susceptibility to jamming, which had been foreseen from the beginning. Almost exactly as had been expected, the Germans began effective jamming some five months after the general introduction of *Gee*, and after that fixes could rarely be obtained anywhere east of the Dutch coast, and *Gee* became useful only for navigation over the North Sea and parts of France, as well as for homing to base. Another disadvantage of *Gee* was that, being more accurate over England than over Germany, it conferred a greater target-finding advantage on the *Luftwaffe* than on Bomber Command. This eventually led to the necessity for coding the *Gee* pulses, which increased the time taken to get a fix and raised possibilities of confusion which sometimes occurred.

DEVELOPMENT AND INTRODUCTION OF GEE

Scientific proposals for a system like that eventually used for *Gee* were put forward in 1938, but it was not until 1940 that the actual development

¹ The code name *Gee* was derived from the letter G for grid.

² Sometimes the range was much greater. On the night of 3rd December 1942, for example, accurate *Gee* fixes were taken by some navigators over Turin, which was 730 miles from the 'Master' station in use that night. A.H.B. Monograph.

of the apparatus was begun. Two officers from Bomber Command were given an airborne demonstration of the equipment by the Telecommunications Research Establishment in October 1940 and official recognition of the potential value of *Gee* followed. There were, however, differences of opinion as to whether the equipment should be put into the earliest possible operational use in a small number of bombers which could be used in a kind of pathfinder role as fire-raisers or whether it should be delayed until a really substantial number of bombers could be equipped.

While this debate was going on, the service trials of *Gee* were begun in May 1941 when the device was still primarily regarded as a means of blind bombing, but mass production was delayed by severe technical difficulties with the production of one of the valves. Nevertheless, a small number of Wellingtons belonging to 115 Squadron had been equipped with *Gee* by July 1941 and the system was operated over Germany for the first time in two of these Wellingtons on the night of 11th August 1941 when very encouraging results were obtained over the Ruhr. On the night of 12th August two *Gee* Wellingtons flew over Hanover, but one of them failed to return, and after a third *Gee* operation, also involving the use of two Wellingtons, it was decided not to make any further use of the equipment until three hundred bombers could be equipped with it. This target had, however, by no means been reached, when on the night of 8th March 1942 *Gee* was put into general operational service with Bomber Command. Though there is no evidence to suggest that the Germans learnt anything from the *Gee* Wellington which was brought down on the night of 12th August 1941, they did start effective *Gee* jamming on the night of 4th August 1942.¹

Despite the jamming, *Gee* justly continued to be regarded as essential equipment for Bomber Command. By August 1942, eighty per cent of the operational force was equipped with it and by January 1943 the whole force had been fitted.² The *Gee* coverage, which had initially been focused on the Ruhr by a group of transmitters known as the Eastern Chain, was also increased by the opening of further chains among which were the Northern and Southern Chains, the latter of which covered northern France. An improved version of the equipment, known as *Gee* Mark II, was operationally introduced in February 1943, and by the end of March 1943, sixty per cent of the force had received the new equipment. Its anti-jamming devices afforded some slight and temporary relief from the German counter-measures, but apart from being rather easier to use in the air, the Mark II equipment had no other significant advantages by comparison with the Mark I. No effective and lasting means of cutting out the enemy jamming of *Gee* was ever found,³ but throughout the war the equipment was always valued by those who used it even if only because it offered them an easy and safe passage home after they had completed their operation.

¹ A.H.B. Monograph and Bomber Cmd. memo. on introduction of *Gee*, May 1942.

² O.R.S.(B.C.) Report, 20th May 1943. 'Before the end of the war 80 per cent of the 8th Air Force was flying with it [*Gee*], and the 9th, 12th, and 15th were using it as well.' James Phinney Baxter 3rd: *Scientists Against Time* (Boston, 1946), p. 95.

³ A.H.B. Monograph.

The *Oboe* System

Oboe was a system of blind bombing in which the aircraft was controlled by a pair of ground stations. Each ground station transmitted pulses and received them back after they had been boosted by equipment in the aircraft. This enabled the ground stations to measure the range of the aircraft from themselves. One station, known as the 'Cat', was responsible for the track of the aircraft over the target and the other, known as the 'Mouse', calculated the point on that track at which the bombs should be released. The method of achieving this was to describe an arc through the target of constant range from the 'Cat' station. This arc was, in effect, part of a circle whose circumference passed through the target and whose centre was the 'Cat'. The task of the 'Cat' was to keep the aircraft flying along the arc or, in other words, to keep it moving at a constant distance from itself. This was done by measuring its range and transmitting dots or dashes to indicate deviations to either side of the required track.¹ Meanwhile, the 'Mouse' station, which was normally situated about a hundred miles from the 'Cat', was, also by the process of range measurement, able to compute the movement of the aircraft as a component of its progress along a line joining the 'Mouse' station and the target.² By considering these data and taking into account the ballistics of the bomb or marker to be dropped, the moment to release the weapon could be calculated and signalled to the aircraft.

The range of *Oboe* was limited by the fact that the pulses travelled at a tangent to the surface of the earth and it was, therefore, controlled by the altitude which could be reached by the aircraft. At about twenty-eight thousand feet the range was approximately two-hundred and seventy miles, which meant that targets in the Ruhr could be reached. This consideration of altitude was one of the determining factors in the decision to use Mosquitoes as the vehicle of *Oboe* since they had a greater ceiling than any other aircraft in Bomber Command.³ Another factor in the same decision was the great speed of the Mosquito, which made it less vulnerable to the enemy defences while engaged on its *Oboe* run, during which, of course, evasive action had to be avoided. *Oboe* aircraft normally navigated by other means to a point within about ten miles from the target and listened to the 'Cat' and 'Mouse' thereafter.

The accuracy of blind bombing by *Oboe* under operational conditions was difficult to determine. It has been discussed at various stages of the war in the preceding volumes and it would, perhaps, be misleading to say more here than that it was normally to be measured in terms not, as was the case with *Gee*, of miles, but of hundreds of yards. Obviously the *Oboe* system required a high degree of flying skill by the crew of the aircraft

¹ It seemed to some that the sounds produced by an experimental version of this equipment resembled those emitted by an oboe. Hence arose the code name *Oboe*.

² Though the aircraft did not, of course, actually travel along this line.

³ A method of extending *Oboe* range by boosting the signals with *Oboe* repeaters carried in aircraft flying between the ground stations and the *Oboe* aircraft was developed. By this means it was intended to bring the whole of Germany within *Oboe* range, but the system was not extensively developed during the war.

as well as most accurate calculations by the staff at the ground stations. The improving accuracy of *Oboe* in the later stages of the war was due as much to the increasing fund of experience of its use in the air and on the ground and to greater precision in the calibration of the equipment as to actual improvements in the device itself.

LIMITATIONS AND DISADVANTAGES OF *OBOE*

As in the case of *Gee*, one of the principal limitations of *Oboe* was its lack of range but, as has been seen, this in the case of the latter was even more restricted than in that of the former. It seems evident that one of the reasons for which a greater effort was not made to increase the range of *Oboe* by the introduction of repeater aircraft, was the unduly optimistic expectation with which the introduction of *H2S* was awaited.

Oboe also had the disadvantage of being susceptible not only to enemy jamming but to interference from other radar transmissions being made by or for the benefit of Bomber Command. These difficulties would, perhaps, ultimately have largely neutralised the value of Mark I *Oboe* which operated on a wavelength of one and a half metres. The introduction of a complex method of avoiding interference known as 'K' *Oboe* and later the production of centimetric Mark II and Mark III *Oboe* fortunately succeeded not only in maintaining but actually increasing the operational value of the device until the end of the war.

There was, however, a fundamental limitation to the use of *Oboe* which was not in any sense shared by *Gee*. This related to the number of aircraft which could operate the system at the same time. Initially one pair of *Oboe* transmitters could control only one aircraft at the same time, and since an *Oboe* run normally took about ten minutes this meant that only six *Oboe*-directed bombs or markers could be dropped in the space of an hour. Target indicators generally burned for only six minutes, which meant that *Oboe* marking was, in the early stages, certain to be punctuated with four-minute gaps, and in the event of a single *Oboe* run failing, the gap would be extended to fourteen minutes. The methods by which Bomber Command adapted its tactics to combat this limitation have been discussed,¹ but the opening of more *Oboe* transmitting stations as well as the development of multi-channel control, whereby a single pair of stations could control more than one aircraft by working on different pulse frequencies, gradually increased the *Oboe* concentration which could be achieved. Between December 1942, when *Oboe* was first operationally introduced, and the end of the war, the Royal Air Force carried out some one thousand seven hundred and ninety-one operations in which *Oboe*-equipped aircraft took part. These involved 9,624 individual *Oboe* sorties. The United States Army Air Forces also used *Oboe*, and between 20th October 1943 and 1st May 1945 they undertook 627 *Oboe* operations involving some 1,663 *Oboe* sorties.²

The numbers limitation did, however, always mean that *Oboe* could not be used as an instrument of the main force. In fact, it was largely,

¹ See Vol. II, Ch. X.

² In July 1943 three pairs of *Oboe* stations were operating. This meant that eighteen *Oboe* Mosquitoes per hour could be controlled. See *Bomber Offensive*, pp. 160-161.

though not exclusively, used for Pathfinder Force marking from Mosquito aircraft. Small forces of Mosquitoes also employed it for precision bombing, and in the later stages of the war it was used both in Lancasters and Mosquitoes by the leading aircraft in *Oboe* formation bombing.¹

DEVELOPMENT AND INTRODUCTION OF *OBOE*

The development of *Oboe* originally proceeded from the use in 1940 of Lorenz beams by the *Luftwaffe* which were the subject of much popular speculation both at the time and since. In November 1940 it was discovered that the Germans had adopted the method of laying two radio beams over England in such a way as to intersect at the target. They thus formed both a navigation and bombing aid to German aircraft in their night offensive against British targets.

These German beam methods were promptly investigated by the Wireless Investigation and Development Unit at Boscombe Down, which was a part of the radio counter-measures organisation, then known as 80 Wing. In December 1940, the Boscombe Down Unit was formed into a 3 Group Squadron and given the subsequently famous number of 109. 109 Squadron was initially equipped with one flight of Ansons which were to be engaged upon the development of radio counter-measures and one of Wellingtons which was primarily to be devoted to the development of blind beam attack by Bomber Command. From the Anson flight there were eventually derived the operational radio counter-measures squadrons of 100 Group, and from the Wellington flight came the *Oboe* marking squadrons of the Pathfinder Force. The German Lorenz beams, indeed, initiated a development which ultimately did vastly more harm to Germany than to Britain.

The initial use of beams by 109 Squadron was somewhat crude. In December 1940 and January 1941 aircraft of the Wellington flight were fitted with equipment which enabled them to fly down the German Lorenz beams. They then did this and dropped bombs when they reached the zone of silence over the Cherbourg peninsula. The result was not, however, the destruction of the Lorenz transmitters. Meanwhile, partly on the basis of these experiences, the Telecommunications Research Establishment began to experiment with radar range and bearing apparatus which eventually developed into the *Oboe* system, and in December 1941 a rudimentary form of *Oboe* was used by 3 Group Stirlings of 7 and 15 Squadrons carrying second pilots and wireless operators from 109 Squadron, in a series of attempts to bomb the *Scharnhorst* and the *Gneisenau* at Brest. Some reasonably accurate results were obtained, but the equipment proved to be highly unreliable in operation. Nevertheless, Bomber Command now gave full support to the plans for the development of the *Oboe* system, which it was then hoped would come into operation in July 1942. In fact, however, *Oboe* Mark I was operationally introduced in December 1942, *Oboe* Mark II in October 1943 and *Oboe* Mark III in April 1944.²

¹ The foregoing passages are largely based upon the A.H.B. Monograph.

² A.H.B. Monograph.

The introduction of *Oboe*, which could only be used by a very small number of aircraft, did not confront the Air Staff with the kind of policy problems which had been raised by the development of *Gee*, which could be used by an unlimited number of aircraft. It was, therefore, after the successful flight trials of *Oboe* in the spring of 1942, not difficult to decide that the equipment should be developed and pressed into service at the greatest possible speed. But to achieve this, selective decisions inevitably involving heavy sacrifices had to be made. The plan to introduce *Oboe* Mark I for use against the Ruhr as soon as possible had the result of delaying the development of Mark II and Mark III centimetric *Oboe* and also the *Oboe* repeater project by which it was intended to bring targets as far afield as Berlin and Munich within range. It did, however, mean, as has already been mentioned, that Mark I *Oboe* was ready for the use of 109 Squadron Mosquitoes by the end of 1942, and the effect of this on the Battle of the Ruhr, which began in March 1943, can scarcely be exaggerated.

Nevertheless, because of the susceptibility to jamming of Mark I *Oboe*, which it was reasonable to suppose would quickly be exploited by the Germans, the development of centimetric *Oboe* could not be and was not abandoned. On the other hand, the repeater project was unfortunately looked on with less favour owing to the mistaken belief that *H2S* would provide an adequate alternative to the extension of *Oboe* range. The Germans, however, were somewhat slow in reacting to the *Oboe* challenge, and they do not appear to have succeeded in operating any jammers until August 1943. Even so, serious interference with *Oboe* reception due to other causes, among them the use of *Monica* by Bomber Command,¹ became apparent in the spring of 1943. As a result, 'K' *Oboe* was introduced and the changeover was completed by the middle of June 1943.

Meanwhile, experiments with various kinds of centimetric Mark II *Oboe*, which were given the code names of *Penuiper*, *Pepperbox* and *Album Leaf*, were proceeding. The *Album Leaf Oboe*, which consisted of a hybrid American-produced transmitter and modulator and a British-produced receiver, established itself as the best device, and it did so only just in time. Though at the beginning of November 1943 Bomber Command had affirmed that Mark I *Oboe* was still functioning satisfactorily, the system was virtually disrupted by jamming in the middle of the same month. *Album Leaf Oboe*, working on the centimetric wavelength, then came rapidly into service. Mark III *Oboe*, which differed from the Mark II only in that it had a different kind of filter unit, was also pressed forward.

In addition to the opening of numerous fixed *Oboe* stations in England, (by December 1943 there were fourteen of them) mobile stations were also prepared which, after the invasion of Europe, moved up behind the allied armies and extended the range of the system by that means. The first of these mobile stations was moved to France towards the end of August 1944, and eventually several were moved into German territory. In April 1945

¹ *Monica* was a radar device similar in principle to *H2S*. A backward-looking transmitter sent out signals which were reflected by aircraft in the vicinity. Range and bearing data were displayed on a cathode-ray tube. The object was to provide early warning of fighter attack.

Oboe was used for marking Berlin itself. By that time the Germans were having some success in jamming centimetric *Oboe*, but the equipment never yielded to counter-measures to anything like the extent which had been the fate of *Gee*.¹

The *H2S* System

H2S provided a method of radar map-reading which could be used as an aid to navigation and as a means of blind bombing. The system depended upon the discovery that radar transmissions were returned as echoes of a different and distinctive nature by ground features of a different and distinctive nature. Thus, the radar echo produced by a built-up area was different from that produced by open country, the echo from a land surface was different from that from a water surface and the echo from a ship on the surface of the sea could be distinguished from that of the sea.

The way in which this discovery was exploited in the case of *H2S* was to equip the aircraft with a downward-looking rotating radar transmitter which 'scanned' the ground beneath the aircraft. The returning echoes were picked up by receiving equipment in the aircraft and displayed on a circular cathode-ray tube which corresponded to the circular rotation of the transmitter. Thus, the navigator was presented with a radar impression of the territory over which his aircraft was passing. Since the distinction between water and land was particularly clear, coastlines, lakes and large rivers could be identified. The radar response of towns could also be seen, and sometimes even railway lines could be identified. By measuring his bearing and distance from identified features on either side of his track the navigator could fix his position and, in this way, use *H2S* as an aid to navigation. Moreover, as the aircraft approached the target, and, provided it could be identified on the *H2S* cathode-ray tube, the bombing run could be made blindly and the bombs dropped blindly, purely on *H2S* indications. If the target could not be identified by *H2S* or by visual means, an *H2S* run to a nearby identifiable landmark could be made and a timed run from there to the target could be carried out.

Since both the transmission and reception was effected exclusively by equipment in the aircraft, there was no dependence upon ground transmitters and the range at which *H2S* could be used was, therefore, limited only by that of the aircraft which carried it. In this respect, *H2S* was markedly superior both to *Gee* and to *Oboe*.

LIMITATIONS AND DISADVANTAGES OF *H2S*

H2S did, nevertheless, suffer from some limitations, and there were also a number of serious disadvantages which arose from its use. Though the shape of coastlines, lakes and large waterways was generally indicated with a high degree of geographical veracity, the same was not often the case where the reflections from built-up area were concerned. It was generally quite easy to determine whether the aircraft was near a town or in open country, but in the former case it was often very difficult to determine

¹ A.H.B. Monograph.

which town was on the screen, and in the latter case it was even more difficult to determine the locality. The radar image of a town by no means necessarily corresponded with the actual shape of that town and the image which was reproduced varied considerably in accordance with the angle from which it was 'looked at' by the radar scanner. *H2S* interpretation was, therefore, a highly skilled business, and on many occasions it was only possible at all if the navigator already knew from other sources at least approximately where he was. *H2S* by no means presented the clear and precise picture which has often been attributed to it.

Another limitation of *H2S* was the fact that over very large built-up areas the whole screen was filled with such an intense blaze of response that it became impossible to identify anything. This was especially the case over Berlin and its suburbs. It meant that the value of *H2S* as a means of blind bombing was conditioned not only by the radar characteristics but also by the size of the target. As will have become apparent, *H2S* as a means of blind bombing was, in fact, a poor substitute for *Oboe* except in the case of certain targets with pronounced *H2S* features, notable among which was Hamburg.

In addition to its limitations, the use of *H2S* had two salient disadvantages. Since it depended upon transmitters in the aircraft it inevitably provided the Germans with an excellent radar means of locating the bomber stream and thus enabling their night fighters to 'home' to the source. Secondly, since the principle of *H2S* was strictly similar to that of A.S.V., which was used by Coastal Command to locate ships and submarines on the surface of the sea,¹ the use of *H2S* over enemy territory naturally endangered the secrecy which had previously shrouded A.S.V.

H2S working on a centimetric wavelength was operationally introduced in January 1943, and early in the following March the Germans recovered a set from a Bomber Command aircraft which came down near Rotterdam. The equipment was badly damaged, but the Germans succeeded in reassembling it at the Telefunken laboratories. There, by a curious stroke of chance, it was again badly damaged in an air raid, but once again it was reassembled, this time in one of Berlin's air-raid bunkers. Professor Brandt, who had supervised these operations, was then able to watch the radar impression of Berlin produced by this Bomber Command *H2S* apparatus, and the significance of what was revealed did not escape him and his assistants. It became clear, though only after a surprisingly long delay, that the explanation of Coastal Command's recent success against submarines must be due to the introduction of centimetric A.S.V. German U-boats which had been getting no response from their A.S.V. warning apparatus on a metric wavelength were, though again after a long delay, equipped with a device called *Naxos*. This enabled them to pick up A.S.V. centimetric transmissions and, therefore, to submerge before being attacked.²

Naxos, however, had another application which meanwhile had offered Bomber Command a severe and direct threat. The *Naxos* search apparatus

¹ A.S.V. stood for Air to Surface Vessel.

² The Germans began to equip U-boats with *Naxos* in October 1943, but it was not until the end of the year that the full implications of centimetric A.S.V. were realised by Admiral Doenitz.

was adapted and fitted to German night fighters, in which it proved to have a homing range of about fifty kilometres. Thus, the interception problem of the German night fighters in their struggle against the night bombers was greatly reduced. By the end of the war some 1,500 German night fighters had been equipped with *Naxos*.¹

The existence of *Naxos* was realised at Bomber Command and some ugly rumours about its efficiency were sometimes discussed in the briefing rooms on the squadrons. The decision as to whether the advantages of *H2S* outweighed the dangers of *Naxos* or not was a difficult one, but as is recorded in an appendix to Sir Arthur Harris' Despatch, a partial *H2S* silence was imposed upon Bomber Command in the autumn of 1944.² If more had been known in Britain at the time about the second German exploitation of *H2S*, this decision might well have been taken earlier.

In addition to the development of sea and airborne *Naxos* the Germans also perfected a device known as *Korfu*, which enabled them to detect *H2S* from the ground. In due course a *Korfu* network was spread throughout the entire air defence system of western Germany and it produced remarkable results. *H2S* transmissions coming from bombers parked on their bases in England could be detected in Germany, and the position of any *H2S* bomber stream could constantly be plotted from the time of its take-off until its landing.³

DEVELOPMENT AND INTRODUCTION OF *H2S*

Historically, *H2S* was the earliest of the Bomber Command radar aids, for it owed its origin to the development of airborne radar apparatus which eventually came into service as A.I. for the detection of enemy aircraft.⁴ By December 1936 a radar receiver had been installed in a Heyford aircraft. Early in 1937 this was supplemented by a small transmitter, and flight trials were begun. The receiver proved to be insufficiently sensitive to record echoes from other aircraft, but it did show the difference between responses from land and water and between those from built-up and open country. On one of these test flights the position of the railway lines approaching Harwich was remarkably clear.

Dr. E. G. Bowen, who had been largely responsible for these experiments and had himself seen the Harwich response, immediately realised the navigational significance of what had occurred, but the overriding priority then being accorded to the scientific problems of air defence delayed the development of what in a rudimentary form was *H2S*. The continuing priority for air defence and, therefore, in this connection, for the development of A.I., was not, however, sufficient to kill Dr. Bowen's interest in *H2S*, nor did it dissuade the Commander-in-Chief, Bomber

¹ Frankfurt Radar Conference, 1953. Extract from paper by Professor L. Brandt.

² *Harris Despatch* and A.H.B. Monograph. *Naxos* came into operational service with *Gruppe II* in January 1944. Though it enabled German pilots to home on the bomber stream it was not precise enough for individual target selection. Thus, the conclusion reached in the course of 1944 by Bomber Command that an aircraft equipped with *H2S* was, as an individual, in no greater danger than one without *H2S*, was correct.

³ Paper by Professor Brandt cited above and A.H.B. Monograph. *Korfu* was in extensive operational service by July 1944.

⁴ A.I. stood for Air Interception.

Command, Sir Edgar Ludlow-Hewitt, from making a clear statement of the operational need for it in 1938.¹ Nevertheless, it was not until Lord Cherwell had emphasised the findings of the Butt Report in September 1941 that any vigorous official support was given to the idea of adapting A.S.V. to the navigational requirements of Bomber Command.

Centimetric A.I. equipment in a Blenheim night fighter was then adjusted and an *H2S*, or as it was then called B.N. for Blind Navigation, test flight was undertaken on 1st November 1941 with very promising results. The disadvantages of using centimetric radar over enemy territory were, however, obvious. Moreover, the best results could only be obtained by the use of the still highly-secret magnetron valve. These were serious considerations which did not accelerate the introduction of *H2S*.

The use of the Klystron valve, which was known to the Germans, produced much less precise *H2S* results, but it was considered that these would be good enough substantially to increase the proportion of bombs falling on built-up areas as opposed to open country, and the decision to develop Klystron *H2S* for Bomber Command was taken early in 1942. Meanwhile, magnetron A.S.V. was being developed for Coastal Command. Flight trials of Klystron *H2S* carried out in a Halifax during April 1942 were, however, disappointing, and a serious setback occurred in June 1942 when nearly half of the scientific team engaged on *H2S* development was killed in a Halifax crash. Ultimately, in the late summer, it was decided that the magnetron valve should be used in *H2S*.

Serious production difficulties still lay ahead, but by the middle of January ten Halifaxes of 35 Squadron and thirteen Stirlings of 7 Squadron had been fitted with *H2S*. Even this had only been achieved after serious competition between the A.S.V. requirement of Coastal Command and that for *H2S* of Bomber Command. The first operational use of *H2S* by Bomber Command occurred on the night of 30th January 1943 when the target was Hamburg, but the fitting of the new equipment continued to be slow, and by the end of May 1943 the highest number of *H2S* aircraft operating in a single attack was no more than eighteen. After that, production increased more rapidly, and by the middle of August 1943 some 840 *H2S* sets had been produced. By 12th October 1943, 255 Lancasters, 155 Halifaxes and 70 Stirlings had been equipped with *H2S* and delivered to Bomber Command.² By the time of the Battle of Berlin in the winter of 1943-44 more than ninety per cent of Bomber Command had been equipped with *H2S*, which in the same period had been developed through several marks which produced increasingly clear definition. The *H2S* principle was also applied to the development of other Bomber Command radar equipment, notably *Monica* and *Fishpond* which provided indications of the presence of aircraft in the vicinity.³

Despite its limitations and disadvantages, *H2S* was certainly the most

¹ The apparatus was not yet known as *H2S*. It is interesting to note that Sir Henry Tizard foresaw the principal disadvantage of *H2S* in February 1939 when he referred to the objection of a device which would have to transmit over enemy territory. A.H.B. Monograph.

² Of these, fifty Lancasters, seventy Halifaxes and twenty-nine Stirlings had by that time been lost.

³ A.H.B. Monograph.

widely useful aid to navigation and bomb-aiming which was ever produced for Bomber Command during the war. The United States Army Air Forces employed a similar equipment which they named *H2X*.¹

The *G-H* System

G-H was a system of navigation and blind bombing which had much in common with *Oboe* and incorporated *Gee*. The *H* system was really a kind of *Oboe* in reverse. The aircraft was equipped with a radar transmitter and receiver, by means of which it could measure its distance from two ground stations. Thus, the ground position of the aircraft could be determined by plotting the point at which the two distance lines from the two ground stations intersected. Since *H* depended upon transmissions to and from ground stations, its range, like that of *Oboe* and *Gee*, was limited, but, unlike *Gee*, its accuracy did not decline with increasing distance and, in fact, depended only upon the angle at which the two position lines intersected. Moreover, the accuracy of an *H* fix was much greater than that provided, even under the most favourable conditions, by *Gee*. *G-H* was simply the combination of the *Gee* and *H* systems, but *H* could be and actually was used in combination with other radar aids, including *H2S*.

The accuracy of *H* corresponded approximately with that of *Oboe*, but its use was a somewhat laborious business which entailed a high degree of precision by the aircrew. In combination with *Gee*, however, there was no need to make constant use of it except when the aircraft was in the immediate vicinity of the target and particularly when it was on a blind-bombing run. The great advantage of *G-H* by comparison with *Oboe* was that the former device could be operated by a substantial number of aircraft, amounting to about a hundred, simultaneously, and that its range did not to the same extent depend upon the altitude of the aircraft using it. Had it not been for these factors, there would have been little point in introducing *G-H*, which performed substantially the same functions at substantially the same ranges as *Oboe*.

LIMITATIONS AND DISADVANTAGES OF *G-H*

In addition to the limitation of its range imposed by the dependence of the system upon ground stations, *G-H* was also susceptible to jamming and other kinds of interference. This, however, at least as far as *H* was concerned, had little effect upon its satisfactory working. The main disadvantages of the system were twofold. Firstly, though as has already been mentioned, *G-H* could be simultaneously used by about 100 aircraft, in which respect it was much superior to *Oboe*, it could not, like *Gee* and *H2S*, be used by the whole force. Secondly, the onus of skill and work was laid upon the aircrew instead of, as in the case of *Oboe*, upon the staff

¹ This was developed by the U.S. Radiation Laboratory, an organisation similar to the Telecommunications Research Establishment. It set up a branch in Britain and the British and U.S. organisations worked closely together. As early as 1940 the British communicated to the United States the discovery of the cavity magnetron which Professor Baxter has described as 'the most valuable cargo ever brought to our shores' and 'the most important item in reverse Lease-Lend'. James Phinney Baxter 3rd: *Scientists Against Time*, p. 142.

at the ground station. This was a disadvantage if only because it was easier to make a mistaken calculation or adjustment when in a bomber over enemy territory than when on a ground base in England. In addition, it has to be remembered that the operation of *H* was considerably more complicated than that of *Gee*.

DEVELOPMENT AND INTRODUCTION OF *G-H*

In June 1940, the Air Ministry Research Establishment proposed the adoption of the *H* system as an alternative to *Gee* on the grounds that it was the more accurate of the two. But in view of the fact that *Gee* could be operated simultaneously in unlimited numbers of aircraft and *H* could not, the decision to develop *Gee* was taken and *H* was not declared to be an operational requirement. Later, however, it became apparent that the combination of *Gee*, *Oboe* and *H2S* would not meet all the requirements of Bomber Command. *Gee* was liable to be jammed and in any case was not accurate enough for blind bombing. *Oboe* could only be used by a handful of aircraft at the same time. *H2S* was not sensitive enough to pick up small targets. Therefore, if a means of blind precision bombing against small targets was to be provided, some further radar device was required. This was the requirement which, in July 1942, initiated the development of *G-H*.

Much of this development took place on the basis of the already existing *Gee* installations and it was, therefore, more rapid than would otherwise have been the case. Some delay was occasioned by doubts as to whether *G-H* should be installed in Mosquitoes or other types of aircraft, but eventually the service trials of *G-H* were begun in a Lancaster at the end of June 1943. These showed that much remained to be done in determining the best ways of using the equipment and also in building up a reserve of *G-H* instructors. Further trials were undertaken in the autumn of 1943, but by that time Bomber Command was turning its attention to Berlin far beyond *G-H* range and the urgency of introducing the device was less apparent than it was real. 139 Mosquito Squadron initiated the operational trials of *G-H* on the night of 4th October 1943 when one aircraft went to Aachen. On that occasion *G-H* was not actually used for bombing owing to a misunderstanding about the frequencies in use, but three nights later the first blind *G-H* attack was made by a Mosquito. The target was again Aachen. On the night of 3rd November 1943, after more of these Mosquito experiments, the first heavy bomber *G-H* attack was made. Thirty-eight *G-H* Lancasters of 3 and 6 Groups were despatched, as has been mentioned elsewhere, to a factory on the outskirts of Düsseldorf. But, as will have been seen, nearly a year was to pass before Bomber Command made extensive and sustained use of *G-H* for formation daylight bombing. Meanwhile, both the Royal Air Force tactical bombers and also the United States Army Air Forces made more immediate use of *G-H*. As was the case with *Oboe*, *G-H* ground stations were moved to France after the invasion of the continent.¹

The significance of *G-H* as a factor in the final offensive of Bomber

¹ A.H.B. Monograph.

Command need not be stressed here since it has already and inevitably been examined in the previous volume.¹ This, of course, was only a part of its contribution to the development of precision attack which embraced several other elements of air power.

Gee, *Oboe*, *H2S* and *G-H*, the principal, but not the only radar aids to navigation and bomb aiming, were products of the allied genius of Anglo-American scientists and technicians. All had their limitations and disadvantages and some were double-edged weapons, but there is no doubt that their introduction had a revolutionary effect upon the ability of Bomber Command to find and hit its targets. If the need for them had been more readily and authoritatively appreciated earlier, it can scarcely be doubted that they would have rendered longer and, perhaps, also more effective service even than they did.

¹ See above, Vol. III, 173 et seq.

ANNEX II

Radio Counter-measures in support of Bomber Command

WAR in the air, perhaps to a greater extent than any other kind of war, depended upon radio and radar. It is common knowledge that, under the circumstances in which it was fought, the Battle of Britain could not have been won by the Royal Air Force without the radar early warning and the system of radio control upon which the effective activity of Fighter Command largely depended. Similarly it is evident that Bomber Command could never have become an effective instrument of night attack without the radar aids upon which its navigation and its target marking came to be founded. So also, of course, it was with the *Luftwaffe*, and the German night fighter force and flak defences could scarcely have become more than a moral deterrent to Bomber Command had it not been for an elaborate and complex radio and radar development which ultimately governed the performance of both.

The use of radio and radar, however, was a double-edged process and, as will have been seen in the preceding account of radar aids to navigation and bomb aiming, a device designed to confer an advantage upon the attacking bomber could generally be exploited by the enemy to confer an advantage upon the defending fighter as well, and even if this was not the case, the value of the device could often be reduced or even neutralised by radio counter-measures in the form of jamming or interference. When, therefore, it became apparent early in the war that the German air defences were making increasing use of radio and radar, the possibilities of a counter-measures campaign on behalf of Bomber Command became equally apparent.

The principal problems of this radio counter-measures campaign were twofold. First, there was the danger of introducing a measure which might be copied by the Germans and used against the British air defences or, indeed, in some other way. Secondly, there was the difficulty of determining the precise nature of the radar systems being used by the Germans and, therefore, the best means of countering them. The first problem was general and was inherent in all scientific, technical and tactical development and invention in the field of military operations. It meant that the question of whether and when to introduce or even to risk experimenting with new developments had to be not a scientific but a strategic decision. Nor was it a decision which could be taken on the basis of the strategic interests of a single arm of a fighting service, of a single fighting service or even in some cases of a single nation in a warlike coalition.

Measures which were obviously in the interest of Bomber Command as an offensive arm were liable to be prejudicial to the interest of Fighter Command as a defensive arm. Similarly, measures which on balance seemed to be favourable to the Royal Air Force might well be prejudicial

to the Royal Navy and even measures which were advocated by Great Britain might not be favourable to the United States. The debates about the introduction of *H2S* and *Window* serve to illustrate the kind of difficulties which arose in practice at the various levels.

These facts generally, though not, of course, invariably or permanently, tended to work against Bomber Command. Survival was more immediately important than victory, and for much of the war Britain was strategically on the defensive. In the field of radio counter-measures there was a prolonged reluctance to indulge in activities designed to disrupt the German air defences because it was obvious that the Germans might develop the same measures to disrupt the British air defences. The fact that for much of the war Bomber Command could bring greater striking power to bear on Germany than the German bomber force could bring to bear on Britain tended, nevertheless, to be a neglected factor in many crucial decisions.

The second great problem was the particular one of discovering the precise nature of the radar and radio systems by which the German air defences were directed and controlled. Not much thought had been given to this before the war, but when hostilities began it soon appeared that the Germans had advanced to a stage not far behind that of Britain herself. In the course of 1941, the German night fighter force, which had been virtually impotent in 1940, began to develop into a serious threat to Bomber Command as a result of the application of radar and radio to the problem of interception. Evidence also began to accumulate showing that German gun and searchlight laying was at any rate partially radar controlled. Some Bomber Command crews even began to adopt their own private radio counter-measures which varied from the reasonably scientific method of switching on I.F.F. to the more primitive discharge of empty beer bottles.¹

A more serious and co-ordinated radio counter-measures campaign against the German air defences clearly depended, however, not only upon willingness to initiate that kind of action but also upon precise information about the German equipment and techniques which were to be neutralised.

This information was not easily come by because defensive radar, as is nearly always ultimately the case with offensive radar, does not automatically fall into the hands of the people against whom it is being used. Nevertheless, intelligence aided by the indiscretions of prisoners of war and the results of radio monitoring was able to discover the principal features of the German system. By the autumn of 1941 it was clear that the Germans had developed an extensive system of radar early warning by means of devices known as *Freyas*, which enabled them to alert their defences in good time and to detect the general direction of an impending attack. It was also clear that two systems of local radar detection were

¹ I.F.F. stood for Identification Friend or Foe. It was a device fitted in the aircraft which enabled the British air defences to recognise friendly aircraft by radio means. Some Bomber Command crews believed, with some scientific justification, that I.F.F. interfered with German gun and searchlight radar laying. A.H.B. Monograph. Other less scientifically minded crews believed that beer bottles had the same effect and the A.O.C. 5 Group felt that in the interests of morale it would be unwise to disillusion them. See Slessor: *The Central Blues*, p. 374.

being tactically employed by their night fighters. Airborne interception radar (A.I.) was being used and there was also a system of Ground Controlled Interception (G.C.I.) which depended upon a ground-based radar tracking equipment known as *Würzburg*, which enabled a controller on the ground to direct a night fighter by means of radio telephone to the vicinity of a Bomber Command aircraft. These developments were seen to be not unconnected with the rising casualties which Bomber Command was suffering in its night offensive.

There were five principal ways in which radio counter-measures might be employed to disrupt these German devices. First, the Radio Telephone communication between ground controller and fighter pilot could be jammed. Secondly, the radar early warning and tracking apparatus, that is the *Freya* and the *Würzburg*, could be jammed or subjected to interference. Thirdly, deceptive measures could be taken to produce false impressions upon radar search apparatus. Fourthly, the bombers could be fitted with warning apparatus to give notice to their crews that they were under the surveillance of German radar and so enable them to take some appropriate tactical action. Fifthly, Royal Air Force fighters could be equipped with apparatus which would enable them to home on German A.I. transmissions and, therefore, to intercept the night fighters which were using it. Obviously the last two measures called for the development of airborne equipment, but the first three could be prosecuted both from the air and the ground. But the success of any of these measures depended upon the assembly of the correct data about the German installations and the techniques by which they were exploited.¹ Moreover, since the Germans were constantly developing their equipment and techniques this data was always in danger of becoming obsolete.

Owing to a combination of the difficulties connected with gaining precise information about the German radar and an extreme and, perhaps, undue reluctance to embark upon the apparent hazards of a radio- and radar-jamming war, no significant radio counter-measures in support of Bomber Command were introduced until December 1942, though by this time the conception of *Window* was more than a year old and a German *Würzburg* radar plotting apparatus had been in British hands for ten months. In October 1942, however, an important meeting had taken place at Bomber Command. It was presided over by the Senior Air Staff Officer, Air Vice-Marshal Saundby, and attended, among others, by Sir Henry Tizard and Air Commodore Baker. This meeting agreed to recommend the immediate use of I.F.F. for jamming *Würzburgs*,² the development of a more effective means of jamming *Würzburgs* and the introduction of measures to jam *Freyas* both by airborne equipment and from ground stations in England.³ This advice was accepted, and in December 1942 the Radio Counter-measures campaign in support of Bomber Command

¹ The capture of a German '*Würzburg*' radar tracking device in the Bruneval Commando raid in February 1942 was an important step forward in this connection. Possession of the equipment did not, however, solve all the problems connected with its actual use.

² *Würzburgs* were used for local plotting in connection with G.C.I. The jamming measure was known as *Shiver* and it came into operation in December 1942.

³ *Freyas* were used for plotting in connection with early warning. The jamming measure was called *Mandrel*, which was also introduced in December 1942.

at last began to get under way. At the same time measures were taken to jam the German Radio Telephone traffic.¹ There was an immediate decline in Bomber Command casualties after these steps had been taken, but whether the relationship was causal or casual could not be determined.²

These measures were followed in the course of 1943 by others of a similar nature, which were designed to intensify the effects of what had been begun in December 1942 and also to neutralise the alternative equipment which the Germans now, to some extent in consequence, began to use. Thus, for example, the jamming of V.H.F. radio telephone traffic, which the Germans had introduced for fighter control on the Western front in March 1943, was begun in July 1943.³ In April 1943 a station was put into operation at Dunwich which had the function of finding and jamming the frequencies being used by German A.I.⁴ and, as has been fully described elsewhere, *Window* was introduced at the end of July 1943.⁵

These and other counter-measures, though only partially effective, did have a significant effect upon the tactics of the German night fighter force. The working of the initial early warning *Freya* was liable to be disrupted by the operation of *Mandel*, though this was as yet not generated on an adequate scale. The fighter controller was liable to have difficulty in operating the *Würzburg* tracker because of *Window*, and if the *Window* was concentrated he was unable to distinguish individual bombers. He also often found that he could not convey his instructions to the fighter pilot because of *Tinsel* and *Cigar* and the fighter navigator tended to have difficulty with his A.I. because of *Grocer*. The Germans were, therefore, led to accelerate the introduction of new techniques and, in fact, as has already been described, they devised what came to be known as the 'running commentary' system.⁶

This was in complete contrast to the linear method of defence which, having been developed by the G.C.I. technique, had been virtually dislocated by radio counter-measures and especially by *Window*. This linear system depended on a line (known as the Kammhüber line)⁷ of so-called fighter boxes which extended over the air frontier which Bomber Command had to cross in order to reach its targets. Each 'box', on the receipt of early warning from the *Freya* stations, was patrolled by a night fighter and was under the individual control of a *Würzburg* station. This *Würzburg* station directed the fighter towards any bomber which entered the 'box' until

¹This measure was called *Tinsel*, which, like *Shiver* and *Mandel*, came into service in December 1942.

²*Harris Despatch* and A.H.B. Monograph.

³This counter-measure was known as *Cigar*, but the range of the jammers was limited to about 140 miles from the ground station. The extension of the jamming, therefore, as was also the case with *Mandel*, depended upon the development of airborne equipment. This was operationally introduced in October 1943 and was known as *Airborne Cigar* or A.B.C. V.H.F. stood for Very High Frequency Radio. *Harris Despatch* and A.H.B. Monograph.

⁴This was known as *Grocer*, which had a range limitation similar to *Cigar*. It was also later developed as *Airborne Grocer*. *Harris Despatch*.

⁵See Vol. II, pp. 141-145.

⁶do., pp. 153-154.

⁷Until shortly before the introduction of *Window*, General Kammhüber was Commander of the *Luftwaffe* on the Western front. He was succeeded by General Schmidt.

it was within A.I. range. The fighter then closed by A.I. until it was within visual range, when it attacked.

Apart from the eventually successful radio counter-measures to disrupt the *Freyas*, the *Würzburgs*, the radio telephone and the A.I., the obvious protection against this 'box' system was a high degree of concentration since, in one 'box', only one bomber could be dealt with at one time. Moreover, *Window* only produced an effective result when it was dropped in concentration. These were important factors in producing the Bomber Command tactics of the concentrated bomber stream. But the 'running commentary' method produced a means of exploiting the concentration to the advantage of the German fighters. It was a system of concentrated defence in depth as opposed to diluted linear defence and, to the great cost of Bomber Command, it proved to be formidably effective.

Under the 'running commentary' method, the position and direction of the bomber stream was watched by radar and by *Korfu* receivers which picked up the radar transmissions of Bomber Command. On the basis of these observations the whole night fighter effort was marshalled by a single fighter controller who then directed a concentrated attack on the bombers. There were serious difficulties inherent in this technique. The German night fighters had to make much longer flights than had been needed for the 'box' system. They often had to land away from their own bases and they tended to encounter serious navigational problems. Moreover, the controller had to decide where and when to commit his force. If, as was initially the case, he chose the target as the main point of interception, he was in danger of choosing the wrong target, in which error he was often assisted by the ruses of Bomber Command. If, as was later generally the case, he chose what he believed was the route he was liable to find that Bomber Command had made a sudden alteration of course. Nevertheless, the fighters were, of course, much faster than the bombers, and as the 'running commentary' system was developed, route interception became, as has been seen, a highly efficient technique.

Obviously the large and concentrated bomber stream presented the 'running commentary' method with its greatest opportunity. Firstly, it presented the fighter controller with a well-defined target, and secondly it meant that the fighter pilots, once they had been placed in the bomber stream, were more likely to make actual contact with bombers. Thus, the 'running commentary' development placed Bomber Command between two fires. If the concentrated stream was maintained, the 'running commentary' attack was likely to succeed. If, on the other hand, the tactics of dispersed approach were resumed, the G.C.I. technique of attack was liable to be resumed. In the autumn of 1943, Bomber Command was threatened with the gravest tactical situation which had confronted it since night attack had been adopted as its principal activity. The solution seemed to lie in a massive intensification of the radio counter-measures campaign and in a more rigorous prosecution of the counter-fighter offensive with and without *Serrate*. The possibility also had to be faced that Bomber Command would have to operate without the use of its transmitting radar and that it would even have to curtail the scale and the scope of its offensive.

These possibilities and the decisions which they eventually produced have already been examined in the contexts of the strategic and tactical development of Bomber Command. As far as radio counter-measures themselves were concerned, there were a number of things which could be done since the 'running commentary' system, like the G.C.I. technique, had its vulnerable points. One of these, of course, was the channel of communication between the controller on the ground and the fighter force in the air, or, in other words, the 'running commentary' itself. This, as will have been noticed, had, in the case of G.C.I. radio telephone communication, been going on since December 1942. The method used was for aircrew wireless operators to search for radio telephone frequencies in use and to jam any they found, but the problem was now rather different. One controller was now directing the whole fighter effort and his orders were being transmitted from high-powered stations which operated on frequencies which could not be guessed in advance. This called for a much higher concentration of jamming than could be produced by the method known as *Tinsel*. A counter-measure known as *Special Tinsel* was, therefore, introduced. A proportion of the aircrew wireless operators were briefed to stand by for the jamming of the particular frequency on which the 'running commentary' was being broadcast. This frequency was determined by monitoring in England, and the selected wireless operators, who were by then, of course, airborne, were informed about it by W/T. They then all jammed it. The remaining wireless operators continued with ordinary *Tinsel* against G.C.I. broadcasts. The Germans responded by the introduction of multi-channel transmissions, with the result that Bomber Command had to dilute the *Special Tinsel* effort to cover each of them.¹

By thus diluting the *Special Tinsel* jamming, the Germans might have escaped from their difficulties, but the radio counter-measures campaign was now developing into a much more intensive struggle of cut and thrust. Each measure produced a counter-measure and so in turn another measure. To increase the strength of jamming it was decided to equip a number of aircraft with high-powered jamming devices, but this would necessarily take some time.² Meanwhile, in October 1943 high-powered jamming from ground stations was begun under the code name of *Corona*, which, it was discovered, could also be used for broadcasting bogus instructions to the German night fighter force. Indeed, on the first occasion on which *Corona* was used, on the night of 22nd October 1943, a considerable success was achieved. The target was Kassel, and the *Corona* voice speaking in idiomatic German and carefully mimicking the German controller threw the German night fighter force into confusion and the fighter controller into an exceedingly bad temper.³ When later the Germans tried to restore clarity by the sudden introduction of a female voice, *Corona* already had at its service a carefully trained W.A.A.F.

¹ A.H.B. Monograph and *Harris Despatch*.

² Known as *Jostle IV*.

³ At one stage the German controller broke into vigorous swearing, whereupon the *Corona* voice remarked that 'The Englishman is now swearing'. To this the German retorted that 'It is not the Englishman who is swearing, it is me.'

The extent to which these and other counter-measures threw the 'running commentary' into confusion is shown by the German expedient of using the so-called 'Anna Marie' programme, which was broadcast from Stuttgart to entertain the German forces, to convey orders to the night fighter pilots. For this purpose an ingenious code was devised by which, from the nature of the music or of the announcement which preceded it, the position of the Bomber Command stream was conveyed to the night fighter force. But this was detected and the 'Anna Marie' programme was jammed.¹

In the course of 1943 it had become increasingly apparent that the radio counter-measures campaign could be more effectively maintained and developed if a special Bomber Command Group was formed for the specific purpose of its prosecution. The principal reasons underlying this argument were that airborne radio counter-measures were becoming so complex that they could not always be effectively executed by ordinary crews in the main force. Secondly, the equipment was becoming so large that it could not always be carried in aircraft which also had bomb loads. Thirdly, radio counter-measures aircraft often had to operate in areas far removed from the scene of activities of the main force. Fourthly, the fitting and servicing of these aircraft would be simplified if they were placed under a centralised control. Fifthly, specialist direction was called for in the development of the campaign. All these factors supported the argument for a specialised radio counter-measures Group which Bomber Command asked for in June 1943, which was approved by the Air Ministry at the end of September 1943 and which came into being as 100 Group at the end of the year.²

The activities of 100 Group which embraced the operation of ground and airborne radio counter-measures and of a long-range fighter offensive have already been examined. There is no doubt that by such measures as the airborne *Mandrel* screen, the provision of a special *Window* force and the exploitation of an almost innumerable number of other devices and tactics, a considerable measure of protection was afforded to Bomber Command. But, as had been shown, 100 Group did not go into effective action until after the invasion of Europe in June 1944, by which time the German night fighter force was on the brink of a precipitate decline in which the radio counter-measures campaign was only one and certainly not the most important of the operative factors.

Over the period of its main activity between December 1942 and May 1945, the radio counter-measures campaign was an important element in the Bomber Command offensive. Though it never, save for brief periods, dislocated the air defence of Germany, it did stave off a mastery of the night fighter over the night bomber, which might eventually have become as complete as that of the day fighter over the day bomber. In view of the fact that no effective means of providing sustained night fighter support for Bomber Command was ever found, this was a contribution of immense significance.

¹ A.H.B. Monograph.

² *Harris Despatch*.

ANNEX III

Operational Training in Bomber Command¹

MOST of the crews who flew with Bomber Command in the war had been civilians when it began and many of them had at that time been still at school. A few of the somewhat older volunteers for flying duties had some flying experience which had been gained in the Auxiliary Air Force, the Volunteer Reserve or the University Air Squadrons,² but this was generally limited to relatively elementary types of aircraft such as the Hart or even the Tiger Moth. The vast majority had never flown before in any kind of aircraft and the great bulk of them had, perhaps, never even thought of doing so. One of the main tasks of the small regular force of officers and men which Bomber Command possessed at the beginning of the war was, therefore, to receive and to train the influx of volunteers who were anxious to join them, and, for this purpose, thirteen squadrons were 'rolled up' in September 1939 and made into training squadrons,³ from which, at the beginning of 1940, the Operational Training Units were formed.

Volunteers were not, of course, posted to Bomber Command until they had received their basic theoretical and flying training which was undertaken in Training Command.⁴ Much of the flying which this involved was, as a result of the Empire Air Training Agreement and other arrangements, carried out far away from the congested and insecure air over Britain, in the Dominions and in the United States. Though there were inevitably some difficulties in adjusting the competing requirements for quality and for quantity and also in organising the flow of thousands of men from recruiting centre to operational command by way of long sea voyages all over the world and often in submarine-infested waters, this visionary scheme did not fail to provide for the reinforcement and enormous expansion of all the fighting commands of the Royal Air Force which extended from Europe through the Middle East to the Far East.

Flying Training Command produced pilots, navigators, bomb aimers, wireless operators and air gunners, but it did not produce crews. The men who passed out of Flying Training Command had a certain basic flying experience of their various and particular skills, but they were still individual specialists whose contacts had been mainly with others of their own kind. It was for Bomber Command to weld its proportion of these men into fighting crews and to familiarise them with the particular type of aircraft in which they would have to operate. The main task of operational training in Bomber Command was, therefore, two-fold. First,

¹ The principal source used in this account is the *Harris Despatch*.

² Group Captain Cheshire, V.C., for example, had been a member of the Oxford University Air Squadron before the war.

³ Known as Group Pool Squadrons.

⁴ Later named Flying Training Command.

crews had to be forged from individuals and, secondly, these crews had to be 'converted' from the training to the operational types of aircraft.

As far as 'conversion' was concerned, the problem was at its simplest in the first two years of the war, when Blenheims, Hampdens, Wellingtons and Whitleys were the predominant types of aircraft in the operational squadrons. These were all twin-engined machines and though they were, of course, far more complex than the Ansons and Oxfords upon which most pilots had completed their course in Flying Training Command, they were at least the next logical step after those training aircraft which were also twin-engined. Moreover, there was never at any stage any tendency to neglect the importance of pilot training. Though courses were sometimes curtailed in order to increase supply, it was always obvious that bad pilots would yield unsuccessful operations and probably disasters as well. When, however, in 1942, large numbers of four-engined Stirlings, Halifaxes and Lancasters began to come into operational service, the conversion problem became more complex, and additional stages of operational training at specifically conversion units had to be introduced.

As far as crew building was concerned, the problem was, on the contrary, at its greatest in the early stages of the war. This was because, at the outset, there was no clear idea of what a bomber crew was, beyond the general belief that all heavy aircraft required two pilots. The rest of the crew, in the case of a Wellington, for example, consisted of an observer, a wireless operator and, in most cases, two air gunners, but the precise nature of the duties to be performed by these men and the extent to which they required pre-operational training was obscure. The conditions of long-range high-level flying, especially at night, in complex aircraft of the Wellington and Whitley class had scarcely been tested before the war and there were in high places some extraordinary estimates of what they would be which, no doubt, owed much to the days of open cockpit flying in very different kinds of aircraft.

These and other doubts about the functions of the various members of the bomber crew inevitably impeded the development of a sound operational training policy in Bomber Command, but in one major respect a clear, courageous and ultimately justified decision was taken. The front line was denied a proportion of its aircraft and crews in the interest of the operational training organisation. Bombers of the same types as those being used in the operational squadrons were put into the training squadrons or Operational Training Units as they were later called. These units were formed into a separate group and commanded by Air Vice-Marshal MacNeece Foster.¹

As a result of his experience in command of and, on many occasions, in the air with 6 Group, Air Vice-Marshal MacNeece Foster came to the conclusion that the second pilot was a superfluous member of the bomber crew. He observed that he was, in fact, little more than a passenger who,

¹ This was 6 Group. In July 1940 a second O.T.U. Group was formed and numbered 7. These were later renumbered 91 and 92 Groups and a third O.T.U. Group, 93, was added. The expansion of the operational training organisation can be seen in the Bomber Command Orders of Battle reproduced in Section VI.

so far from gaining experience, actually tended, because of lack of practice, to decline in efficiency during the period of his tutelage. He also observed that long and arduous flights were carried out not only in Wellingtons and Whitleys, which had two pilots, but also in Hampdens, which had accommodation for only one. These views were initially received with scepticism, but Air Vice-Marshal MacNeece Foster pressed them with such persistent vigour upon his superiors that between the autumn of 1941 and the spring of 1942 they were accepted.¹ This was the first and the most important step in a radical reorganisation of the bomber crew which was introduced in March 1942.

The second pilot was dropped from all Bomber Command crews and at the same time the duties of the observer were subdivided and defined. One man, now called the Navigator, was made responsible for the navigation. He was released from the duty of dropping the bombs, which was to be performed by a new member of the crew, the Air Bomber. The wireless operator was also released from his gunnery duties and gunners were no longer required to undergo wireless training. To assist the single pilot in four-engined aircraft, a Flight Engineer was introduced. These changes had the effect of allowing each member of the crew to specialise, and it, therefore, permitted him to receive much more thorough training than had previously been the case. The demand for pilots in Bomber Command was greatly reduced, and this also meant that those who were required could be more thoroughly trained. It also meant that a higher proportion of recruits who would, perhaps, have made second-rate pilots at best could be diverted to other activities and, perhaps, made into first-rate navigators or air bombers.²

Without these changes, Bomber Command would certainly never have approached the degree of efficiency which it ultimately attained, but, as far as the single-pilot policy was concerned, there was another and much more immediate consequence. With a single pilot in each aircraft a much larger force could be operated. If all the aircraft concerned had had to be manned by two pilots, the thousand-bomber attacks of 1942 could not have been launched.

By the time of these changes the length of the operational training course had established its level at eighty flying hours, and though the syllabus was changed from time to time to meet changing circumstances, this remained substantially the same until the end of the war. These developments were of fundamental importance, but they did not by any means wholly solve the problem of operational training in Bomber Command. It had soon become evident that the only useful flying instructors at Operational Training Units were those who had completed tours of operations in the squadrons. Such men were indispensable, but they were hard to obtain owing to the high casualty rate sustained on operations and, of course, the need to leaven the expanding front line with a good

¹ Letters MacNeece Foster to Peirse and Baldwin, 31st Oct. 1941, 9th and 13th Jan. 1942.

² A high proportion of the Navigators and Air Bombers of 1942-45 had, in fact, joined the service as pilots.

proportion of experienced crews.¹ For most of the war, the Operational Training Units had to make do with less than their established strength in flying instructors.²

Another problem, as has already been mentioned, was created by the introduction of the new four-engined heavy bombers. Until that time, the Operational Training Units, with their Wellingtons, Whitleys, Hampdens and Blenheims, had the same types of aircraft as the squadrons and there was no reason why the crews should not pass straight from Operational Training Unit to Squadron. When Stirlings and Halifaxes began to appear in the squadrons, however, a different situation was seen to prevail. The initial problem was to convert the operational crews from the old to the new types, which could only be effected by withdrawing the squadrons from the line. But after that the new incoming crews also, of course, had to be converted. Moreover, the Wellingtons, which now predominated in the Operational Training Units, did not have mid-upper turrets, nor did they carry Flight Engineers. At first, this additional training and conversion commitment was met by the use of the reserve aircraft in the squadrons concerned, but as the number of four-engined squadrons increased a more radical solution was adopted and Heavy Conversion Units were formed. These were equipped with Halifaxes or Stirlings according to the groups which they backed and the courses at them developed into a second stage of operational training.³

When Lancasters came into service, the problem became yet more complicated. It was not that Lancasters were more complex than Stirlings or Halifaxes. In fact, they were less so, but there was a natural reluctance to deny the front line more than the absolute minimum of these magnificent but, for long, very scarce aircraft. For that reason a number of Heavy Conversion Units were established with fifty per cent Halifax and fifty per cent Lancaster strengths so that at least part of the conversion of crews from Wellingtons to Lancasters could be accomplished in Halifaxes, but this was obviously not an ideal arrangement, and in 1943 it was abandoned. Lancasters were then withdrawn from Heavy Conversion Units, which reverted for what may be described as the second phase of operational training purely to Halifaxes and Stirlings.⁴ Crews being posted to Lancaster squadrons were then sent for a very brief third phase of conversion to Lancaster Finishing Schools. Eventually when, in 1944, the supply of Lancasters became more satisfactory, the appropriate Heavy Conversion Units were equipped with them and the Lancaster Finishing Schools were dropped. Thus, without doing violence to the now

¹ In addition, there was the fact that Bomber Command O.T.U.s supplied the Middle East where many tour-expired crews were retained for various duties instead, as the Commander-in-Chief, Bomber Command, wished, of being returned as instructors to the home-based O.T.U.s.

² The shortage of experienced pilots, navigators and air bombers was, until the last year of the war, particularly acute.

³ The Heavy Conversion Units were formed within the operational groups which they served, but in November 1944, by which time there were seventeen of them, they were formed into a separate Group which was numbered 7.

⁴ This phase amounted to about forty to forty-five flying hours and, of course, increased the demand for ex-operational flying instructors.

smoothly working Operational Training Unit organisation, the requirements of the Stirling, Halifax and Lancaster squadrons were met. Naturally, however, most good squadron commanders put their new crews through an intensive series of training exercises after they had joined their squadrons, if, as was often not the case, the circumstances permitted.

The Bomber Command Mosquito squadrons created a special training problem. Like Lancasters, Mosquitoes were highly valuable aircraft in short supply which could not be spared from the front line. But they could not be shadowed at the conversion stage as Lancasters to some extent could be by Halifaxes, because there was nothing comparable to a Mosquito. To deal with this situation a small Mosquito Training Unit was formed in the Pathfinder Force and, in order to reduce its demand for aircraft to the minimum, only pilots and navigators who, by virtue of previous operational experience in Bomber Command or elsewhere, were likely to learn the fastest were sent to it. Eventually, when the supply of Mosquitoes improved and the demand for crews to fly them increased, a complete Operational Training Unit was re-equipped with Mosquitoes, and this backed the whole Mosquito bomber force which eventually amounted to twelve squadrons.¹

In addition to these Operational Training Unit and Heavy Conversion Unit courses special training units had from time to time to be opened to give instruction on new equipment or special techniques which, because they were being adopted on a limited scale, were not appropriate to the normal operational training squadrons. Examples of these were provided by special *G-H* training units and by the Navigation Training Unit in the Pathfinder Force.²

There can be no doubt that the operational training organisation of Bomber Command achieved much of its purpose, and it must not be forgotten that in addition to providing the source of manpower upon which the whole operational effort of the squadrons ultimately depended, an actual contribution to that effort itself was also made by the training and conversion units. There are, however, two important qualifying conclusions to which Sir Arthur Harris has drawn attention in his Despatch. One refers to the equipment of the Operational Training and Heavy Conversion Units and the other to the quantity and quality of flying instructors made available to them.

Operational training could have been made much more efficient if the most suitable types of aircraft had always been made available and if, at that preliminary stage, the crews had been familiarised with all the equipment in operational use at the squadrons to which they were going to be posted. As it was, Lancaster crews had often completed more than half of their conversion course on Stirlings or Halifaxes and on innumerable occasions they had never even heard of much of the ancillary equipment which they found in their aircraft when they reached a squadron. If, however, these defects had been remedied, the striking power of the

¹ The selected O.T.U. was number 16, which had previously been equipped with Wellingtons. Most of the P.F.F. Mosquito Training Unit was absorbed by it when this change was made.

² At the latter, special instruction in marking techniques was given.

front line would inevitably have been reduced. It was a question of balancing that consideration against the requirement for effective operational training.

Operational training could also have been made more efficient if more and, in some cases better, flying instructors had been available. One remedy would have been to take a selected number and quality of aircrews off operations prematurely, but this too would have reduced the striking power of the front line. Another remedy, which Sir Arthur Harris believes was insufficiently applied, would have been to bring tour-expired crews home from the Middle East more quickly, though it has to be remembered that these men, because of their particular experience, could be most profitably employed as instructors only in the Operational Training Units which were backing the Middle East.

It is impossible to know or even to guess the number of casualties which Bomber Command sustained as a result of inadequate training and it is also not possible to estimate the effect of the same thing upon the efficiency of operations. It is, however, certain that many crews met their deaths while attempting tasks which were beyond their capacities and yet were within the capacity of the bulk of their comrades. It is equally certain that many bombs went wide because of lack of crew training, but, important as these factors undoubtedly were, they should not be overstressed. Operational training of any kind was a poor substitute for operational experience and it was by no means always the most highly trained who succeeded or who survived. As to casualties, there was, throughout the night offensive, a weighty element of good or ill luck. As to success, there was the equally unpredictable but even more weighty element of determination and tenacity in the face of the enemy. Operational training in Bomber Command did not fail to provide most crews with a reasonable basis upon which to test their fortunes and their courage.

ANNEX IV

Bombs and Bombsights

THE wide range of weapons dropped by Bomber Command in the strategic air offensive, in addition to air-laid mines, was made up by three principal and distinctive groups, namely, high-explosive bombs, incendiary bombs and target indicators, and these weapons, when visual conditions permitted it, were aimed by a number of different kinds of bombsights. Many of the types of bombs and some of the bombsights have been referred to in the text of the preceding volumes, but here it is intended to provide a brief summary of the principal types.

I. HIGH-EXPLOSIVE BOMBS

There were three main types of High-Explosive bomb, namely, General Purpose (G.P.), Medium Capacity (M.C.) and High Capacity (H.C.). The principal difference between these types lay in their varying charge-weight ratios. The higher-capacity bombs had the higher charge-weight ratios and, therefore, had thinner and lighter casings. They thus produced a greater blast value but tended to have less penetration and, in some cases, a poorer ballistic performance than their lower-capacity equivalents. In addition, there were a number of specialised high-explosive bombs which ranged from the Wallis dams weapon to the more conventional armour-piercing (A.P.), semi-armour-piercing (S.A.P.) and capital-ship (C.S.) bombs.

(a) *General-Purpose Bombs*, as their name implied, were designed with the widest possible range of objects in mind and it was, perhaps, partly for that reason that they tended to be relatively ineffective for most particular purposes. Made in seven different sizes ranging from twenty to 4,000 pounds, they were, nevertheless, manufactured and dropped on a very large scale. Between 1939 and 1945 Bomber Command dropped over half a million 500-lb. G.P. bombs and nearly 150,000 two-hundred-and-fifty-pounders.¹ Not only were these bombs often unsuited to the tasks for which they were used because of their general characteristics, which consisted of an unhappy compromise between strength of casing and weight of explosive, but they were also relatively inefficient and all too often defective weapons. Their charge-weight ratio was only about twenty-seven per cent as compared with the fifty per cent ratio of the corresponding German bombs, the explosives with which they were charged were relatively ineffective and large numbers of the bombs failed to detonate. It was not, however, until the end of 1940 that any serious remedial action was taken. Thereafter, attempts were made not only to

¹ The sizes of G.P. bombs with the numbers dropped by Bomber Command 1939-45 were: 20 lb. (4,940), 40 lb. (42,939), 250 lb. (149,656), 500 lb. (551,334), 1,000 lb. (82,164), 1,900 lb. (2,141) and 4,000 lb. (217). A.H.B. Monograph. This annex is principally based upon this Monograph and the *Harris Despatch*.

increase the charge-weight ratio of G.P. bombs, to improve their casings and to fill them with more effective explosives but also to introduce new bombs of higher capacity. Efforts were also concentrated upon the rather larger types at the expense of the smaller, but all this as far as G.P. bombs were concerned met with limited success. The 4,000-lb. G.P. bomb, for example, which, except on one occasion, was not used until 1943, was a failure. When fused for delay action, it was liable to break up on impact, and when fused for instantaneous action, its blast effect was much inferior to that of the corresponding H.C. bomb.¹

During the first two years of the war G.P. bombs predominated in the high-explosive armoury of Bomber Command and huge stocks of them were accumulated to provide for bomb loads which were intended to be made up of two-thirds or more high-explosive content. The fact that they continued to be so extensively used after the incendiary policy had been adopted and after much superior types of high-explosive bombs had been introduced was, as Sir Arthur Harris has pointed out, a serious disadvantage. Incendiary loads, in fact, rarely amounted to the theoretically correct proportion because of the difficulty of making up economical loads. Moreover, stocks of the better types of high-explosive bombs, and particularly of the 1,000-lb. M.C. bomb, were seldom adequate.²

(b) *Medium-Capacity Bombs* were developed for Bomber Command largely as a result of the revealed and suspected shortcomings of G.P. bombs by comparison with the superior weapons being used by the Germans.³ It was intended that the M.C. bombs should have a charge-weight ratio of at least forty per cent and that they should be filled with more efficient explosives than had been used in their G.P. equivalents. In point of fact, however, inferior explosives often had to be accepted because superior ones were not always available in sufficient quantity. More-

¹ A.H.B. Monograph and *Harris Despatch*. The shift from the smaller to the larger G.P. bombs is illustrated by the following figures for those dropped by Bomber Command in each year.

Year	4,000 lb.	1,900 lb.	1,000 lb.	500 lb.	250 lb.	40 lb.	20 lb.
1939	—	—	—	29	50	—	—
1940	—	—	153	20,106	61,572	26,179	2,132
1941	—	482	10,447	65,341	34,692	4,650	192
1942	1	1,241	14,409	29,481	15,206	6,938	—
1943	40	28	36,182	13,659	3,188	5,172	500
1944	176	366	20,845	395,641	7,768	—	2,116
1945	—	24	128	27,180	27,180	—	—

A.H.B. Monograph.

² The fact that more than 395,000 five-hundred-pound G.P. bombs were discharged by Bomber Command in 1944 will have been noticed. This was due to the inflation of High-Explosive bomb requirements arising from the changes in bombing policy which began with the pre-*Overlord* bombing plan. Stocks of M.C. bombs, and notably of 1,000-pounders, were inadequate to meet the need. This, Sir Arthur Harris states, 'at times gave rise to the gravest concern . . .' *Harris Despatch*.

³ A meeting was held on 6th December 1940 to consider whether the existing G.P. bombs were good enough. It was attended by the Vice Chief of the Air Staff, the Director of Armament Production and Armament Development, the Assistant Chief of the Air Staff (Technical) and representatives of the Directorate of Operational Requirements and the Ministry of Home Security. A.H.B. Monograph.

over, some marks of the five-hundred-pound M.C. bomb, which was the first to be developed and which began to come into service towards the end of 1941, were unsatisfactory. They tended to break up on impact and there was reason to suppose that the proportion of them which failed to detonate was as high as thirty or even forty per cent. Though the later marks were much more satisfactory, they not unnaturally inherited a bad name. Nevertheless, a greater number of them than of any other kind of high-explosive bomb, except the far less efficient five-hundred-pound G.P. bomb, were dropped by Bomber Command during the war. One-thousand and four-thousand pound M.C. bombs were also developed and used by Bomber Command from 1943 onwards. The one-thousand-pound version was regarded as particularly effective against a wide range of targets, but it was often in gravely short supply. The four-thousand-pound M.C. bomb was not extensively used by Bomber Command though it was often carried by Mosquitoes during 1944, and it was also responsible for the breaching of the Walcheren dykes at the end of that year. The twelve-thousand-pound *Tallboy* and twenty-two-thousand-pound *Grand Slam* bombs, which could only be carried in modified Lancasters, were M.C. weapons of extraordinary effectiveness.

M.C. bombs had a considerably greater blast value than their G.P. equivalents, but their casings were, nevertheless, tough enough to give them, and particularly, of course, the *Tallboys* and *Grand Slams*, substantial powers of penetration.

(c) *High-Capacity Bombs* were developed for the specific purpose of causing the maximum blast value. They, therefore, had the highest possible charge-weight ratio, amounting in some cases to more than eighty per cent. To produce this they were provided with the thinnest and lightest possible casings. They were designed to fall at the lowest possible terminal velocity and they tended to have poor ballistics. The early versions were fitted with parachutes which, in addition to being inefficient, made it impossible to aim the bombs with even remote accuracy. When it was decided that delay-action fusing was less important than reasonable aiming possibilities, the parachutes were abandoned and replaced by metal tails. These primary weapons of the area offensive were produced in four different sizes, of two thousand, four thousand, eight thousand and twelve thousand pounds. They came progressively into service after the beginning of 1942 and were popularly known as 'block busters'. The eight- and twelve-thousand-pound versions were carried in modified Lancasters.

(d) *Special High-Explosive Bombs*. In addition to the standard G.P., M.C. and H.C. bombs and the M.C. *Tallboys* and *Grand Slams*, Bomber Command was also provided with a number of special high-explosive weapons. The most remarkable of these was the Wallis cylindrical rotating bomb with which the Möhne and Eder Dams were breached in May 1943. That, however, was the only occasion on which these astonishing weapons were used and the stock of them which remained at the end of the war was dumped in the sea. Most of the other special bombs were designed for the destruction of ships and were not part of the armoury of the strategic air offensive. Many of them also proved to be ineffective weapons.

A few semi-armour-piercing bombs were, however, used for general bombing in 1944 when there was a shortage of more appropriate types. Considerable numbers of American bombs were also dropped by Bomber Command.¹

2. INCENDIARY BOMBS

Incendiary bombs, unlike high explosives, were designed not to destroy their targets but, by setting fire to them, to exploit their own latent power of self-destruction. Since, in most cases, this was more likely to be achieved by the cumulative effect of a great number of small fires rather than by a smaller number of large ones, incendiary bombs were generally small, and in the course of the war, again unlike high-explosive bombs, they showed little tendency to get larger. The main incendiary weapon of Bomber Command throughout the war was the four-pound magnesium incendiary bomb. This, owing to shortages of magnesium and the almost astronomical demands for the bomb after the adoption of incendiary tactics, was from time to time modified in attempts to make economies. Some of these modifications had the effect of reducing the efficiency of the bomb. The main difficulty with the four-pound incendiary bomb was not, however, connected with its efficiency but with the problem of aiming it.

Incendiary bombs were initially carried in tin boxes known as Small Bomb Containers, but these boxes remained on the aircraft and the bombs fell out of them and took their earthward plunge as individuals. Owing to their light weight and enormous quantity they, therefore, spread out over wide areas which not only made it impossible to concentrate them on and around the aiming point, but also created a hazard to the bomber stream. Bomber Command aircraft must, in fact, have been brought down by four-pound British incendiary bombs, and certainly most crews with sustained experience of major operations endured at one time or another the unpleasant prospect of seeing their aircraft peppered with these dangerous missiles.

The solution of this problem, of course, lay in the clustering of incendiary bombs so that they could be dropped in concentrated groups and dispersed only when they were nearing their destination. Moreover, since the clusters, which were developed in 350-, 500- and 1,000-pound sizes, could be given reasonable ballistic qualities, the aims of concentration and relative safety could be achieved by the same measure. This development was, however, very slow in taking place and, as will have been noticed, the vast majority of the phenomenal numbers of four-pound incendiary bombs dropped by Bomber Command, were dropped from Small Bomb Containers. These weapons, therefore, did more damage to Bomber Command aircraft and less to their targets than need have been the case.

Some much larger incendiary bombs were also developed for Bomber Command, but the story of these is a sad one. The forty-pound incendiary

¹ Similar difficulties were experienced by the United States Army Air Forces. In fact, such have occurred in all wars of long duration.

bomb was abandoned in the summer of 1941 on the ground that it was uneconomical to present the Germans with thirty-five pounds of good steel in order to deliver five pounds of magnesium. The twenty-five-pound incendiary bomb, which generally broke up without igniting, was abandoned in 1942 after about 20,000 of them had been dropped by Bomber Command. Some 400,000 more were reduced to scrap.¹ In addition, there was a range of liquid-filled incendiary bombs weighing from twenty pounds upwards. Of these, the most extensively used was the so-called 'J' bomb of thirty pounds which, despite the strongest possible opposition from the Commander-in-Chief, was pressed upon Bomber Command in considerable quantities and first used in April 1944 during an attack on Brunswick, when over four hundred tons of the weapons were dropped. Thereafter nearly half a million 'J' bombs were carried to Germany by Bomber Command in the face of a continuing series of protests from Sir Arthur Harris who, among other things, complained bitterly of the fact that clusters were being provided for 'J' bombs but not for four-pound magnesium bombs which he claimed were more than twice as efficient. Some justification of his view was eventually provided by the fact that he heard that the Germans were collecting dud 'J' bombs on a large scale and filling the tanks of their military vehicles with the contents.²

3. TARGET INDICATORS

It will have been seen that at the beginning of the war there were no target-indicator bombs. Night bombing was supposed to be undertaken on the individual visual recognition of the target by each crew and flares of a somewhat inefficient nature were used in an attempt to facilitate the process. Later, concentrations of incendiary bombs were to some extent used not merely as a means of burning the target but, in the process, of indicating its whereabouts to those who could not find it. A further development, which marked an important step towards the target indicator, was the use of larger incendiaries for specifically marking purposes. First a two-hundred-and-fifty-pound benzol, rubber and phosphorus-filled bomb was used and then the so-called 'Pink Pansy' was introduced. This was a 4,000-lb. M.C. bomb casing similarly charged with benzol, rubber and phosphorus but specially treated to ignite with a distinctively pink flash.³

The creation of the Pathfinder Force in August 1942 raised an obvious and an urgent need for more efficient target indicators. The requirement was for a weapon with good ballistics, so that it could be accurately aimed, and with a clear pyrotechnic display, so that it could readily be seen by the crews of the main force. This was not a simple proposition and it took some time to meet it. The first target-indicator bombs were not, in fact, dropped until the night of 16th January 1943 when they were used

¹ A.H.B. Monograph.

² do.

³ Owing to the lower density of this incendiary filling, the total weight of the 'Pink Pansy' was actually 2,800 pounds.

S.A.O.—IV—D

in an attack on Berlin.¹ Thereafter, target indicators were constantly modified and developed to meet changing requirements and above all the constant attempts of the Germans to simulate them, but all of the forty or so versions of the target indicator which were used between the beginning of 1943 and the end of the war, were fundamentally similar to these original weapons of January 1943.

Target-indicator bombs consisted basically of metal cases with good ballistic qualities from which at any predetermined height pyrotechnic candles of predetermined colour were ejected. These candles could either be set to ignite on ejection, in which case they cascaded to the ground like fireworks, or they could be set to ignite when they reached the ground, in which case they formed a pool of coloured fire. The bursting of the bomb was controlled by a barometric fuse and the radius of ground marking normally produced by the cascading target indicator of two hundred and fifty pounds was about a hundred yards.² To discourage German fire-fighters, ground-burning target indicators were often provided with a proportion of explosive candles and, for sky marking, the candles were each fitted with a small parachute. Thus when a sky-marking target indicator burst a candle effect was produced. It should, perhaps, be mentioned in passing that despite their warlike purposes, the pyrotechnic displays produced by these various kinds of target indicators were among the most beautiful and impressive sights of the otherwise generally darkened nocturnal scenes of the Second World War. They were also, of course, a singularly welcome prospect to anxious and harassed crews who were searching for the target. They added immeasurably to the striking efficiency of Bomber Command and without them the Pathfinder Force would have been virtually impotent.

The most commonly used target indicators weighed two hundred and fifty pounds, but in due course a thousand-pound version was introduced in an attempt to intensify the marking effect and to make it more distinguishable from German simulation. But these heavier target indicators unfortunately proved to have unstable ballistic qualities when dropped from the high altitudes at which the Pathfinder Force habitually operated. To meet the need towards the end of the war for daylight marking, coloured smoke generating target indicators were developed, but the difficulty with these was that their display was often obscured by the vast quantities of smoke and dust thrown up even in the early stages of major attacks. A partial solution was provided by the introduction of a pigment-fitted marker which left a puff of coloured dust in the air above the target. These puffs were remarkably clear and persistent and, in reasonably favourable conditions, could be used as aiming points for about two minutes after going off.³

¹ See Vol. II, pp. 101-102.

² T.I.s could be used as general guides by bursting them at altitudes up to about 9,000 feet, which made them visible from great distances.

³ *Harris Despatch*.

4. BOMBSIGHTS

The factors which have to be taken into account when aiming a bomb are the height, course and speed of the aircraft, the direction and speed of the wind and the ballistic performance of the bomb. The problem, of course, was to provide an instrument which, by relating these data, would indicate the point at which the bomb should be released in order to strike a given point on the ground below, and the sights used by Bomber Command during the war for this purpose were of two distinctive types. In the first case, the bombing data were computed and set, either manually or automatically, on the bombsight before the attack took place. The point of release was then indicated as the aircraft ran up on the target. This was known generally as the Course-Setting Bombsight (C.S.B.S.) and it had the obvious disadvantage that some of the data, and especially the wind vector, might have been incorrectly calculated. The second type, known as tachometric, involved the observation of the movement of the target relative to the aircraft against azimuth and vertical data and enabled the aircraft to be manoeuvred on to an interception course. With the additional information regarding altitude and bomb ballistics, the point of release could thus also be reached but, since actual observation of phenomena tends to be more precise than calculated estimates of them, tachometric bombsights were inherently more precise than course-setting bombsights.

(a) *Course-Setting Bombsights* were developed during the First World War, and though they had been modified and improved in the interval they were still in general service with Bomber Command at the outbreak of the Second World War. These sights were partly automatic, but most of the vital settings had to be made manually by the bomb aimer. Moreover, the aircraft had to be maintained on a straight and level course throughout the bombing run. Small deviations in the air produced large errors on the ground, and though exceedingly accurate results could be obtained in peace time, or under practice conditions, the sight, owing to its tactical rigidity, was much less satisfactory in war operations.

(b) *Stabilised Vector Sights* were developed in order to overcome this difficulty which became accentuated as the German air defences became stronger. These new sights, of which the Mark XIV was by far the most widely used, worked on the same basic principles as the C.S.B.S., but being more fully automatic and because it permitted more room for manoeuvre on the bombing run, it was at once more simple to operate and more realistically adapted to war conditions. Manual control knobs for setting the wind velocity, height, sea-level pressure and terminal velocity were provided, but all the other data were automatically digested by a highly complex computer box. Gentle evasive action could be taken up to the actual moment of release and bombs could even be accurately aimed from an aircraft making a turn, provided that it was correctly banked.

The Mark XIV bombsight was operationally introduced in the summer of 1942 and the newly formed Pathfinder Force was the first to receive it. By January 1944 practically every heavy operational bomber in the force

had been equipped with it.¹ In meeting the general requirement for which it was designed, the Mark XIV bombsight was virtually ideal, but it was not, in the strict sense, a precise instrument.² Also, of course, its operation depended upon an accurate calculation of the wind velocity in the target area at the bombing height. To meet the requirement for the most precise results the tachometric sights were developed.

(c) *Tachometric Bombsights* had reached an advanced experimental stage in 1939, but various difficulties with their complex mechanisms delayed their operational introduction. In the spring of 1942 the Mark II Stabilised Automatic Bombsight (S.A.B.S.) was fitted into Hampdens for training purposes and into Lancasters for operational trials. As a result of experience, further modifications were made and the Mark IIA version was produced. By February 1943 two Lancaster squadrons had been equipped with S.A.B.S. and three other squadrons each had three aircraft fitted with them. But, at that time, it was decided to replace these with Mark XIV stabilised vector sights. This was because the S.A.B.S., like the C.S.B.S., required a straight and level bombing run which, at the height of the area offensive, was considered to be a disadvantage outweighing the greater accuracy of the S.A.B.S. Moreover, the S.A.B.S. was not simple to use and it was found difficult to provide the bomb aimers with sufficient practice when all the squadrons were operating at great intensity. In the following August, however, as will have been seen,³ the S.A.B.S. was given to 617 Squadron and there it played a significant part in the development of precision bombing techniques.

(d) *Low-Level Bombsights* of various kinds were developed during the war, but none of them was extensively used in the course of the strategic air offensive which was principally executed from medium and high levels. In addition, however, to the ingenious but simple 'home made' sight used in the famous dams raid of May 1943, 617 Squadron also made use during 1944 of the Mark III low-level angular bombsight. This instrument established the release point by measuring the angular velocity of the target, that is the rate at which the angle between the vertical and a line projected from the aircraft to the target changed. This had the great advantage of eliminating the need for height estimation.⁴

5. CONCLUSION

Bomber Command was, perhaps, more fortunate in its bombsights than in its bombs. Though even the best crews could not rely on an aiming error of less than a hundred and fifty yards with the Mark XIV sight and though only the best crews could get the better results which were pos-

¹ During this period, various modifications were introduced. The Mark XIVA sight had an increased altitude capacity, which in the case of the Mark XIV was 20,000 feet. American versions of the Marks XIV and XIVA, known as T.I. and T.I.A., were also widely used in Bomber Command. By the end of 1943, for example, all operational Wellington squadrons in Bomber Command were equipped with T.I. sights. These American versions were almost identical with their British counterparts.

² It was termed the 'area sight'.

³ See Vol. II, p. 186 ff.

⁴ A.H.B. Monograph and *Harris Despatch*.

sible with the Mark IIA S.A.B.S., these two instruments were respectively excellent weapons for area and precision bombing. As to the bombs themselves, there were some weapons of astonishing effectiveness and especially so in the case of those specialised bombs which were designed by Mr. Wallis. Target-indicator bombs were also generally satisfactory and the four-pound incendiary bomb had immense destructive potential. There were, nevertheless, some persistently weak features about the armoury of Bomber Command and these, unfortunately, were especially connected with the bombs which were produced on the largest scale.

ANNEX V

The British and United States Surveys of the Strategic Bombing Offensive

THE statistical tables in this volume are taken from the British and United States surveys which have been one of the major sources of the conclusions reached in this book on the results of the strategic bombing offensive. It seems necessary, therefore, to give some information concerning the organisations set up for this purpose and the methods of investigation which they employed. Since each organisation, though surveying a combined offensive, was mainly interested in the results achieved by the air forces of its own country, the history of the British survey is especially important. It is, indeed, one of the more curious, and, in some respects, unfortunate, episodes of these years.

The desire for a scientific evaluation of the results of the offensive was a natural one and was in the minds of those directing the air forces from an early date. The United States Air Staff sent independent evaluation teams to its overseas forces and, as early as March 1944, began to plan for a comprehensive survey of the whole offensive. From the first they were determined that the report should be made by a United States team alone and not be a joint report of British and United States organisations, in spite of the fact that the offensive had been a combined one. They also from the first accepted the principle that if such a report was to be regarded as authoritative, it must be produced by an entirely independent body and not be issued under the auspices of the Army Air Forces or its Commands. These objectives they steadfastly pursued throughout the ensuing months and in a large measure achieved them.

Thus, in September and November 1944, President Roosevelt and Mr. Stimson issued instructions based on these principles, which were transmitted by Generals Marshall and Arnold to General Spaatz and General Fickel, the head of the Evaluation Board.¹ The two generals were ordered to give every assistance to the civilian survey, which was put under the direction of Mr. Franklin d'Olier, head of the Prudential Insurance Co. of America, and Mr. H. C. Alexander, President of J. P. Morgan and Co. and a Director of General Motors, as second in command. With them was a board of nine civilian directors drawn from industry, commerce and academic life, none of whom had been directly concerned with the offensive, though they had held official positions during the war.² They were allotted a staff of over 1,000, of whom 350 were to be

¹ Letters Roosevelt to Stimson, 9th Sept. 1944, Stimson to d'Olier, 3rd Nov. 1944, Arnold to Fickel (Chairman, Air Forces Evaluation Board, England), 3rd Nov. 1944, and to Spaatz, 3rd Nov. 1944. See *The Army Air Forces in World War II*, Vol. III, pp. 789-792, for a fuller account of the organisation.

² Minutes of a meeting between Mr. Franklin d'Olier and staff and Air Marshal

civilian experts specially appointed and 350 serving officers from the evaluation teams and other departments already in Europe. By November 1944 Mr. Franklin d'Olier had chosen most of the directors and had come to Europe with his colleagues to set up the framework of the organisation which was rapidly developed. At the same time, teams under its direction were getting ready for work in France and to advance into Germany behind the armies. It was hoped that the Russians, who had been co-operative in a United States investigation of the results of the attack on Ploesti, would allow entry into their zone of occupation and even take part in the work of investigation.¹

Meanwhile, similar ideas existed in Britain and, as a result of advice from Mr. Vickers, Sir Norman Bottomley initiated interdepartmental discussions on the subject. In May 1944 a meeting was held composed of high-ranking air force officers and representatives of the Research Department of the Ministry of Home Security and the Ministry of Economic Warfare. Their plan was approved in principle by the Chiefs of Staff on 10th August 1944 when the Air Ministry was specifically charged with the task of organising it in detail. The British would have preferred a joint survey, but soon realised that they were unlikely to get the United States to agree to such a course. They also accepted the principle that the survey must be placed under the direction of a civilian of high position, perhaps an ex-Cabinet Minister, who had had no responsibilities for the formulation or execution of the policy of the strategic offensive. Some tentative suggestions to United States staffs confirmed their expectation that a separate report must be made, but they hoped that the work of investigation might to a large extent be pursued in common or at least in co-operation.²

It soon became clear, however, that those who had played a prominent part in advising on or executing the policy of the offensive were anxious to obtain some control over the investigations. Thus, in September, a Bombing Analysis Unit (B.A.U.) was set up in S.H.A.E.F. to investigate the

Bottomley and staff 27th Nov. 1944. The Directors of the Survey and their departments were appointed as follows:

Transportation: Mr. George W. Ball, Office of Lend-Lease Administration.

Physical Damage: Professor Harry L. Bowman of the Draxell Institute.

Overall Effects and Area Bombing: Professor John K. Galbraith, Harvard, Princeton and Office of Price Administration.

Morale: Mr. Rensis Lickert, Dept. of Agriculture and Adviser to the Treasury Dept.

Civil Defence: Mr. Frank A. McNamee, Dep. National Director, Office of Civilian Defence.

Bearings, Abrasives, Machine Tools, Electrical Engineering, Electronics and Optical and Precision Machinery: Mr. Paul H. Nitze, Partner Dillon and Read, Foreign Economic Administration.

Oil, Rubber and Chemicals: Mr. Robert P. Russell, President of the Standard Oil Development Co.

Heavy Industry, Ordnance, motor vehicles, tanks, submarines: Mr. Fred Searls, Jun., Office of War Mobilisation.

Aircraft, light metals, V-weapons: Mr. Theodore P. Wright, Civil Aeronautics Administrator. The Secretary was Judge Charles C. Cabot. Some of these had not yet arrived and there were some changes before the team was finally constituted as above.

¹ Later, at Yalta, Marshal Stalin promised co-operation, but none was ever given, and except for a few forays the United States investigators were excluded from the Russian-occupied zone.

² Mins. of D.C.A.S. Conf., 12th May 1944, Air Min. Mtgs., 26th May and 17th June 1944, and of C.O.S. Mtg., 10th Aug. 1944.

results of the pre-*Overlord* bombing offensive in France and Belgium. Its head was Group Captain E. S. D. Drury, succeeded by Group Captain A. N. Combe, but its guiding hand was its scientific director, Professor Zuckerman, who had been, and still was, Sir Arthur Tedder's principal adviser in the attack on communications. At the same time he wrote a letter to Air Marshal Bottomley urging the necessity of ascertaining the respective merits of area and precision bombing and the use of technicians and scientists for that purpose.¹ Sir Arthur Harris was of the opinion that the survey should be kept in the hands of the Air Ministry. He also claimed the right to make his own immediate investigation, and with the consent of the Air Staff a small team was sent to the Continent from Bomber Command staffed partly by its Operational Research Section.² This was a natural development. Clearly such experts could be of great use in the survey, but, of course, much depended on how their activities were controlled and how the final assessment of results was obtained.

This would depend on the character of the wider scheme, which was meant to absorb or supersede all these tentative efforts. It was planned on a comprehensive scale. A British Bombing Survey Unit (B.B.S.U.) was set up by the Air Ministry under Air Commodore Pelly to prepare a plan and enlist personnel. In London also there was the desire of those who had been advising on the offensive to take part in it. R.E.8, which, it will be remembered, had been reinforced by valuable United States technicians, expected to have an important position in it, and Squadron Leader Dewdney, the head of R.E.8, was closely associated with the plan from the first.³ M.E.W. also was deeply concerned with it and it was suggested that for this purpose M.E.W. should supply 100 technicians drawn from M.E.W. itself, the supply departments and industry.⁴ It was understood that, whoever controlled the work of investigation, the analysis of their findings and the report itself were to be directed by an independent body with an authoritative head and scientific adviser. But clearly the operative investigating body would have a great influence on the final result. The Air Commodore in charge, Air Commodore Bufton insisted, must believe in the potentialities of strategic bombing.⁵

Unfortunately, however, while the United States organisation was already in being and developing quickly, the British was still only a paper scheme. It was still necessary to obtain approval at the highest level for the proposed plan. This was comprehensive enough and Air Commodore Pelly, the head of B.B.S.U., accepting the inclusion of the experts to be provided by R.E.8 and M.E.W., though he had no authority or resources to obtain their services, had suggested a total number not much less

¹ Letter Zuckerman to Bottomley, 25th Sept. 1944. Min. Bufton to Williams, 7th Oct. 1944. The name of the unit was changed to R.A.F. Bombing Analysis Unit to show that it was not only concerned with the *Overlord* bombing, though its headquarters were still at S.H.A.E.F.

² Letter Bottomley to Harris, 3rd Nov. 1944.

³ Min. Williams (A.C.A.S.(Ops)) to Slessor (A.M.P.), 8th Sept. 1945. 'Dewdney is a key man in this organisation . . .'

⁴ Draft Memo. by Bottomley as a basis for a memo. from Portal to Sinclair, 6th Oct. 1944.

⁵ Min. Bufton to Williams, 7th Sept. 1944.

than that already engaged by their ally. This, as was to be seen, was a mistaken approach to the problem and was no doubt partly due to the fact that it was felt necessary to be able to compete with the United States organisation. Tentative enquiries were made as to the civilian head and Lord Trent was the most favoured of a number of names suggested. Names were also considered for a scientific adviser and Sir Henry Tizard and Sir George Thomson were consulted on the subject. At this stage the Air Ministry did not intend that S.H.A.E.F. should take part in the investigation. The whole was to be called the British Bombing Research Mission and the B.B.S.U. was to be absorbed in it.¹

All this took a great deal of time, and, indeed, Air Commodore Pelly attributed the refusal of the United States to join in a combined report to Mr. d'Olier's belief that the British would take too long to make their plan and too long to carry it out, as well as to a distrust of M.E.W., which Mr. d'Olier thought was likely to play a determining part in the investigation.² Whatever truth there was in this view, the plan still hung fire. It was approved by the J.I.C. and then by the Chiefs of Staff, but it was then thought best for Sir Archibald Sinclair to submit it to Mr. Churchill as Minister of Defence. At the end of November he secured the approval of the Ministers of Economic Warfare and Home Security and he informed Lord Cherwell that he proposed to ask Lord Trent to be the head of the British Bombing Research Mission and Sir Thomas Merton to be its scientific adviser.³ But Mr. Churchill was busy with other matters and no answer had come by the end of December. In urging Sir Archibald Sinclair to obtain one as soon as possible when the Minister of Defence returned from his visit to Greece, Sir Charles Portal clearly thought that there would be no great difficulty in obtaining approval of the scheme, which, he said, did not seem to him 'to be very complicated and is, so far as I know, entirely non-controversial'.⁴

All the greater, therefore, must have been the shock of Mr. Churchill's reply on 3rd January 1945. It was an absolute refusal to sanction any scheme of the magnitude suggested. 'Your paper', this minute ran, 'does not state the number of personnel who will be required, but from the chart which you attached it is clear that this number will be very large and in addition you state that a considerable proportion must be high grade specialists. Having regard to the fact that the final report would not be made until eighteen months after the defeat of Germany, I cannot agree to the use of manpower and brain power on this scale.

'If, however, you can assure me that there is a reasonable prospect of

¹ The Scientific Adviser to the Air Ministry (Sir G. Thomson) pointed out 'As a matter of principle the investigation of damage should not be by the people who are responsible for planning the attack, particularly in cases like this where there has been controversy as to the merits of some of the methods.' Min. to Bufton through Williams, 10th June 1944.

² Min. Pelly to Bottomley, 6th Nov. 1944.

³ C.O.S. Mtg., 10th Aug. 1944. Mins. Portal to Sinclair, 17th Oct. 1944, Sinclair to Cherwell, 30th Nov. 1944. The correspondence with other Departments is in the same file.

⁴ Min. Portal to Sinclair, 29th Dec. 1944.

getting results soon enough to be of material assistance in the war against Japan, and that these results could not be obtained by the means already at our disposal, I would be prepared to sanction the employment of some twenty or thirty persons on this work. The question of expanding this number after the end of the German war could be considered later in the light of circumstances.

‘On this basis you may submit a scheme to the Cabinet.’¹

On the receipt of this bombshell Sir Archibald Sinclair immediately sought the advice of the Chief of the Air Staff and permanent Under-Secretary of the Air Ministry and another scheme was prepared of more limited immediate application, but which could be expanded as circumstances arose. He again tried to obtain for the scheme the support of fellow ministers and did get that of the First Lord of the Admiralty, the Minister of War and the Minister of Economic Warfare with some reservations. A memorandum was drawn up for the War Cabinet on 5th February 1945. In this it was proposed that the Chief of the Mission and his scientific adviser should be appointed forthwith, that an Advisory Committee of the representatives of the interested government departments should be constituted and that the Chief of the Mission should take over such investigating bodies as already existed and choose and earmark further personnel, but not ask for their services until the work developed.² Thus, the large number so categorically refused by Mr. Churchill would be greatly reduced and the personnel gradually increased as they were released from other duties. But after a month’s delay Mr. Churchill refused to allow this paper to go before the War Cabinet. He insisted that it should be first examined by the Treasury, costed as in peace time and submitted to a sub-committee of three ministers concerned and the Chancellor of the Exchequer.³

This action aroused the indignation of the Air Ministry and Sir Charles Portal resolved to appeal to his colleagues on the Chiefs of Staff Committee. In a trenchant memorandum he reviewed the course of the plan and the delays to which it had been subjected. ‘We have thus’, he commented, ‘reached a stage where, nearly eight months after it had been approved by the Chiefs of Staff, this important project has made no material progress.’ Thus, while the Ruhr and the Rhineland were being occupied, neither the plans, personnel nor administrative machinery were ready. The Chiefs of Staff approved his proposal to appeal direct to the Prime Minister without the intermediary of ministers. They persisted in sending the plan to him in a considered memorandum even though they were

¹ Min. Churchill to Sinclair, 3rd Jan. 1945.

² Min. P.S. to Sinclair to P.S.’s to Portal and P.U.S., 3rd Jan. 1945. Draft memo. for submission to Ministers, Jan. 1945. The correspondence with the Ministers is given in the same file. War Cab. Paper, 5th Feb. 1945. The Secretary of State for War was of the opinion that just as S.H.A.E.F. was to be excluded, so should the Operational Research Sections of the services. ‘No doubt’, he wrote, ‘you will consult us as joint sponsors before appointments to key positions in the Mission are made.’ The First Lord of the Admiralty made a similar demand. The Minister of Home Security thought it was no longer necessary for him to co-operate since Civil Defence could be studied at leisure. Letters Grigg, Alexander, Morrison to Sinclair, 2nd Feb., 27th Jan., 26th Jan. 1945.

³ Min. Churchill to Sinclair, Alexander and Grigg, 6th March 1945.

informed that Sir John Anderson's Ministerial Committee was about to make its report.¹

But again Mr. Churchill was adamant. His reply on 8th April was to reiterate in even harsher terms his refusal to sanction an organisation on the scale proposed for what he termed a 'sterile task'. He offered as before the use of thirty experts.² It was an unfortunate decision, made against the advice of all those who were able to judge the advantages of such an enquiry. It is the main reason why no authoritative pronouncement has ever been made in Britain, then or since, on the conduct and results of the strategic offensive. It may be questioned whether the lack of an authoritative and independent survey has affected the planning in the period since the war, as Sir Charles Portal was afraid would happen. But it is certainly true, as he also said would be the case, that opinion in this country on this question has been 'based largely on propaganda, personal recollection or on the results of investigations by other nations'.

Before this answer was received Sir John Anderson's Ministerial Committee reported. It did no more than to propose the setting up of a new Committee to consider how the British Bombing Research Mission should be constituted.³ This Committee, of which Mr. Vickers was Chairman, did not meet till June and its report was not ready until September. By that time the work of investigation so far as it could be undertaken with the means available was already far advanced and the United States organisation had conducted extensive researches in Germany under the direction of Mr. d'Olier's Board. The procedure followed in London had prevented any comparable British organisation from being set in motion.

In the circumstances the Air Ministry did the best it could to combine its scanty resources into a working organisation, late in the day as it was. It was also now necessary to join forces with S.H.A.E.F., where the B.A.U. under the scientific direction of Professor Zuckerman had been doing all it could to make investigations by a few teams manned to a large extent from his staff. Sir Arthur Tedder had written enthusiastically of this work and he and Sir Charles Portal now agreed to amalgamate all the enquiries in progress. Professor Zuckerman thus became scientific adviser to the B.B.S.U., which was still in being under Air Commodore Pelly with Squadron Leader Dewdney as its secretary. Mr. Lawrence and other members of the Enemy Activities Branch were utilised to enlarge its scope.⁴

¹ Note by Portal, 20th March 1945, printed at the end of this Annex on p. 56. C.O.S. Mtg., 3rd April 1945. Min. C.O.S. to Churchill, 4th April 1945.

² The minute is printed in Sir Winston Churchill: *The Second World War*, Vol. VI, p. 640. In a later minute on another matter to Sir Archibald Sinclair and Mr. Bevin he wrote: 'It is intolerable that these efforts should be made to find all kinds of sterile jobs for people. I had the same trouble with the commission which was to examine the effects of bombing, which was to amount to about a thousand persons.' *do.*, p. 651.

³ Mtg. of Ministers, 6th April 1945. It consisted of the Chancellor of the Exchequer, the Secretary of State for Air, the First Lord of the Admiralty, the Minister of Economic Warfare, the Permanent Under-Secretary of the War Office, the Deputy Chief of the Imperial General Staff with Sir Edward Bridges. Min. Anderson to Churchill, 7th April 1945.

⁴ Letters Tedder to Portal, 22nd March and 5th April 1945. Draft letter prepared by Bottomley for Portal to Tedder, 14th April 1945. Bomber Command at this time protested at the delay in setting up the B.B.R.M. and was told that a decision would be arrived at shortly. Letters Saundby (for Harris) to Air Min., 11th April, Bottomley to Harris, 13th April 1945.

Professor Zuckerman thought that what was most needed was the collection of documents rather than field surveys or investigation on the spot. Such teams as the British possessed were, indeed, incapable of making full and comprehensive surveys of particular towns and industries except in a very limited way. They had not the resources which were at the disposal of the United States survey. Other investigators were also enquiring into every aspect of the German economy and fighting forces, including the Field Information Agency Technical (F.I.A.T.) which had been set up under S.H.A.E.F. before the war ended.¹ There was thus an abundance of reports and statistical material and to these were added the ninety-two interrogations of Speer and his staff made by every kind of department. The B.B.S.U. took a small share in this, using an elaborate questionnaire which was drawn up in London. They had also one comprehensive British survey, that on the offensive against oil, drawn up by Sir Harold Hartley's Committee which had advised the Government on this question throughout the war.

In these circumstances the achievement of the B.B.S.U. was a remarkable one. Nine panels were ultimately constituted to study different aspects of the offensive.² They used mainly the statistics produced by the United States survey team which put their material freely at the disposal of the British. Some statistical experts were enlisted and a special study was made of the effects of area bombing as Professor Zuckerman had from the first demanded. It was founded on a statistical enquiry not checked by direct observation. Its nature is discussed later in this annex. By the spring of 1946 the nine panels had produced their reports and these had been used for a general survey of the whole strategic offensive.

This last is a review of the strategy as well as the results of the bombing and many of its judgments carry conviction. It includes a number of graphs and statistical tables, some of which are reproduced in this volume. But the account is not documented and it is not always possible to ascertain on what evidence judgments are based. The effect of the attack on communications is strongly stressed. No doubt those who made it endeavoured to assemble and analyse the facts and draw deductions from them in a completely impartial and scientific spirit. But the survey was largely directed by men who had themselves played an important part in making the appreciation on which the Chiefs of Staff and the Defence Committee had based their strategy. It was inevitable that the report should bear the impress of their own experience.

¹ Mins. of Mtg. of B.B.S.U. Advisory Cttee., 6th June 1945. Among those present were Air Commodore Pelly (its head), Professor Zuckerman, Dr. B. G. Dickens (O.R.S. Bomber Cmd.), and Mr. Lawrence and Mr. Wood (E.A.B.). Mr. Lawrence was critical of Professor Zuckerman's view that only documentary evidence was necessary. Both Air Commodore Pelly and Group Captain Combe had pointed out the inadequacy of British Field Units. It was very necessary, it was stated, to have good relations with F.I.A.T. The Bombing Analysis Unit had already prepared a number of reports on limited objectives. Memo. Pelly to Bottomley, 25th April 1945. Copy of letter Combe (B.A.U.) to Breaky (A.C.A.S.(T.R.)) and others, 2nd May 1945, sent to Pelly.

² These were Towns; Aircraft Industry; Shipbuilding; Sea-Communications; Inland Communications; Weapon Effectiveness; Underground structures; Civil Defence; U-boat Industry. In addition there was the report by the Technical Sub-Committee on Axis Oil under the title *Oil as a Factor in the German War Effort, 1939-1945*. A number of preliminary reports and studies were made, including one on the Iron and Steel Industry.

As has been seen, this danger had been from the first recognised by those who originated the proposal for a survey. They had desired that it should be directed by independent civilians of high position who had no responsibility for the offensive, as had been done in the case of the United States survey. They had also wished to associate in the work all the departments of the Government concerned in the offensive so that those who made the final assessment should have before them the accumulated experience of the war. There had been a failure to secure these objects while the investigation was being made, but it was still possible for the results to be submitted to an impartial body, subjected to an examination by independent experts and only issued after some authoritative person had satisfied himself that so far as possible justice had been done to all concerned.

This was still the view of the Vickers Committee when it reported in September 1945. It suggested that an inter-departmental Committee should be set up for this purpose with its own staff of experts and a civilian head approved by the Prime Minister and that its report should be made to the Minister of Defence and not to the Air Ministry.¹ Nothing was, however, done about these recommendations. When the B.B.S.U. had finished its survey and a final decision had to be made, circumstances had changed. The Air Ministry showed little desire for the report to be scrutinised by an independent body. The other departments had lost interest, their war personnel had disappeared and some had ceased to exist. None wished to take responsibility for a report over the making of which they had had little influence. The use of the atomic bomb had so altered the technical position that it was thought by many that the report had only an academic interest.

Thus, it was decided merely to engage in correspondence with such departments as were interested, no authoritative head was appointed and the report was never scrutinised by any independent body set up for the purpose. It remained a confidential document of the Air Ministry communicated with the usual restrictions to other departments and never made available to the general public.²

Meanwhile, the United States Survey (U.S.S.B.S.) had been completed. Its general report³ is also a splendidly executed piece of research and organisation. It is, however, perhaps more successful as an account of the German economy than as a discussion of the effects of bombing upon it. It was produced by distinguished economists under the direction of an impartial body. But the material used was produced by teams staffed partly by serving officers whose opinions were to some extent reflected in the emphasis placed on the various aspects of the offensive. Thus, far less is said about communications than in the British report and the attack on oil is given a greater share in producing the final result. But its statistical appendices are a solid foundation for the survey and in addition there are

¹ Report of the Vickers Cttee., 8th Sept. 1945. It was approved by the Defence Committee. Def. Cttee. Mtg., 5th Oct. 1945.

² Memo. Pelly to Williams, 8th March 1946. Memo. Williams to A.U.S.(G), 24th April 1946.

³ *U.S.S.B.S. The Effects of Strategic Bombing on the German War Economy* (No. 3).

the 205 special reports.¹ These special reports are naturally uneven in value. A few are almost worthless, either because they were too hurriedly made, or because the subject was not susceptible to scientific treatment, or because the investigators were incompetent. But in most of them there was an effective attempt by impartial investigators to assemble the facts on which judgment could be based, and the conclusions reached were in accordance with the evidence submitted. In a number of them no judgment was made because it was considered that there was not sufficient evidence on which it could be based. It should be noted also that a similar series of reports were written under the same direction with one or two changes on the war in the Pacific.

Moreover, though these United States reports were at first kept secret many of them were after no long time declassified, made available to students and subjected to public criticism. The general survey has been, indeed, the main source for many books on this aspect of the war. It is to be regretted that the British survey could not be released in the same way and its conclusions receive public discussion and criticism.

These facts should be kept in mind when the evidence provided by them is used. But it should also be remembered that the surveys contain an impressive body of statistical material which throws light on many aspects of the strategic offensive. Though their findings show a different emphasis on various parts of the offensive, they do not in the main conflict with one another. Nor do the authors of this book differ from them as regards much of what they set down, though they consider that neither survey pays sufficient attention to the effect on the offensive of the winning of air superiority.

The conclusion that with the use of conventional bombs selective and precise bombing was more effective than area bombing, if the former could be carried out, is not one which is now much disputed. But some differences of opinion will always exist as to when exactly and under what conditions selective and more especially precision bombing could be effectively carried out and what objectives were calculated to produce the most immediate and decisive results.

Finally, since so much of the British offensive was devoted to area bombing something must be said of the special reports produced by each survey on this subject, the results of which were in one form or another incorporated in their general reports.

The question of area bombing was naturally a foremost one in the minds of the British team. The United States survey had also to deal with a method condemned so often on both practical and humanitarian grounds by the United States Army Air Forces until they came to apply it themselves to Japan. The British survey, as was right and natural, made a much more elaborate and determined attempt to tackle the problem. If neither attempt is quite satisfactory or convincing it is far better to have judgments founded on some kind of statistical analysis than on the vague generalisations based on some particular piece of evidence or on the opinions of the

¹ In addition, a number of other reports were written which were not circulated. A comprehensive bibliography of the survey is given in Index to Records of the United States Strategic Bombing Survey, June 1947.

Germans themselves freely expressed in their interrogations after the war. When the two surveys attempted to discover the effect of area bombing in this way, they were also attempting one of their most difficult problems, for area bombing is the most complicated in its effects of all kinds of bombing. When considering the question of the statistical expression of bombing effect, it is, therefore, of particular interest to examine the ways in which the calculations about the effects of area bombing were conducted.

The U.S.S.B.S. produced the following figures as an indication of the loss of production as a percentage of total annual German production attributable to area bombing.¹

Year	%
1942	2.5
1943	9.0
1944	17.0
1945	6.5 (January to April only)

The B.B.S.U. reached the following rather different conclusions.²

Type of Production	1942	1943		1944		1945
	Jan.-Dec.	1st Half	2nd	1st Half	2nd	1st Half
War	0.25	1.8	3.8	1.0	0.9	1.2
All	0.56	2.7	8.2	4.4	7.2	9.7

The U.S.S.B.S. pointed out clearly that the 'number of variables involved' made these 'estimates very rough, especially towards the end of the period'.³ In any case, the report went on to point out, these figures did not give a good indication of the extent to which war production had suffered, because it had generally been possible to divert production losses from the essential industries.

The B.B.S.U.'s special report on the air attacks on German towns was made by statisticians who had not been concerned with the problem during the war and who approached it without any preconceptions. They indicated some of the uncertainties of their figures, but were nevertheless much more confident about the results which they obtained. They were also more ambitious than the U.S.S.B.S., for they sought to show the effect not only on total production, but, within that, the effect on war production as well. On the evidence, the B.B.S.U. concluded that 'area attacks against German cities could not have been responsible for more than a very small part of the fall which actually had occurred in German production by the spring of 1945, and . . . in terms of bombing effort, they were also a very costly way of achieving the results which they did achieve'.⁴

Area attacks accounted for nearly half of the entire effort put forth by the R.A.F. Bomber Command during the whole of the war. During this great offensive it was calculated that no less than 478,000 tons of bombs

¹ U.S.S.B.S. *Area Studies Division Report* (No. 31), p. 18. See also App. 49 (xiii).

² B.B.S.U. *Effects of Strategic Air Attacks on German Towns*, p. 30. See also App. 49 (xii).

³ U.S.S.B.S. *Area Studies Division Report*, p. 18 ff.

⁴ B.B.S.U. *The Strategic Air War*, p. 97.

were dropped¹ and some 300,000 Germans were killed, in addition to a further 780,000 wounded.² 82,000 acres of built-up areas in Germany were devastated.³ It is natural that there should exist the desire to find some precise statement of what this effort achieved.

Figures like those produced by the U.S.S.B.S. and the B.B.S.U. as the solution to this problem do, however, present serious dangers. Even if the points at which the calculation becomes a speculation, and if the methods of the calculation as well as the sources on which it is based are advertised, there is still a tendency for the figures themselves to gain the mastery which they may not deserve. Even as the broadest indication of the effect of the area bombing offensive these figures can only be of value if these points are carefully exposed.

The investigations of the U.S.S.B.S. and the B.B.S.U. were both based upon statistical analyses and these analyses in turn were principally based upon the answers to questionnaires submitted by the U.S.S.B.S. to a very large number of industrial firms in Germany, the interrogation of the heads of some of those firms, and the examination of German statistical records.⁴

In addition to the many and obvious disadvantages of the questionnaires as a historical source there were two which in this case are worthy of special mention. The firms which had been bombed out of existence did not return questionnaires for obvious reasons. This threw the sample out of balance and tended to produce an understatement of the effect of bombing. The U.S.S.B.S. came to the conclusion that the loss of production towards the end of the war, which was attributable to the general collapse of the German economy, and not specifically to the area bombing attacks which would tend to exaggerate the effects of area bombing, would compensate for this error.⁵ This was, of course, quite true, but whether these two compensating factors would, in fact, cancel each other out, or, indeed, whether they were even remotely comparable was a problem far beyond the realm of calculation. The B.B.S.U. decided that the same error would be compensated for by the fact that workers from the totally destroyed factories would have been absorbed by others which were continuing and increasing production.⁶ It is unnecessary to comment upon the speculative nature of these assumptions.

The second principal disadvantage from which the questionnaires suffered was the unreliability of the answers. There is a strong supposition that many of the firms did not possess the necessary records to make detailed answers to the questions which were put to them. Indeed, during the war the *Statistische Reichsamt* had found it impossible to collect complete information for this and other reasons.⁷

¹ *B.B.S.U. The Strategic Air War*, p. 56.

² *U.S.S.B.S. Overall Report* (No. 2), p. 1. (Approximate figures for whole combined bomber offensive.)

³ *do.*, p. 13.

⁴ *U.S.S.B.S. Area Studies Division Report*, p. 1, and *B.B.S.U. German Towns*, App. C, p. 46.

⁵ *U.S.S.B.S. Area Studies Division Report*, p. 8.

⁶ *B.B.S.U. German Towns*, p. 46.

⁷ *do.*, p. 47.

German statistical records which might have provided a useful check upon these questionnaires also suffered from severe disadvantages. The files of the *Reichsgruppe Industrie*, which were one of the main sources, fell into a disordered state owing to the repeated evacuation of the offices in which they were maintained.¹ In some cases there was no assurance that the figures which were being studied represented actual or merely estimated production levels. Figures from the *Statistische Reichsamt* appear to have been liable to errors resulting from mistaken classification of the industrial groups and double reporting.² After the war Speer commented upon the unsatisfactory way in which industrial statistics were collected in Germany during the war, and he also referred to incompetent processing of the figures which sometimes produced 'appalling inaccuracies' (*ungeheure Fehler*).³ Thus, the U.S.S.B.S. and the B.B.S.U. were presented with material which concealed more than the usual statistical hazards. These were likely to introduce an element of error into any calculation.

Finding that it was impossible to collect production statistics in terms of units produced, the U.S.S.B.S. had to establish production levels by reference to receipts from sales, a method often used for such purpose. This did not, of course, establish the production level directly, because the receipts would not indicate whether the goods sold had come from direct production or from stocks. Similarly they would not show the amount of stock-piling which was going on. In order to correct this error the U.S.S.B.S. also consulted the statistics of electricity consumption by the firms. There was considerable correspondence between the two, sufficient at any rate to give the statisticians confidence in their figures. In this way the best index of production which could be devised was then calculated and related to total German production at various times. The next step was to calculate how many tons of bombs had produced the loss in production thus determined. In this a special difficulty arose in that area bombing had varied so much in accuracy and intensity in the course of the war. It was necessary, therefore, to calculate the intensity of the attacks on the cities selected as the sample. They, therefore, made a calculation of intensity based on the percentage of the houses of a city totally destroyed by a raid. These statistics were, as has often been indicated in the text, only approximate, nor need the actual loss of production during a raid necessarily correspond to the number of houses destroyed. Much might depend on how far the factories themselves were injured, and this varied greatly in different towns. A sample of ten towns is hardly sufficient to make a calculation of such importance. Nevertheless, on this basis it was decided that 15,000 tons of bombs destroyed one per cent of national production.⁴ By a rule-of-three method it was then a simple matter to calculate the effect on national production of any given tonnage of bombs. In this way the overall estimates, which have already been quoted, were reached. In this connection it is important to note that any inherent errors

¹ U.S.S.B.S. *Overall Economic Effects Division* (No. 134), *Industrial Sales, Output and Productivity*, p. 27.

² *do.*, p. 26.

³ *Speer Interrogations*.

⁴ U.S.S.B.S. *Area Studies Division Report*, p. 18.

in the calculation were multiplied by the number of times 15,000 would go into the tonnage which was actually dropped, in other words, by about two in 1942, about nine in 1943 and about seventeen in 1944.¹ In addition to this, however, there was another serious possible source of error in this calculation. The calculation was based upon figures which were collected for 1943 and the first half of 1944, but the results were computed for 1942 and 1945 as well as the second half of 1944. As the U.S.S.B.S. Report pointed out, bombing accuracy improved as the war went on, and this meant that the figures for the second half of 1944 and the first part of 1945 would tend to be an understatement of the actual effect of the bombing. On the other hand, the fact that an ever-increasing number of bombs would fall into craters made by old ones and the effects would, therefore, become subject to the law of diminishing returns would tend to compensate for this error. Even so, this was another speculation which could not be checked, and may have produced a larger or a smaller error.

The B.B.S.U. devised a different employment for substantially the same basic material. They endeavoured to find what the trend of production in the bombed towns would have been if they had not been bombed, and then, by a comparison with the actual production, to find what the bombing effect had been. They were presented with the same problem as the U.S.S.B.S. in finding a satisfactory index of production, and like the U.S.S.B.S. they used the receipts of the firms as the indication of their production. By this means they calculated the production levels in a number of representative towns which had not been bombed. These 'controls' they considered represented the trend of production in Germany. The majority of these towns were small towns and it is not certain, therefore, that the sample was sufficiently representative. They then repeated the process in a sample of twenty-one towns which had been subjected to typical area bombing. The effect of the bombing was deduced from a comparison of the two results.

This investigation was not, however, designed to show the effects on the towns, but upon various groups of industry. By considering the figures for the groups of industry the B.B.S.U. found it possible to calculate figures of the extent to which area bombing depressed not only national production, but within that, national war production. This was more ambitious than the calculation which had already been made by the U.S.S.B.S. The B.B.S.U. calculation produced the following figures for the iron and metal processing industry.²

	1942	1943		1944		1945
		1st Half	2nd	1st Half	2nd	Jan.-April
War	3·0	14·5	46·5	24·2	39	54·2
All	2·1	10·3	31·9	16·8	26·4	37·1

The interesting thing about these figures is not only that they show a very

¹ The hazards of this type of calculation had already been demonstrated by the fantastic calculations of the effect bombing would have which were worked out on the multiplication system before the war, using results in the 1914-18 war as the basis. See Vol. I, pp. 63, 184.

² *B.B.S.U. German Towns*, p. 30.

high rate of loss attributable to area bombing, but that they also show a higher rate of loss in the sector of war production than in that of total production. Both of the conclusions which these figures suggested cut across the evidence which other information suggested, and, in fact, the B.B.S.U. found that these particular figures were 'spurious', as no doubt they were, and they were accordingly excluded from the final reckoning.¹ If, however, these particular figures were 'spurious', some suspicion is thrown on the other figures, which incidentally produced results which were more in accordance with the general trend of the evidence. After all, the figures were the production of the same calculation.

In their calculation of the fall in production the U.S.S.B.S. had taken into account the effect of indirect loss caused by the necessity to replace buildings, machinery and raw materials, houses and household possessions, and concluded that it was equal to the direct loss caused by direct damage to factories and absenteeism. The B.B.S.U. Towns Panel, on the other hand, confined their estimates to actual production losses because it 'was unable to obtain sufficient reliable data to warrant a detailed examination of this subject and it has not, therefore, taken it into consideration'.² This no doubt accounts for some of the differences between the two reports.

There is, however, much evidence of the effect produced by this necessity on the resources available for production. Even if the unskilled workers are considered replaceable because of the use of prisoners of war, a large, though unknown, number of skilled workers were engaged in this task who were permanently removed from production throughout 1943 and 1944. Moreover, this reduction in the number of skilled workers would affect the production in the unbombed towns as well as the bombed towns, and, in fact, be spread over the whole of the Reich. It is impossible to determine how far production was affected by this particular cause or how much of that loss was due to area bombing and how much to precision bombing. But that some of this effect was caused by area bombing seems clear. Similarly, as has been seen in the text, there were important effects on the construction of the land defences which should be reckoned as part of war production.

It is now possible to consider the validity of these two calculations. On the admission of the U.S.S.B.S. and the B.B.S.U. they cannot be accepted, and are not intended, as exact statements of bombing effect. But there is much other direct evidence of the effect of area bombing on production which, if considered together, shows that the figures of the surveys, if neither is an exact computation of the effect of area bombing, are sufficiently accurate to show the general effect. The statistics of particular towns examined by the U.S.S.B.S. are of varying value, but they show in many cases the effect on the total production of a particular city in a precise period of time. Similarly, the curves of electricity production consumption indicate the rapidity with which production recovered in these and other cities. The statistics of the main industries and armaments such as steel, aircraft production, tank and artillery production, in fact, the whole

¹ *B.B.S.U. German Towns*, p. 29. No explanation is given as to why this curious result was produced.

² *do.*, pp. 40-41, para. 130.

range of industry, also show without doubt the limited effect of area bombing upon them. This evidence is confirmed by the interrogations of those responsible for the running of these industries. In some cases their answers might be guided by the nature of the questioning. There might also be a desire amongst Germans to show that area bombing, which had produced such destruction and misery, was unnecessary and inhumane. But still the unanimity is remarkable and cannot be disregarded. There is indisputable evidence that area bombing practised in the strategic offensive against Germany did not produce any sensible effect on German production of armaments until the closing months, when the attack was at its greatest height.

It is here, as is discussed in Chapter XIV, that the difficulty is greatest, for the statistics are largely non-existent. There is no doubt that the attacks on oil and communications were the greatest contribution in the end to the final disruption of German industry, the first because it crippled the means of defence, the second because it deprived industry of the coal and raw materials and prevented its products being transferred from one place to another. But area bombing in this period, as has been seen, affected both oil and communications to a sensible degree in addition to destroying far more completely than at any other period sections of German industry in the Ruhr before the attack on communications had produced its full effect.

For these reasons the authors have quoted the figures of the surveys as an approximate indication of what actually happened except in the final stages of the war. Then indeed the problem becomes irrelevant because so many different attacks were producing the final collapse, including that of the ground forces. In the previous volumes the authors have given both the larger figures of loss of production, which include the curious iron and metal calculations and the smaller ones which are preferred by the survey team. But neither set of figures should be taken as exact, though it is clear that the margin of error cannot be so large as to affect the conclusions on the general question of the effect of area bombing on production.

Something must also be said about the surveys of the oil offensive which was of such crucial importance in the closing stages of the war. Both the British and the United States teams contained highly qualified experts and produced most valuable surveys full of evidence on most of the important problems. The British survey was made by the Technical Committee which had advised on the nature of the oil plants throughout the war and the Oil Committee which from July 1944 onwards was the main source of the priorities given to the various targets. It was edited by Mr. O. F. Thompson, who had had a principal role in the oil section of M.E.W.¹ The United States survey, on the other hand, was made under the direction of the President of a great oil company, who had had no such responsibilities. Indeed, one of the criticisms of this survey was that in the United States the oil committee did not include experienced technicians in its panel but only consulted them occasionally on various points.

The British survey was based on the records and statistical evidence found in Germany, most of it by the United States teams, and the interrogations of Speer and his staff and the high officers of the *Wehrmacht*

¹ Acknowledgment is also given in its preface to the Inter-Departmental Bombing Survey but, as has been seen, this had never come into existence except informally.

and the *Luftwaffe*. There was no British investigation of the plants except a rather perfunctory one by the O.R.S. team of some in the Ruhr and one by observers who participated in the survey of the Rumanian refineries. The United States teams, however, made a detailed and expert examination of seven plants and a more hasty survey of four others. They were thus able to check the evidence of the records and find out much about the results which could not be learnt from statistical evidence. They obtained, for example, conclusive evidence of the greater effect produced by a successful attack by Bomber Command than one by the United States air forces because of the heavier bombs carried by the British aircraft.

Both surveys consider how far the estimates made by the oil committees were in accordance with the actual figures revealed by the post-war investigations. The task was a complicated one. The difficulties as to stock comparisons have been discussed in Chapter V (Vol. I, p. 288). But there were also great difficulties in comparing the figures for production and consumption in Germany because the Allied estimates had been of Axis Europe while the German figures were of the greater German Reich. Both surveys admit that large errors were made though, as might be expected, the United States survey is more forthright and candid on this point.

The United States oil division final report is accompanied by a volume of appendices. It surveys the effect of the offensive not only on the production of oil but on that of explosives, propellants, rubber, rocket production and the chemical industry. This comprehensive survey is founded on a large number of different studies made by its own division and the other divisions of the organisation. It emphasises what it considers to be a grave error on the part of the oil committees, the failure to appreciate the connection between synthetic oil and the raw material for explosives. Though this must have been known it is certainly curious that it did not receive more emphasis in the appreciations made by the committees. Curiously enough also, the British survey does not consider this question except in one or two perfunctory references to the supply of nitrogen. The British survey, on the other hand, pays a good deal of attention to the effect of the oil attack on the operations of the German army, navy and air force, and quotes a considerable amount of evidence from the interrogations of Speer and his staff and high officers of the *Wehrmacht* and *Luftwaffe*. The United States survey only provides generalities on this subject.

There are other differences of opinion and emphasis, some of which it has been necessary to point out in the course of these volumes. But both surveys, while indicating the errors made, agree that the general trend of the advice tendered by the oil committees was always correct and show the energy and skill which enabled so formidable a task to be on the whole efficiently performed.

The surveys of the attack on communications need not be considered in detail. Suffice it to say that the British survey is more elaborate than that of the United States and discusses in detail the attack on communications during the invasions of Italy and France.¹ These attitudes are reflected in

¹ For the estimate of the effect of strategic bombing of communications on German production in the last period of the war, it relies, however, mainly on the statistics produced by the United States survey.

the overall reports, where in the British survey the attack on communications is made the principal cause of the final defeat, while the United States survey gives a much greater share of the credit to the attack on oil and its references to the attack on communications are rather perfunctory.

Note by the Chief of the Air Staff on the British Bombing Research Mission, 30th March 1945

At their Meeting on 10th August, 1944, the Chiefs of Staff approved certain proposals I had put forward, for an impartial investigation into the effects of the Combined Bomber Offensive upon the German war effort, and for the formation of a British Bombing Research Mission. The object of the proposed investigation was to assess the correctness or otherwise of the bombing policies adopted; the efficacy of the technique of Allied bombing, and the relative effectiveness of the various weapons employed. It was hoped that the preliminary results of the investigations would be of value in the conduct of the war against Japan, and that the ultimate findings would contribute in great measure to the framing of our defence policy in a number of fields.

2. As a result of the approval of the proposal by the Chiefs of Staff and in anticipation of Government agreement, the Air Ministry undertook the preliminary organisation of this Mission, on behalf of the various Government Departments concerned, and appointed a special Administrative Staff in October 1944. In November, a memorandum which explained the objects of the Mission and set out its terms of reference was prepared by the Secretary of State for Air, in consultation with the First Lord of the Admiralty, the Secretary of State for War, the Minister of Home Security and the Minister of Economic Warfare. This was submitted to the Prime Minister on 14 December.

3. The Prime Minister replied (Personal Minute) on 3rd January, 1945, that he could not at that time agree to the use of manpower and brainpower on the scale contemplated, but that if he could be assured that the results would be of assistance in the war against Japan, and that these results could not be obtained by the means already at our disposal, he would be prepared to sanction the employment of some twenty to thirty persons on this work. The question of expanding this number after the German war could be considered later. On this basis he sanctioned the scheme being put to the Cabinet.

4. A Memorandum was accordingly circulated to the War Cabinet on 5th February, 1945. This memorandum proposed:

- (a) that the Head of the Mission and his Economic and Technical Advisers should be appointed forthwith;
- (b) that an Advisory Committee of representatives from the Government Departments chiefly concerned should be appointed;
- (c) that the Head of the Mission should take over the direction of personnel already engaged on investigations covered by the terms of reference of the Mission;

(d) that as soon as plans were made, the Head of the Mission should choose and earmark personnel needed for the full investigation, but should not ask for their services until the work called for it.

5. This paper was not taken by the Cabinet. On the 6th March, 1945, the Prime Minister addressed to the Secretary of State for Air, the First Lord of the Admiralty and the Secretary of State for War a minute in which he stated that the matter should be dealt with in the first instance between the Service Ministers and the Chancellor of the Exchequer, and that it should be brought to the Cabinet only after it had been thoroughly examined by the Treasury, as such a proposal would be in peacetime. As part of this examination, it would be necessary to ascertain the exact cost of this scheme as well as its effect on other aspects of the desired revival of our civil life.

6. We have thus reached a stage where, nearly eight months after it had been approved by the Chiefs of Staff, this important project has made no material progress. No head or Directing Staff has been appointed to the Mission, neither have they had the opportunity to study the problem and to outline their plans. In the meantime, the Ruhr and the Rhineland, areas which have been subjected to the most intensive bombing throughout the war, are being occupied by our land forces, and we have neither the plans, personnel nor the administrative machinery ready to take advantage of this state of affairs.

7. I am gravely concerned at this unfavourable position in which we now find ourselves. In a letter which I have just received, the Deputy Supreme Commander A.E.F. has himself stressed the urgency of the need to start collecting evidence at the earliest opportunity; he rightly points out that many of these investigations, if they are to be of real value, must be initiated immediately the targets are uncovered. Otherwise material evidence becomes vitiated or is lost altogether.

8. Whilst the British organisation has thus fallen so far behind events, the United States Strategic Bombing Survey, a body set up by the direction of the President, has reached an advanced stage of readiness. Under the leadership of eminent business men such as Mr. Franklin d'Olier and Mr. Henry Alexander, a body of 700 investigators has been organised and trained: some are already at work on the Continent, and the remainder are in England ready to move into Germany. In addition they have established in London and on the Continent, Headquarters Staffs amounting to some 200 persons; full administrative services have been made available for them. The United States Mission has acquired the services of several leading industrialists and scientists to form their directing staff, and at Yalta President Roosevelt has obtained Marshal Stalin's approval for American teams to enter the Russian Zone in Eastern Germany.

9. I look on the British Mission as a means of providing the Government with indispensable data, relevant to future defence policy, about the effect on an industrialised country of direct attack against its war economy. It is largely immaterial whether the weapons used in future are aircraft and bombs, or weapons of other kinds; what we need to study is the effect of attacking the economic and industrial systems of a country, by whatever

means the attack is delivered. The war against Germany has provided us with a unique opportunity, which we cannot afford to neglect, of learning lessons which are fundamental to our national planning. We shall have to build up our offensive power and evolve our future strategy on a sound doctrine of economic warfare. Scientific research and new weapons must be guided and developed along the lines of such doctrine; they do not in themselves create it. With regard to our defensive policy, the Government will have to consider such questions as the location and layout of industry and the protection of the civil population.

10. For many years to come, unless another war supervenes, I cannot conceive that any examination of the offensive or defensive aspects of attacks on industry can fail to be influenced by the results of the bomber offensive on Germany. If we do not proceed without delay with the British Bombing Research Mission, we shall face the grave danger of Government opinion on the lessons of this war being based largely on propaganda, personal recollection, or on the results of investigations by other nations. The only body which would be adequately constituted to assess the results of the Combined Bomber Offensive and pronounce authoritatively on its value would be an American body. I should regard this as most unsatisfactory. American bombing methods have differed from our own. It is therefore only to be expected that the American report would concentrate upon those results for which the Americans have been mainly responsible and in which they would quite naturally be most interested. On the other hand, it would almost certainly ignore or obscure some of the results of Bomber Command's operations of which I consider it essential to ascertain the importance. Moreover, there would be a danger that a rather incomplete picture would be given to the world of results of an offensive in which a large proportion of British resources had been employed in this war.

11. I suggest that the Committee should consider whether it can assist in getting the outline plans for the Mission approved without more delay. The discussions that have taken place with the Treasury have served to show that no further progress can be made without an approved Government requirement. It is inviting failure to fix an arbitrary allotment of manpower for the Mission but assign to it a task appropriate to a much larger body; I suggest it is indispensable for the Government to decide the scope of the investigation needed for purposes of future national defence. It will then be possible to work out, with full regard to economy, the composition of a Mission appropriate to that task.

12. I therefore recommend that the Chiefs of Staff should bring the following points to the notice of the Prime Minister:

- (a) A comprehensive and impartial investigation, covering in particular the economic effects of the Bomber Offensive, will be of great and permanent value to the future defence planning of this country.
- (b) An approved Government requirement is essential to planning the size and composition of the Mission.
- (c) Further delay in constituting the Mission will gravely prejudice its work.

(Intld.) C. P.

SECTION II

Documents and Schedules
1923-1939

INTRODUCTION

THESE documents and tables have been selected from the immense number available because they illustrate some of the main factors in the creation of the strategic air force. The first two demonstrate how the doctrine of the all-importance of the offensive was laid down and upheld while Marshal of the Royal Air Force Lord Trenchard was Chief of the Air Staff. Numbers four, five and seven exhibit the difficulty of applying the doctrine when the imminence of war with Germany became apparent, the impact on it of the necessity of providing for an effective fighter force and finally the plans for the strategic offensive that had been adopted as possible operations for Bomber Command when war broke out. Numbers three and six show the policy of delay in the creation of effective military forces laid down by the Government after the First World War and the series of production plans put forward by the Air Staff when the urgency of the situation was realised.

APPENDIX 1

Minutes of a Conference held in the room of the Chief of the Air Staff, Air Ministry, on 19th July 1923

Present: C.A.S.¹
D.C.A.S.²
Air Vice Marshal Game.³
D.T.S.D.⁴
D.D.O.I.⁵
D.D.O.⁶
Squadron Leader Portal.⁷
S.6.⁸

C.A.S. said the object of this Conference was to get a little enlightenment concerning certain points, and to discuss those points without forming any definite decision at this Meeting. He also wanted Air Vice Marshal Game to have an opportunity of grasping the problems we had to solve, so that at the final Meeting he would be able to play a more useful part than would otherwise be the case.

With regard to the proportions of fighters and bombers, the Staff College had divided them approximately the same as he had done. He had put 24 day bombers, 13 fighters and 15 night bombers. One meeting at the Staff College had gone much farther, and had advocated no less than 25 fighters, 15 day bombers and 12 night bombers. Originally, he thought D.C.A.S. had given 20 fighters, 17 day bombers and 15 night bombers. The Directing Staff of the Staff College had given 14 fighters, but had not given their reasons for their proportions. They had argued a great deal as to where Squadrons should be placed, and had talked a certain amount about interception but had apparently not argued why they wanted such a small proportion of fighters. Another point they talked of was that fighters could be day and night fighters. One of the arguments at the last meeting had been that day and night fighting must be done by two different machines. The equipment would be different and the training would be different, and D.T.S.D. had thought they could not stand the strain. He did not attach any weight to the

¹ Air Chief Marshal Sir Hugh Trenchard, Chief of the Air Staff.

² Air Vice-Marshal J. M. Steel, Deputy Chief of the Air Staff.

³ Air Vice-Marshal Game was Air Officer Commanding, Royal Air Force, India.

⁴ Air Commodore T. C. R. Higgins, Director Training and Staff Duties.

⁵ Group Captain C. S. Burnett, Deputy Director of Operations and Intelligence.

⁶ Group Captain R. P. Mills, Deputy Director of Organization.

⁷ Squadron Leader Portal was attached to the Directorate of Operations and intelligence.

⁸ Air Ministry Secretariat.

question of strain, as that was purely a matter for the Commanding Officer, who could judge what his pilots could stand. What would bear weight with him was the matter of the equipment for night fighters being heavier and totally different, and the question of the training. The Directing Staff at the Staff College had not placed much weight on the argument of Equipment, neither had the young pupils the contention being that the extra Equipment was very little. Before our next Meeting, therefore, it will be necessary to ascertain the exact differences in the equipment of a day fighter and a night fighter. *D.T.S.D. would do this.* The chief thing to be ascertained was the difference in weight, and he would like *D.T.S.D.* to send him in a short paper, not more than one foolscap sheet.

D.C.A.S. said that they had that data in his Department.

D.D.O.I. said he thought it was about 100 lbs. difference.

C.A.S. said in that case *D.C.A.S.* would produce this information and circulate it. He would like Air Vice Marshal Game to consider the question of the advantages of being able to use both day and night fighters if the Commanding Officer thought well to put up all his machines. It might also be considered whether they should be of one type in the more dangerous zones so that they could be used together or separately as desired, and in the less dangerous zones where there would be less work to do the same machines could be the day and night fighters. One Squadron doing the day work for two sectors and another Squadron the night work for the same two sectors.

Air Vice Marshal Game said that what he was afraid of was that in any case when there was a raid they would all be sent up whether day or night fighters.

C.A.S. said that was what he thought too. But the question was should we work on the principle that they could be trained for both, or on the principle that they trained and equipped separately, and that the *C.O.* improvised for both.

Air Vice Marshal Game said he thought on the spur of the moment, that we should train for night fighting up to the maximum we could usefully employ. He thought there was such a maximum.

C.A.S. said there was a limit but we had so few Squadrons. 12 machines per Squadron meant 9 available at any time.

D.T.S.D. said that during the war we had 12 mile sectors for Home Defence and seven machines went up from each Squadron. The standard patrol was seven machines which did a two hours' patrol. A quarter of an hour before they were due on the ground a second seven machines went up.

C.A.S. said that was 14 machines.

D.T.S.D. said we had 24 machines in each Squadron, and there were nine squadrons, but not all round London. Our space at that time was very restricted between the inner and outer barrages.

C.A.S. asked if the patrols were permanent.

D.T.S.D. replied they only went up when the alarm came through.

Air Vice Marshal Game said personally he was in favour of training them all for night fighting.

C.A.S. said in this way we should be able to employ the whole Squadron. Did that mean training them also for day fighting?

Air Vice Marshal Game said it did.

D.T.S.D. said the type of machine came into the question. It was a matter of tactics. He thought the type of machine required for day fighting would be quite different from the night machine. The night machine could not be used to assist the day machines. The tactics by day would be a Squadron flying in formation carrying out tactics. It was difficult to get the whole squadron to go up within five minutes from the warning, and to get that squadron in formation ready to carry out tactics. Night work was entirely individual work.

C.A.S. asked if it would be much of a strain for pilots to go on day work after doing night work while training.

D.T.S.D. said it would. They would be doing night flying and then formation flying the next day.

C.A.S. said there may be very little in that considering that we had plenty of time before us. Most of the pilots would be three or four years in a squadron and two new ones would be coming each year. It might be possible to put in three months on night work and then say nine months on day work.

D.T.S.D. said he would like to start straight off with the two types of machines for day and night work. We did not put pilots on day and night work even in the war, when casualties did not matter.

Air Vice Marshal Game said, in France there were only one or two night squadrons and they got in as good results as if they had a great many more.

C.A.S. said a point made last meeting was that there was no good done in night work in France until they got over two Squadrons specially trained in the work.

Air Vice Marshal Game said he agreed to that, but he did not see why we should not train pilots for day and night work. He did not think the squadrons should be too thick on the ground, or they would get in each others way.

C.A.S. asked Air Vice Marshal Game if he was arguing for the least number of fighters as well as for day-and-night fighters.

D.C.A.S. said he was afraid the knowledge of what went on during the war was apt to put us wrong. The enemy would send over a proportion of their machines by day, and a proportion by night, but we did not know what these proportions would be.

C.A.S. said we did. We had their strength. They had at present 20 day bombers, 12 night bombers and 39 Army Co-operation Squadrons that could be used.

D.C.A.S. said we must assume that their tactics would be continued by night. Anyhow, we must cater for it.

Air Vice Marshal Game said he agreed to that.

D.C.A.S. said it would not be like the last war where we had an hour's warning that there was going to be a raid, which gave you time to get things started.

D.T.S.D. said we had about half an hour's warning, and when the

raid was over, it was not a case of now it was finished for that night. Sometimes there was another warning.

D.C.A.S. said he did not remember having more than one raid in one night.

C.A.S. said he was under the impression there had been such cases.

D.T.S.D. said he did not remember at the moment more than one raid in the same night, but on at least two occasions there had been other alarms subsequent to the raid. On other occasions there had been alarms when machines had not been sent up.

C.A.S. said the point was that they only had two squadrons employed—there were going to be 12, and we should have it night after night.

D.C.A.S. said that rather pointed to the impossibility of expecting one squadron to go on for 24 hours out of the 24, with a prospect of its continuing.

Squadron Leader Portal said he thought we ought to train all the squadrons to do day and night fighting. If pilots were only trained in one branch and they were employed on the other in emergency they would not be able to do it. Also they would be apt to say that was not their job, and to leave it to those trained for it. If they were trained for both, they would be able to tackle both, and would regard either as their job. With regard to the machines put into the air, he did not think you could do more than take into consideration what scale of attack was to be met, and to put into the air the number you thought necessary to meet it, and see what they could do.

C.A.S. asked if he meant that for the first two or three days or nights he would put into the air everything he could possibly put up, and then let circumstances dictate how much less could be put up as the days went on in order to meet the attacks.

Squadron Leader Portal said he thought that would be left to the C.O.

D.D.O.I. said he thought also that the Squadrons should be trained in both day and night work. He considered that we must have enough machines to do day work and meet the forces we might have against us. If the enemy happened to be working in relays and our machines went up against the first, we might have practically no machines to put into the air for the second raid unless the night machines were available, and the same applied to a night raid.

C.A.S. said in that case the C.O. would use his discretion as to whether he sent up all his machines—he would always do that, as he would always use his machines to what he considered the best advantage. He would probably send up three-quarters of his machines against the first raid, keeping the other quarter as a reserve, and they would go up against the second relay, and in the meantime the first machines would replenish and get up again if possible. The C.O. would rarely put all his eggs in one basket and send them all up together.

D.D.O.I. said he would probably send up a good number against the first raid, and the second would probably be the main raid made under cover of the feint of the first one.

The C.A.S. said that was where the judgment of the C.O. would come in. Sometimes he would be wrong of course, but he would naturally judge

from the information he had received, and he would not put up unnecessarily large numbers. It might be that we had an attack all along the line and the whole of the machines available had to be sent up the first time, and unless you had a very large number of squadrons there would be none left for the second attack.

D.D.O.I. said of course it would be necessary to strike a medium, but he thought it was dangerous to have too few.

Air Vice Marshal Game said he thought the tendency would be to put up too much.

C.A.S. said a good C.O. would make a good judgment. Occasionally he would be caught, but a good C.O. would instinctively do the right thing nine times out of ten, and he would usually keep something up his sleeve unless he was positive there was nothing to follow, and occasionally he would make a coup. There was another side to the question. Would it be best to have less fighters and more bombers to bomb the enemy and trust to their people cracking before ours, or have more fighters in order to bring down more of the enemy bombers. It would be rather like putting two teams to play each other at football, and telling one team they must only defend their own goal, and keep all their men on that one point. The defending team would certainly not be beaten, but they would equally certainly not win, nor would they stop the attack on their goal from continuing. I would like to make this point again. I feel that although there would be an outcry, the French in a bombing duel would probably squeal before we did. That was really the final thing. The nation that would stand being bombed longest would win in the end. He would ask Air Vice Marshal Game, if he had the running of the defence scheme, would he concentrate on counter-bombing or would he concentrate on bringing down the enemy bombers.

Air Vice Marshal Game said he would put all his money into bombing, as you got positive results. He did not think much would be got out of doubling the number of fighters.

C.A.S. said that at the last meeting it had been argued that adding 4 extra bombing squadrons would not give very much extra effect against France, whereas 4 extra fighting squadrons would give a very great effect. He had argued in the opposite direction—that attacking France with 48 extra bombers would have a considerable moral effect, whereas bringing down a few more of their bombers would have very little effect on the French nation, who would probably never hear of it.

D.C.A.S. said it all depended on what number the increase of bombers was made on. If it was an increase of 4 squadrons on 2, that is an increase from 2 to 6, it would have a very great effect, but it was questionable whether an increase from 32 to 36 would make much difference. He said it must not be lost sight of that the effect on the morale of the pilots of knowing that in all probability they would be brought down before they got back would be tremendous.

Air Vice Marshal Game thought it would certainly have a great moral effect if a squadron came over with 12 machines and went back with only 4.

C.A.S. said he agreed that this would have a greater effect on the morale

of the French pilots than it would on ours. Casualties affect the French more than they did the British. That would have to be taken into consideration too, but the policy of hitting the French nation and making them squeal before we did was a vital one—more vital than anything else. The question had been asked at Camberley 'Why is it that your policy of attack from the air is so different from the policy of the Army, whose policy it is to attack the enemy's army, while yours is to attack the civil population.' The answer was that we were able to do this while the Army were not, and so go straight to the source of supply and stop it. Instead of attacking a machine with 10 bombs we would go straight to the source of supply of the bombs and demolish it, and the same with the source of production of the machines. It was a quicker process than allowing the output to go on. The Army policy was to defeat the enemy Army—ours to defeat the enemy nation. The Army only defeated the enemy Army because they could not get at the enemy nation. We must avoid allowing our policy to be affected by the policy of the Army and the Navy. Our policy in strategy was totally different from that of the Army.

Air Vice Marshal Game said that it would have a considerable moral effect if a very large number of machines were brought down in one raid. Coming to the general question of actual numbers, he had started out with no views, but very roughly he had worked it out to 16 fighters, 24 day bombers and 12 night bombers.

C.A.S. said that was 16 fighters; Air Commodore Brooke-Popham had given 14 fighters and D.C.A.S. 20 fighters. It could be left at that for the present, and come up again at the next meeting when the other officers came up. It would not be decided then however, but they would go away and put down what they thought. The whole of D.D.O.'s work was held up on this question. He did not know if D.D.O. could get on with any arrangements with regard to certain aerodromes by knowing that the fighters would be 14 or over, 12 night bombers or over, and 15 day bombers or over.

D.D.O. said they would have to wait, as it would all turn on the proportions of Auxiliaries and Cadres.

D.C.A.S. said they must not lose sight of the question of actual material. Would the machines stand the day and night business? At present they had only considered the effect on the personnel and had ignored the machines.

C.A.S. said this brought them back to the same argument. It must be left to the C.O. If they would not stand it, he would not be able to put them up. He will know whether he has the machines available for the work required at the time or not.

D.C.A.S. asked if there were to be 12 machines in the Squadrons for war.

C.A.S. said that was going into a question he did not wish to discuss now. He did not want to discuss the expansion. As far as D.C.A.S.'s Department was concerned, from an operational point of view, it could be assumed that it would be 12. Whether they could afterwards be increased to 18 was a matter for decision. He would like to just touch on

equipment. He did think it was most necessary now that he should lay down that we should not try to have two different types of machines. We should not try and advocate different types of machine for day and night fighters.

D.D.O.I. asked if we must not go for the highest performance. If we could not get the load on—

C.A.S. interrupted to say that nothing he could decide would alter that. We knew that directly we put on load we lost the performance. He thought we must decide that there must be but one type.

D.C.A.S. said he would like to play with a second type.

C.A.S. said that could be done in Research work, but he was speaking of getting out the machines and equipping them and getting to work. The nation expected us to get the Force going in some sort of way, and we could not sit and wait for research.

D.T.S.D. asked if C.A.S. had read A.M.S.R's¹ file on this subject—day and night fighters for Home Defence.

C.A.S. asked how it affected the question. Would it cause us to break the policy of only having one type of machine for the fighters.

D.C.A.S. said he thought the question had better be left over till the next meeting.

Air Vice Marshal Game asked if, apart from the weight, there was any property in the night fighter which made it unsuitable as a day fighter.

D.D.O.I. said there was speed in landing. He had been told by Research that if they could get up to 54 or 56 miles per hour landing they would get a much higher performance for it.

Air Vice Marshal Game asked what was required for night flying.

D.D.O.I. replied that a much less speed than that was required.

C.A.S. asked if that was not a point for compromise.

Air Vice Marshal Game said he had been told by night flying pilots that there was no great difficulty in landing.

D.T.S.D. said the Camel had been a very lightly loaded machine and was good for night landing. The Snipe was not so good.

C.A.S. said we had heard all these arguments regarding landings before. When we go to war we sacrifice a good deal in the way of performance, and more in the way of safety.

D.T.S.D. asked if casualties in peace time did not count.

C.A.S. said they did, but not as against the enemy.

Air Vice Marshal Game said Air Commodore Brooke-Popham had expressed a very strong opinion in favour of one type of machine.

C.A.S. said the whole of the Staff College were in favour of one type. When we had started the discussion D.D.O.I. had said that the machines should do day and night fighting. He did not know whether he had altered his opinion during the discussion, but he seemed to be rather contradicting his previous arguments. He did not want to continue the arguments now, but he would ask them, in thinking it over to read again the opinions of the Staff College Directing Staff and their subordinates. Air Commodore Brooke-Popham had had a lot of experience on that

¹ Air Vice-Marshal Sir William G. H. Salmond.

subject. He agreed it was possible to have a better machine for each separate purpose than if one machine was used for both purposes.

D.T.S.D. said he thought the day machine could be used for night work, but not the other way round.

D.C.A.S said he would like the question put to the Staff College as to what was their opinion as to the requirements of day and night fighters in performance, type, etc.

C.A.S. said D.T.S.D. should do that today, and also ask the Staff College reasons for their conclusion regarding the proportions of fighters and bombers.

C.A.S. said that Air Commodore Brooke-Popham advocated what he thought a still more difficult thing, and that was a common type for day and night bombing. He looked upon this as an ideal to strive for, but was it aiming too much at a compromise, for it seemed almost impracticable. He thought we might have to have two types of night bombers, of which one type would be common to day bombing work, one type doing only night work, for close French bombing. He did not mean long distance work where the machine might have to complete its return in the day time, but in France we should go and come back in the night, and in the summer there would of course be less number of raids than in the winter time. We should have one to carry very big bombs. He would like an opinion on that.

Squadron Leader Portal said he agreed with the Staff College that night bombers could be used for day bombing work.

C.A.S. said for the moment he would argue against him. Had he taken into consideration that when it was wanted to get a large number of machines off by day, it was not easy to get these great twin-engined machines off, carrying a maximum load of two to three thousand pounds.

Squadron Leader Portal said he was thinking of making the day bomb smaller.

C.A.S. asked if he did not think the tendency would be to carry the maximum size bomb possible. It would occasionally be necessary to carry a 4000 lb. bomb. For the first 4000 lb. bomb dropped here we should carry one and drop it. The pressure would be so great we should have to do it. The question in this hemisphere was whether you could work a large amount at night at certain times, but there was only about 4 months of the year in which the nights were what he would call short nights.

Air Vice Marshal Game said it would be an enormous advantage to use night bombers as day bombers, but he thought the night bomber was quite incapable of doing day work.

D.D.O.I. said the ideal would be to have one machine to do the two, but it could not be done.

D.C.A.S. said that all the arguments used in connection with fighters applied also to bombers in this respect.

C.A.S. said the arguments were the same, only more so.

D.C.A.S. said he thought there was no question that we must have a separate night bomber.

C.A.S. said he would like to touch on one thing. One of these Staff

College conferences had said that it was an abuse of Air power to have interception squadrons to bring down machines going back. He wanted to say it was not. That must be communicated at once to the Staff College. With regard to the interception squadron on the coast, he thoroughly agreed with the principle that we must have two or three squadrons as near the coast as we could possibly have them. He thought he had seen it in recent arguments that it was the only protection we could have from low flying squadrons which came over to attack coast towns. He considered there would be many occasions when these squadrons would be able to get up in time to stop the bombers coming. It might be signalled from the Channel by Wireless that machines had passed flying for England. He could see no reason why sometimes that information should not be received in time for us to be able to break up their formations. We would not call these squadrons Interception Squadrons, we would call them Advance Squadrons or something of that kind. We would allocate 3 therefore. With regard to Portsmouth, he thought it should be indicated when we were working with the General Staff in future, that we would give some form of protection to Portsmouth. It would not be as much as a zone sector, but it would be there to help in the defence of Portsmouth.

Squadron Leader Portal said he agreed absolutely with the C.A.S. that these squadrons would be most useful. With regard to Portsmouth, would they be as much good there as they would be elsewhere?

C.A.S. said he would not put them absolutely in Portsmouth, so that they could do work elsewhere. We should tell Portsmouth that their protection is undertaken by the general system of defence of the country. We should not tell Portsmouth that we can do anything to protect them by air.

Air Vice Marshal Game said he was all in favour of telling them that. The only thing was he would put more than three.

C.A.S. said he was not prepared to argue at this meeting. This was only a stage.

D.C.A.S. said we were on dangerous ground, because we should always be pressed to have squadrons everywhere for local defence.

C.A.S. said the outcry would be to have more fighters from the Ministers, from the General Staff, and from some of our own people, and even from our own Minister. We must be prepared for that.

C.A.S. said the next meeting would be on Wednesday, July 25th, at 11 a.m. in his room.

APPENDIX 2

Memorandum by the Chief of the Air Staff and comments by his colleagues, May 1928

(i)

*Memorandum by the Chief of the Air Staff for the Chiefs of Staff
Sub-Committee on The War Object of an Air Force, 2nd May 1928*

The Secretary,
Chiefs of Staff Sub-Committee.

I forward a memorandum that I would ask to be circulated to the Chiefs of Staff Sub-Committee.

It will be remembered that at the 65th Meeting on February 23rd, when we discussed the report of the Commandant of the Imperial Defence College, I drew attention to the fact that I thought there was some diversity of view on the part of the Navy and Army with reference to the contention of the Air Staff that in future wars air attacks would most certainly be carried out against most vital centres of communication, and munition centres, no matter where they were situated.

Therefore I would ask that this subject might be discussed, and my paper is intended as a basis for that discussion. I suggest that the proceedings can be informal at the start, so as to have a very frank discussion. Then it would be for the Committee to decide what its procedure should be, in future on this subject.

(Sgd.) H. TRENCHARD,
Marshal of the Royal Air Force,
Chief of the Air Staff.

ENCLOSURE

At a recent meeting of the Chiefs of Staff Sub-Committee the Report of the Commandant of the Imperial Defence College for the 1st Course (1927) was discussed. In that report the Commandant recommended that the principles of war should be described in identical terms in the Manuals of all three Services. He also expressed the view that at present the situation as regards air warfare was indeterminate. I suggested that this view had arisen from an unwillingness on the part of the other Services to accept the contention of the Air Staff that in future wars air attacks would most certainly be carried out against the vital centres of communication and of the manufacture of munitions of war of every sort no matter where these centres were situated.

It seems to me that the time is now ripe to lay down explicitly the

doctrine of the Air Staff as to the object to be pursued by an Air Force in war.

The doctrine which in the past has determined and still determines the object to be pursued by Navies and Armies is laid down in the respective Service Manuals in these words:

- (i) *The Navy*: The Military aim of a Navy is to destroy in battle or to neutralise and to weaken the opposing navy including its directing will and morale.
- (ii) *The Army*: The ultimate military aim in war is the destruction of the enemy's main forces on the battlefield.

I would state definitely that in the view of the Air Staff the object to be sought by air action will be to paralyse from the very outset the enemy's productive centres of munitions of war of every sort and to stop all communications and transportation.

In the new Royal Air Force War Manual this object will be stated in some such general terms as the following—the actual terms have not been defined:

'The aim of the Air Force is to break down the enemy's means of resistance by attacks on objectives selected as most likely to achieve this end.'

I will now proceed to examine this object from three viewpoints:

- (i) Does this doctrine violate any true principle of war?
- (ii) Is an air offensive of this kind contrary either to international law or to the dictates of humanity?
- (iii) Is the object sought one which will lead to victory, and in that respect, therefore, a correct employment of air power?

Does this doctrine violate any true principle of war?

In my view the object of all three Services is the same, to defeat the enemy nation, not merely its army, navy or air force.

For any army to do this, it is almost always necessary as a preliminary step to defeat the enemy's army, which imposes itself as a barrier that must first be broken down.

It is not, however, necessary for an air force, in order to defeat the enemy nation, to defeat its armed forces first. Air power can dispense with that intermediate step, can pass over the enemy navies and armies, and penetrate the air defences and attack direct the centres of production, transportation and communication from which the enemy war effort is maintained.

This does not mean that air fighting will not take place. On the contrary, intense air fighting will be inevitable, but it will not take the form of a series of battles between the opposing air forces to gain supremacy as a first step before the victor proceeds to the attack of other objectives. Nor does it mean that attacks on air bases will not take place. It will from time to time certainly be found advantageous to turn to the attack of an enemy air base, but such attacks will not be the main operation.

For his main operation each belligerent will set out to attack direct those objectives which he considers most vital to the enemy. Each will penetrate the defences of the other to a certain degree.

The stronger side, by developing the more powerful offensive, will provoke in his weaker enemy increasingly insistent calls for the protective employment of aircraft. In this way he will throw the enemy on to the defensive and it will be in this manner that air superiority will be obtained, and not by direct destruction of air forces.

The gaining of air superiority will be incidental to this main direct offensive upon the enemy's vital centres and simultaneous with it.

There is no new principle involved in this attacking direct the enemy nation and its means and power to continue fighting. It is simply that a new method is now available for attaining the old object, the defeat of the enemy nation, and no principle of war is violated by it.

Is an air offensive of this kind contrary to international law or to the dictates of humanity?

As regards the question of legality, no authority would contend that it is unlawful to bomb military objectives, wherever situated. There is no written international law as yet upon this subject, but the legality of such operations was admitted by the Commission of Jurists who drew up a draft code of rules for air warfare at The Hague in 1922-23. Although the code then drawn up has not been officially adopted it is likely to represent the practice which will be regarded as lawful in any future war. Among military objectives must be included the factories in which war material (including aircraft) is made, the depots in which it is stored, the railway termini and docks at which it is loaded or troops entrain or embark, and in general the means of communication and transportation of military *personnel* and *material*. Such objectives may be situated in centres of population in which their destruction from the Air will result in casualties also to the neighbouring civilian population, in the same way as the long-range bombardment of a defended coastal town by a naval force results also in the incidental destruction of civilian life and property. The fact that air attack may have that result is no reason for regarding the bombing as illegitimate provided all reasonable care is taken to confine the scope of the bombing to the military objective. Otherwise a belligerent would be able to secure complete immunity for his war manufactures and depots merely by locating them in a large city, which would, in effect, become *neutral* territory—a position which the opposing belligerent would never accept. What is illegitimate, as being contrary to the dictates of humanity, is the indiscriminate bombing of a city for the sole purpose of terrorising the civilian population. It is an entirely different matter to terrorise munition workers (men and women) into absenting themselves from work or stevedores into abandoning the loading of a ship with munitions through fear of air attack upon the factory or dock concerned. Moral effect is created by the bombing in such circumstances but it is the inevitable result of a lawful operation of war—the bombing of a military objective. The laws of warfare have never prohibited such destruction as is 'imperatively demanded by the necessities of war'

(Hague Rules, 1907) and the same principle which allows a belligerent to destroy munitions destined to be used against him would justify him also in taking action to interrupt the manufacture and movement of such munitions and thus securing the same end at an earlier stage.

Is this object one which will lead to victory, and a correct employment of air power?

Before I deal with the above heading I would like to state here that, in a war of the first magnitude with civilised nations, I do not for a moment wish to imply by the following remarks that the Air by itself can finish the war. But it will materially assist, and will be one of the many means of exercising pressure on the enemy, in conjunction with sea power and blockade and the defeat of his armies.

In pursuit of this object, air attacks will be directed against any objectives which will contribute effectively towards the destruction of the enemy's means of resistance and the lowering of his determination to fight.

These objectives will be military objectives. Among these will be comprised the enemy's great centres of production of every kind of war material, from battleships to boots, his essential munition factories, the centres of all his systems of communications and transportation, his docks and shipyards, railway workshops, wireless stations, and postal and telegraph systems.

There is no need to attack the enemy's organised air forces as a preliminary to this direct assault. It will be just as necessary in the future, as it has been in the past, for the Army, assisted by aircraft, to seek out and attack the enemy's Army, but the weight of the air forces will be more effectively delivered against the targets mentioned above rather than against the enemy's armed forces. These objectives are more vulnerable to the attack and generally exact a smaller toll from the attacker.

It will be harder to affect the morale of an Army in the field by air attack than to affect the morale of the Nation by air attacks on its centres of supply and communications as a whole; but to attack—let alone do serious damage—an Air Force in the field is even more difficult. Air bases can be well camouflaged; they can be prepared so that the personnel and material are well protected against bomb attack and their lay-out can be so arranged and spaced as to present a difficult target. An attacker can be induced to waste his strength by deception, such as by dummy aerodromes. Air units can be widely dispersed over the country-side so that it will be difficult to find them and do them extensive damage.

To attack the armed forces is thus to attack the enemy at his strongest point. On the other hand, by attacking the sources from which these armed forces are maintained infinitely more effect is obtained. In the course of a day's attack upon the aerodromes of the enemy perhaps 50 aeroplanes could be destroyed; whereas a modern industrial state will produce 100 in a day—and production will far more than replace any destruction we can hope to do in the forward zone. On the other hand, by attacking the enemy's factories, then output is reduced by a much greater proportion.

In the same way, instead of attacking the rifle and the machine gun in

the trench where they can exact the highest price from us for the smallest gain we shall attack direct the factory where these are made.

We shall attack the vital centres of transportation and seriously impede these arms and munitions reaching the battlefield and, therefore, more successfully assist the Army in its direct attack on the enemy's Army. We shall attack the communications without which the national effort cannot be co-ordinated and directed.

These are the points at which the enemy is weakest. The rifleman or the sailor is protected, armed and disciplined, and will stand under fire. The great centres of manufacture, transport and communications cannot be wholly protected. The personnel, again, who man them are not armed and cannot shoot back. They are not disciplined and it cannot be expected of them that they will stick stolidly to their lathes and benches under the recurring threat of air bombardment.

The moral effect of such attacks is very great. Even in the last war ten years ago, before any of the heavier bombers or bombs had really been employed to any extent, the moral effect of such sporadic raids as were then practicable was considerable. With the greater numbers of aircraft, the larger carrying capacity and range, and the heavier bombs available to-day, the effect would seriously impede the work of the enemy's Navy, Army and Air Forces. Each raid spreads far outside the actual zone of the attack. Once a raid has been experienced false alarms are incessant and a state of panic remains in which work comes to a standstill. Of one town in the last war it is recorded that although attacked only seven times, and that by small formations, no less than 107 alarms were sounded, and work abandoned for the day. Each alarm by day brings the day's work to an end—while by night the mere possibility of a raid destroys the chance of sleep for thousands.

These effects, it must be remembered, were produced by occasional raids by very minor forces. The effect on the workers of a Nation of an intensive air campaign will again be infinitely greater than if the main part of that air attack was launched at the enemy's aerodromes and aeroplanes which may be many miles away from the vital points, and, if this air pressure is kept up, it will help to bring about the results that Marshal Foch summed up in the words 'The potentialities of aircraft attacks on a large scale are almost incalculable, but it is clear that such attack, owing to its crushing moral effect on a Nation, may impress the public opinion to a point of disarming the Government and thus becoming decisive.'

This form of warfare is inevitable

I have stated above the object which an Air Force should pursue in war, and the reasons on which the Air Staff base their contention that this object is in full accord with the principles of war, is in conformity with the laws of war, and is the best object by which to reach victory.

There is another side to the matter upon which I must lay stress. There can be no question, whatever views we may hold in regard to it, that this form of warfare will be used.

There may be many who, realising that this new warfare will extend to the whole community the horrors and suffering hitherto confined to the

battlefield would urge that the Air offensive should be restricted to the zone of the opposing armed forces. If this restriction were feasible, I should be the last to quarrel with it; but it is not feasible. In a vital struggle all available weapons always have been used and always will be used. All sides made a beginning in the last war, and what has been done will be done.

We ourselves are especially vulnerable to this form of attack; and foreign thinkers on war have already shown beyond all doubt that our enemies will exploit their advantage over us in this respect and will thus force us to conform and to counter their attacks in kind.

Whatever we may wish or hope, and whatever course of action we may decide, whatever be the views held as to the legality, or the humanity, or the military wisdom and expediency of such operations, there is not the slightest doubt that in the next war both sides will send their aircraft out without scruple to bomb those objectives which they consider the most suitable.

I would, therefore, urge most strongly that we accept this fact and face it; that we do not bury our heads in the sand like ostriches; but that we train our officers and men, and organise our Services, so that they may be prepared to meet and to counter these inevitable air attacks.

(Sgd.) H. TRENCHARD
C.A.S.

(ii)

*Note by the Chief of the Imperial General Staff for the Chiefs of Staff
Sub-Committee on the memorandum by the Chief of the Air Staff,
16th May 1928*

1. The Memorandum by the Chief of the Air Staff sets out to define the object to be pursued by an Air Force in war. It begins by pointing out that there has hitherto been an unwillingness on the part of the other services to accept the contention that in future wars air attacks would most certainly be carried out against the vital centres of communications and of the manufacture of munitions of war of every sort *no matter where these centres were situated*. The Memorandum then states definitely that, in the view of the Air Staff, the object to be sought by air action will be to paralyse from the very outset the enemy's productive centres of munitions of war and to stop all communications and transportation. It proposes that in the new Royal Air Force War Manual this object will be stated in some such general terms as the following:

'The aim of the Air Force is to break down the enemy's means of resistance by attacks on objectives selected as most likely to achieve this end.'

It further states that military objectives may be held to include the enemy's great centres of production of every kind of war material and a

variety of other organisations which are chiefly connected with his means of communication.

If factories that produce every sort of military material are to be regarded as legitimate military targets, it is difficult to see where any distinct line can be drawn, as factories exist in almost every town which produce some article or other that can be regarded as warlike material. It is clear, therefore, that whilst the Memorandum sets out to show that all the objectives suggested are legitimate military ones, the result in practice would be that, though the objective might be a given boot factory, the actual target would be the town in which the factory happened to be located, and the victims would be its unarmed inhabitants. It is ridiculous to contend that the dropping of bombs has reached such a stage of accuracy as to ensure that the bombs would hit only the so-called military targets. In spite, therefore, of the attempt made in the Memorandum to justify the selection of the targets indicated as being legitimate military objectives, the impression produced by the acceptance and publication of such a doctrine will indubitably be that we are advocating what might be termed the indiscriminate bombing of undefended towns and of their unarmed inhabitants.

2. Having stated the war object of an Air Force, the Memorandum proceeds to examine the doctrine outlined from three viewpoints.

Taking these seriatim:

Does this doctrine violate any true principles of war?

The Memorandum states that the object of all three Services is the same—to defeat the enemy nation, not merely its Army, Navy or Air Force. It then goes on to point out that for an Army to do this it is almost always necessary as a preliminary step, to defeat the enemy's Army, but that it is not necessary for an Air Force, in order to defeat the enemy nation, to defeat its armed forces first. It is claimed that there is no new principle involved in an Air Force attacking direct the enemy nation and the nation's warlike resources, but that this is simply a new method for obtaining the old object, i.e. the defeat of the enemy nation. So far as this statement is concerned there is no reason to dispute it, for no new principle is involved in this method. A point, however, with which I am not in complete agreement, is the implication contained in the Memorandum that the opposing air forces in any war can continue to attack each other's economic and vital centres, whilst purely military (I use the word in its widest sense) objectives are relegated to a secondary category of importance. Every new danger, as it arises, sets people thinking to discover its antidote, and the most obvious instance of the truth of this statement I can quote is the organization of the Royal Air Force for the Air Defence of Great Britain. The acceptance of this very phrase as the title of the Chief Air Command in this country implies that arrangements are being made by the Air Staff to counter an air offensive on a large scale against the southern portions of this island. Just as artillery tactics developed in the Great War and the demands for counter battery work assumed more and more importance as the menace of the enemy's guns increased, so, it is reasonable to argue, as the air menace grows, will measures be developed

to combat it. Indeed it is difficult to see how in the end the issue will not be determined by the superiority of one air force over another just as fighting on the ground is determined by the superiority of one army over another. It is in development of this argument that I should prefer to restate the doctrine enunciated by the Chief of the Air Staff somewhat in the following words:

‘The object of the Air Force is to break down the enemy’s means of resistance by attacks on objectives which at the moment are exercising the most deterrent effects on the execution of the main war plan.’

These objectives will, naturally, differ from time to time, and their relative importance can only be measured by the influence they happen to be exerting at any given moment. For instance, when an enemy is concentrating for an attack, the dislocation of his railways and other means of communication may produce results which will influence the course of the war far more than will the bombardment of some of his munitions factories. Again, a concentrated air attack against a defeated army may quite conceivably turn the defeat into a rout, whilst the successful results attained by the enemy’s air forces may demand a concentrated air offensive being directed against them.

3. *Is an air offensive of this kind contrary to international law or to the dictates of humanity?*

This may be regarded as the ethical or moral aspect of the subject. Viewed from this aspect the use of the aeroplane in war does not differ greatly from that of the submarine. In the case of the submarine it has been stated that the sinking of shipping without visit or search or provision for the safety of the passengers and crew is contrary to the principles of conducting war. This contention, however, depends on the correct interpretation of maritime law. Although maritime law may be said to be based partly on the axiom that ‘might is right’, yet some form of code has been, and continues to be, evolved, which is based largely on precedent. From time to time innovations in the interpretation of this code are introduced which are frequently objected to at the time; nevertheless, what in one war is an innovation, and as such is objected to, in the next war comes to be treated as a precedent and, as such, may duly be recognised as law.

This argument used in regard to unrestricted submarine warfare can be applied with equal force to the use of the aeroplane in war, and the precedents of air warfare in the Great War will undoubtedly be used in drawing up the rules for future aerial warfare. In this connection, however, I feel compelled to draw attention to the fact that, in quoting the opinion of the Commission of Jurists on this subject, the Chief of the Air Staff seems to have overlooked an important qualification which was entered by this Body when defining the legality of air operations against factories situated away from the fighting areas. Their report states in Article 24, paragraph (3), that, where such objectives cannot be bom-

barded without the indiscriminate bombardment of the civilian population, aircraft must abstain from bombardment.

Whatever attitude may be adopted towards this aspect of the question, it is essential that the same attitude should be adopted throughout all three Services. If it is held to be justifiable to bomb undefended towns by aircraft, it should equally be held justifiable to sink merchant ships, and to bombard undefended ports or towns, whether from the sea or from the land. It cannot be right to adopt one attitude in the case of one service, and a totally different attitude in the case of another.

4. *Is this object one which will lead to victory and a correct employment of air power?*

Whatever views may be held as to the ethical or moral rights of the case, the point of real importance to this Empire, and about which there should be no doubt, is the practical aspect; in effect is such a policy expedient? The British Isles are particularly vulnerable to direct attack on the national life, whether the attack is delivered against seaborne supplies or from the air against the capital and the nerve centres of the country. It is, I believe, our policy to advocate an attitude towards warfare at sea (surface or submarine) which does not place us in a disadvantageous position in regard to other maritime powers, and to avoid putting a weapon into the hands of an enemy which he can use more effectively against us than we can against him. This line of argument applies equally to the air, for in the air, our position in relation to other European nations is not at all to our advantage. Even supposing that the relative strengths of the respective Air Forces as between ourselves and a continental power are equally balanced, a glance at the map will show that we are at a distinct geographical disadvantage. The distance of London from the Continent (only 90 miles approximately from the French coast) enables any attacking aircraft to approach without much, if any, warning. Further, London, besides being the chief distributing centre, is the capital and the financial centre of the country. On the other hand, Paris is 170 miles from a corresponding point on the English coast; to reach that town our aircraft have to fly for many miles overland, thus giving warning of approach, whilst, in contradistinction to London, Paris is not the vital centre for the whole country. The same conditions apply to Berlin and to other capitals of continental countries, unless, indeed, the conditions of the Great War reproduce themselves and we ourselves are based on a continental country. Even so, in no other European country is there any central objective comparable with London.

It seems, therefore, clear that it is entirely to our advantage to keep within the accepted codes for the conduct of war as regards the employment of our air forces, as it certainly does in the employment of submarines. We should produce all the arguments to the contrary that we can, and make use of every precedent, appeal to humanity, etc. to refute the claim of the right to attack civilian towns from the air, in the same way that we should combat the claim of the right to sink merchant ships. It may, quite justly, be argued that the air action envisaged by the Air Force may be forced upon us if similar action is employed by our

enemies. Admittedly it may become necessary to employ the form of air action advocated by the way of reprisals, but this is a very different matter from publishing to the world at large the fact that we intend to employ these methods from the outset of a war.

5. It is now proposed to discuss in further detail whether this policy, apart from its expediency, will lead to victory. In other words, to what extent can the Air Force carry out the task it has set itself, namely, the paralysing from the outset of the enemy's productive centres of munitions of war and the stoppage of his communications and means of transportation? The most probable war of the near future in which the British Empire might be engaged is against Russia in Central Asia. In view of the locality in which such a war would be fought, it is difficult to see how the paralysis of the enemy's productive centres is to be brought about. The same difficulties of application arise in a war against Japan, and it is hard to believe that aircraft operating from carriers could achieve the war object defined by the Chief of the Air Staff. The most unlikely war in which the British Empire might be engaged, namely a war against France, happens to be the one war in which most can be said in support of the arguments produced by the Chief of the Air Staff. It is necessary however, to consider whether our probable resources in aircraft could alone bring about decisive results or even achieve the object to attain which, in the opinion of the Chief of the Air Staff, they should be employed. Turning to the last phase of the Great War during which the Air Forces of the Allies had reached their maximum development, I find that, apart from American aircraft, there were on the Western Front in November 1918 approximately 2,000 British and 3,000 French aeroplanes of various types. At the same time the Germans possessed 1,861 machines. Even with this vast air superiority there is nothing to show that the necessary paralysis was obtained, and, in point of fact, there is no precedent to show that this has ever been achieved. It is, I think, an historical fact that no military concentration either by the Germans or by the Allies was ever brought to a standstill by air action, no railways on either side were materially affected by air bombardment, the town of Dunkirk, though systematically bombarded throughout the War, continued uninterruptedly to fulfil its functions as a subsidiary naval base, whilst our own air efforts against the enemy submarine bases in Belgium had no lasting effect on the German submarine campaign. The air raids on London, unpleasant as they were, had no result except to harden the Nation's will to war, and they certainly exercised no deterrent effect on the many other large towns in England which were quite unaffected by the treatment suffered by London. Admitting that the improvements in aircraft effected since the War will make the achievement of better results more easy in the future, we must not forget that, on the other side of the account, counter air action has reached at least an equally increased standard of efficiency.

After considering the results achieved by the enormous allied air forces against well defined and generally accurately located objectives during the last year of the Great War, it is surely dangerous to argue that decisive results are to be expected from numerically very much smaller air forces

employed against a large number of ill defined objectives such as are to be sought for in the manufacturing towns of our potential enemy.

6. The Chief of the Air Staff, in urging us to accept what practically amounts to an independent form of strategy for the Royal Air Force, urges us to face the facts and 'not to bury our heads in the sand like ostriches'. I cannot help feeling that, in his anxiety to encourage our confidence in the ability of the Royal Air Force to act independently, he has himself unconsciously shut his eyes to certain of the facts which I have, in this paper, attempted to place in their correct perspective in relation to the problem we are considering.

As regards the ethical aspect of his proposals, it is for His Majesty's Government to accept or to refuse a doctrine which, put into plain English, amounts to one which advocates unrestricted warfare against the civil population of one's enemy. On the military side I have demonstrated that it is clearly to our national disadvantage to subscribe to the policy he advocates, while the adoption of a doctrine by the Royal Air Force which is independent of that under which the two other Services are trained to wage war will inevitably lead to their attempting to wage war independently. In war, concentration of effort alone can bring about success, and my main anxiety, after studying the Air Staff Memorandum, is lest the acceptance of the views advanced may lead us in exactly the opposite direction.

(Sgd.) G. F. MILNE
Chief of the Imperial General Staff.

(iii)

Note by the Chief of Naval Staff for the Chiefs of Staff Sub-Committee on the memorandum of the Chief of the Air Staff, 21st May 1928

A. GENERAL PRINCIPLES

In a Memorandum on 'the war object of an Air Force', the Chief of the Air Staff states that 'the time is now ripe to lay down explicitly the doctrine of the Air Staff as to the object to be pursued by an Air Force in War', and he proceeds to say that this object will be stated in the new Air Force War Manual in some such general terms as the following:

'The aim of the Air Force is to break down the enemy's means of resistance by attacks on objectives selected as most likely to achieve this end.'

This, it is suggested, is not explicit. No attempt is made to define the objective, but we are left to infer that objectives will, and can without detriment, be selected indiscriminately from military or civil interests.

It is argued by the Chief of the Air Staff that the object of all three Services is the same, namely, the defeat of the enemy nation. This is really confusing the political object, which is the defeat of the enemy nation, with the military aim by which the political object is attained.

For this purpose the Navy and the Army concentrate their attention primarily upon the opposing armed forces. With the air force, however, it is claimed that air power can dispense with the intermediate step, can pass over the enemy navies and armies, and penetrate the air defences, and attack direct the centres of production, transportation and a communication from which the enemy war effort is maintained.

Similar claims were made in the late war on behalf of the submarine. The direct attack on the overseas supplies, without which the war effort of the Allies would have been paralysed, was thought to be certain of success with the new method to hand of submarine warfare. The attack failed.

In the paper of the Chief of the Air Staff it is simply stated that new methods consequent on the introduction of air warfare have caused a change, that with air forces it is no longer necessary to consider the opposing armed forces as barriers which must first be broken down. The reason for this is not fully explained in the paper. Presumably it is for air tactical reasons that air fighting forces do not present barriers to air bombing forces.

The situation which is likely to arise in these circumstances is worth picturing. In a war with France, assuming that the French Military School were to hold the same ideas as the Air Staff, the French Air Squadrons would start, say, from Paris, and the British from London. They might pass one another in mid-Channel but take little notice of each other, knowing that, whilst fighting might take place later, each would penetrate the defences of the other and achieve its object of dropping a certain number of bombs on a certain number of ammunition and boot factories.

The picture takes little account of the counter attack. For this main operation each belligerent will set out to attack direct the objectives which he considers most vital to the enemy. 'Each will penetrate the defence of the other to a certain degree.'

In the C.A.S. paper it is taken for granted that direct air attack on the centres of production, transportation and communication must succeed in paralysing the life and effort of the community and therefore of winning the war. No evidence has so far been produced that such bombing in the face of counter attack will have such a result.

Unless such definite evidence is forthcoming, then there is danger of dissipation of effort in the operations of the air force. There will be dispersion on bombing operations which will have little military effect on the conduct of the war and which will bear no relation to the operations on land of the Army or on sea of the Navy. There will in fact be dissipation of force on the part of one of the three Services in the attainment of what should be a single object, and the important principle of concentration on the object will be neglected.

B. INTERNATIONAL LAW

Turning to the question of international law, a departure has been made in that in attacking by air the factories, transport and means of communication of a nation, civilian life is endangered to a far greater degree than has ever hitherto been contemplated under International Law.

It is open to argument whether attacks against resources, communication and transportation will actually weaken morale as is suggested; they may stiffen it. Experience in the past has not shewn that 'this form of' warfare has benefited the Country adopting it, indeed, arguments almost similar to those used for air bombardment of factories were used by the Germans when they decided to adopt a 'sink-at-sight' policy, which was aimed at our resources and the morale of our merchant seamen. The policy reacted against Germany in every sphere of the War. It did more than anything else to bring America in on our side. It did not weaken our morale, but tended to stiffen it.

C. CORRECT EMPLOYMENT OF AIR POWER

As a sea nation we oppose unrestricted submarine warfare, and, whilst admitting the right of visit and search and the sinking, on occasion, of enemy merchant ships, maintain that under international law full arrangements must be made for the safety of non-combatants. If we now advocate as an object of the air force a policy of air bombing, in which proper provision cannot be made for the safety of non-combatants, we are hardly in a position to meet the arguments which will be put forward by a continental military Power in favour of unrestricted submarine war at sea against merchant vessels.

It is therefore considered to be to our disadvantage to initiate the policy suggested, and this is admitted on page 10 of the memorandum¹ of the Chief of the Air Staff, where he says 'We ourselves are specially vulnerable to this form of attack, and foreign thinkers on war have already shown beyond all doubt that our enemies will exploit their advantage over us in this respect.' The conclusion is that it is not for us to advocate or to start this policy, but rather to do all we can to oppose it whenever opportunity arises.

CONCLUSIONS

The conclusion is that the doctrine outlined in the paper of the Chief of the Air Staff is—

- (a) a departure from accepted principles of war,
- (b) this departure cannot be justified by war experience, nor have arguments been produced to show that air warfare necessitates a change,
- (c) civilian life will be endangered to an extent which has hitherto not been contemplated under International Law,
- (d) its adoption is against our national interest.

For the reasons given, I suggest that important questions of high policy, not solely of military concern, are involved, and that before the policy outlined in the Chief of the Air Staff's paper is adopted as the object of the Air Force, the decision of H.M. Government should be obtained upon the matter, after an enquiry by the Committee of Imperial Defence, or such other body as the Prime Minister may appoint.

(Sgd.) C. MADDEN

¹ *Authors' note:* In this volume the reference is to p. 76.

APPENDIX 3

Note by M. P. A. Hankey, Secretary to the Committee of Imperial Defence, for the Committee of Imperial Defence on the Basis of Service Estimates, 2nd July 1928

WHEN considering the reference from the Cabinet of His Majesty's Government in Great Britain (C.I.D. Paper) on the subject of the Basis of Navy Estimates, the Committee of Imperial Defence may like to be reminded of the circumstances in which decisions have been taken at various times during the last few years to base Service Estimates on the assumption that there will be no great war for ten years.

2. The first decision on this subject was taken by the War Cabinet (which had not yet given way to a Peace Cabinet) on the 15th August, 1919. The discussions of the War Cabinet had been preceded four days earlier by a meeting of the Finance Committee of the War Cabinet at which the first suggestion had been made to proceed on the assumption that no great war was to be anticipated within the next ten years, and had been left for discussion between the Prime Minister (Mr. Lloyd George) and the Service Ministers. The pertinent decision of the War Cabinet was as follows:

'The Admiralty and the War Office and Air Ministry should work out their Estimates on the following basis:

- (1) It should be assumed, for framing revised Estimates, that the British Empire will not be engaged in any great war during the next ten years and that no Expeditionary Force is required for this purpose.'

(There were six other decisions which it is unnecessary to reproduce here.)

3. The above decision was not made on a scientific review of the prospects of the next ten years. The Secretary of State for Foreign Affairs (Mr. Balfour) was not present at the meetings either of the Finance Committee or of the War Cabinet at which the matter was discussed. Moreover, material was not available for a scientific appreciation. The Treaty of Versailles was signed but not ratified. None of the other Peace Treaties had yet been completed. The grouping of nations after the chaos of the War could hardly yet be discerned. Very considerable forces were still being maintained in such distant places as the Caucasus, Constantinople, Archangel, Iraq, and the Finance Committee had already discovered that it was imperative to cut down the expenditure on the Fighting Services. The ten years' formula, therefore, was purely empirical.

4. The decision of 1919, quoted above, is the only Cabinet decision laying down a ten years' period as the basis for *all* Service Estimates. As will be seen below, the same principle has been applied to the particular case of war with Japan and to the particular case of Army Estimates, but the formula of 1919 has never been renewed as applicable to all the Services.

5. The next mention of the ten years' period is on the 26th November, 1924, when the Chancellor of the Exchequer suggested to the Cabinet that the Committee of Imperial Defence should be asked to undertake the following enquiries:

- (1) A fresh survey of the situation as a whole and the dangers to which the British Empire is exposed;
- (2) The desirability and practicability of renewing the decision taken by the Cabinet Committee on Finance on the 11th August, 1919, that the Fighting Services 'should proceed on the assumption that no great war is to be anticipated within the next ten years, although provision should be made for the possible expansion of trained units in case of an emergency arising';
- (3) A review of the cruiser programme, and, after an exploration of the whole situation, submit a Report to the Cabinet.

6. As the result of a discussion on this proposal it was left to the Prime Minister to arrange the precise form of the Inquiry and the Terms of Reference after consultation with the Ministers concerned. On the 9th February, 1925, the Cabinet appointed a Naval Programme Committee to consider the programme of construction for replacement of Cruisers and other warships. This Committee found that the Naval Power against which the Admiralty were measuring themselves was Japan. They therefore sought the guidance of the Committee of Imperial Defence upon the question of the probability of a war with Japan in any future period with which it was necessary for them to concern themselves. The Conclusions of the Committee of Imperial Defence, which were subsequently ratified by the Cabinet, included the following:

- (ii) The Committee accept the view of the Secretary of State for Foreign Affairs that in existing circumstances aggressive action against the British Empire on the part of Japan within the next ten years is not a contingency seriously to be apprehended. The Foreign Office should be responsible for warning the Cabinet and the Committee of Imperial Defence of any change in the international situation in the Far East which would necessitate a fresh review of the question.'

(*Note.* The whole of the Conclusions of Imperial Defence on this subject are included in the note by the Secretary.)

It will be noted that the above Conclusion applies only to the case of war with Japan. Since then the Admiralty have themselves decided to extend the date for the completion of the Naval Base at Singapore until 1937, and the time allowed for the completion of the first stage of the plan of defence of Singapore has been extended for two years—i.e., until the end of the financial year 1932-33 (Meeting of the Committee of Imperial Defence).

7. In regard to Air Defence, the Cabinet, at its meeting held on the 3rd December, 1925, approved the recommendation:

'That the Air Ministry should base their Estimates on the assumption that the completion of the scheme of Air expansion

for home defence, approved by the Cabinet and announced in both Houses of Parliament on the 20th June, 1923, is postponed until the year 1935-36.'

8. On the 28th July, 1927, the Cabinet approved the following formula as the basis of Army Estimates:

'That it shall be assumed, for the purpose of the Estimates, that the British Empire will not be engaged in a European war during the next ten years, and that the immediate plans of the Army should be based upon preparedness for an extra-European war.'

It will be noticed that the above decision applies only to Army Estimates.

9. In January, 1928, the Secretary of State for Foreign Affairs was asked to advise the Committee of Imperial Defence, who were at the time considering the question of the South African Coast Defences, as to the probable development of the political situation during the next few years. Sir Austen Chamberlain's opinion, as given in the Report, prepared by the Committee of Imperial Defence for the Government of South Africa, was as follows:

'The Secretary of State for Foreign Affairs has informed the Committee that the situation existing with regard to France, Japan, and the United States of America, the only three naval Powers likely to be in a position to attack the South African ports, is, in his opinion, as follows: War with France, to whom good relations with ourselves mean so much, appears inconceivable. Japan has never been more peacefully inclined than at present, and the only thing that would arouse her would be a menace to her own interests in Manchuria. A direct quarrel with the United States may be regarded as something that neither side would contemplate, though a danger might possibly arise if, in a war with a third Power, a naval blockade were instituted which caused inconvenience to United States trade. Such a war with a third Power the Secretary of State for Foreign Affairs regards as very unlikely, at any rate for some years. *He therefore suggests that the Committee of Imperial Defence might safely assume that no great war was likely to occur during the next ten years.*'

SUMMARY

10. From the above it will be seen that the original decision to adopt the assumption that no great war was likely to occur for ten years was taken on the 15th August, 1919, and that it applied to the Estimates of all three Services; that it has never been specifically renewed as applying to all three Services, although a proposal to this effect was made by the Chancellor of the Exchequer in November, 1924, and an opinion to the same effect has been given by the Secretary of State for Foreign Affairs in January last. But each Service is in fact governed by decisions the effect of which cumulatively does not differ very widely from a renewal of the ten years period, viz., the Navy by the assumption of the 25th June, 1925, that

in existing circumstances aggressive action by Japan within the next ten years is not to be apprehended; the Army by the assumption, approved on the 28th July, 1927, that the British Empire will not be engaged in an European war during the next ten years; and the Royal Air Force by the decision of December 1925 to postpone the completion of the scheme of Air expansion until the year 1935-36.

(Signed) M. P. A. HANKEY

APPENDIX 4

Extract from an appreciation by the Joint Planning Sub-Committee of the Situation in the Event of War Against Germany in 1939, 26th October 1936

PROVISIONAL REPORT

Defence measures at home

97. In Appendix II¹ we have made a study of the German air attack and we have deduced that its character will be influenced by the progress which is made during the next three years in our air raid precautions and the education of the people of this country. The more the populace can be educated to understand the limitations as well as the dangers of air attack, and the more they realise the vital necessity for the maintenance of national morale, the more likely we are to survive the first phase.

The organized air defence system should take a considerable toll of attacking aircraft and should in itself prove a powerful deterrent to the continuance of the German air attacks against this country. The fact that a percentage of German bombers fail to return after each raid, will undoubtedly have a cumulative effect upon the morale of the pilots; also the rate of aircraft wastage in the German Air Striking Force is likely to increase as the personnel in our Fighter Command and Home Defence organization as a whole gain war experience. In the present state of development, however, local defence cannot provide the full measure of security which we require, and it is mainly by the counter-air offensive that the German air attack will be defeated.

Counter offensive measures

98. The offensive employment of our own and allied bombers is the only other measure which could affect the issue during the first few weeks of the war, since neither the Navy nor the Army has the power to impose upon Germany any form of immediate pressure.

Only three classes of objective for allied air attack seem at all likely to afford results in time:

- (a) If our attacks could demoralise the German people, by methods similar to those we foresee the Germans themselves using against us, their Government might be forced to desist from this type of attack.
- (b) If we could discover and attack some target, the security of which was regarded by Germany as vital to her survival during the limited period within which she hoped to gain a decision over us, she would be forced to divert her air attacks on to our own aerodromes and maintenance organisation.

¹ Not printed.

- (c) If our air attacks could inflict direct casualties upon the German bomber aircraft, either in the air or upon the ground or upon their maintenance organisation, the intensity of German attacks would be directly and quickly affected.

With regard to (a). Any attempt to demoralise the German people before German air attacks could demoralise our own people would operate under severe handicap. London is an objective of far greater national importance than Berlin, and for many reasons presents an easier and more effective target for German attack than Berlin does for the Allied air forces. If Germany chose to make London the objective for initial attacks, she might drop even a thousand tons of bombs on it on the first day. Germany covers twice the geographical area of Great Britain, so that opportunities for dispersion are correspondingly greater. German preparations to meet air attack are much in advance of our own. Moreover, a military dictatorship is likely to be less susceptible to popular outcry than a democratic Government. It is, consequently, unsafe to assume that under our present programme our air force, even with the co-operation of the French, will be able, by attacking the morale of the German people, to produce an effect in any way comparable with that which would result from German air attack against our own.

With regard to (b). Investigations into the detail of German national organisation have now been proceeding for over a year. So far, we have been unable to discover any air objective to attack which would be likely to force Germany to divert her own air offensive from the relatively more vulnerable points in our own organisation. Unless, therefore, we discover some unexpected weakness in Germany, it is certain that mutual air attack, even at equal intensity, upon each other's vulnerable points would only lead to a far quicker reduction of the war effort in England than in Germany. Allied air attacks upon German industry, either in the Ruhr or elsewhere, could not adequately affect the issue during the early weeks of the war with which we are here concerned, when Germany would be concentrating everything upon her knock-out blow. Nor could attacks upon units or establishments of the German Army or upon communications behind them, such as the French might be inclined to make, have any serious effect upon German attacks on Great Britain so long as the German higher command remained determined to adhere to its objective.

With regard to (c). This course of action in turn has grave disadvantages. Firstly, our attack would be directed against a military organisation, and the civil populace would not be greatly affected. In consequence, the moral effect produced on the nation as a whole would not compare with that which would result from German air attacks on England of the nature we have assumed. Secondly, we must presume that Germany would do all she could to protect her aerodromes and maintenance organisation by such means as dispersion, the use of camouflage aerodromes, &c., in addition to providing a heavy scale of anti-aircraft defence at any point which she were to regard as especially important. For these reasons it must be admitted that the German air striking force and its maintenance organisation is not a very satisfactory target for air attack, and there is a

possibility that, notwithstanding a considerable bombing effort, we may not succeed in reducing the scale of German air attack on this country to manageable proportions. We consider, however, that the adoption of this course would result in a higher rate of wastage in the German air striking force than in our own, so long as Germany adhered to a policy of attacking our vulnerable points.

From the above examination it is clear that defence against an enemy, presumed to be ruthless, who possesses not only the initiative but possibly also superior air striking power, presents a most difficult problem in air strategy; moreover, in the situation we are considering we have also to take account of the exceptional vulnerability of this country to air attack. While we are forced to admit that there seems to be no satisfactory answer to the problem on such *premises*, nevertheless we are here concerned with doing the best we can with the forces we have presumed to be at our disposal.

It appears that in these circumstances we should be forced (if only because of the time factor) to adopt the last course of action (c) and to direct the bulk of our counter air offensive against the enemy's air striking force and its maintenance organisation as the most immediate method of reducing, however inadequately, the scale of enemy air attack. Nevertheless this course would only be adopted *faute de mieux*, and could be no more than a palliative holding out no hope of eventual victory, even if indeed it could avert defeat. Some provision should also be made, however, for attack on the objectives mentioned in (a) and (b) above, because a comparatively small scale of attack on these 'softer' objectives should at least effect a dispersion of the mobile portion of the enemy air defence and thereby materially assist our attack on our main objective.

Navy

99. The primary task of the Navy during this phase of the campaign would be (in co-operation with the Air Force, where required) to maintain the security of shipping approaching our ports. Attack on our shipping at sea might be part of the German air offensive and would certainly be the task of German naval forces.

Army

100. While the crisis remained centred in Great Britain, the employment of our Field Force on the Continent would be of less importance than the defeat of the German air attack. The field force could only be moved to the Continent if all the army assistance necessary to maintain order and essential services in this country could be afforded by other troops.

Problem of repelling immediate German land and air offensive on Continent

101. As soon as it became apparent that Germany was launching her decisive attack against France, it would become just as important for us to use all our resources to assist in defeating this attack as, in the alternative case, it would be to defeat German air attack on Great Britain. The success of a knockout blow by Germany on the Continent would ulti-

mately be as disastrous to this country as the success of an immediate attack on Great Britain.

102. Our naval superiority would give us the power to assist our Allies on land as well as by air action; and, in this phase, our action must be dictated by the limited military object of arresting the German land and air attacks.

103. The greatest danger of a rapid German success on land seems to lie either in the speed, strength and surprise of her initial attack enabling her to break through French or Belgian defences before they could be fully manned, or in the inability of the Belgian Forces to hold the whole of their northern and eastern frontiers and the failure of the French to concentrate an army in Belgium to support their Allies. Speed in giving whatever help we could would, therefore, be of the first importance and every measure we could take to delay the German attack would acquire corresponding importance.

104. There would be a danger that a rapid German advance might dispose of Holland, Belgium and France successively. Neither we, nor either of our other Allies, could prevent Holland being over-run; but, if our Field Force could come into action quickly in Belgium it might be able to ensure effective co-operation between the forces of that country, France and ourselves.

105. The employment of our Air Force, as of the French Air Force, should be dictated by the object which has been defined above. If there seemed a danger that the German attack on France would succeed through the demoralisation of the French people by air attack, the objectives for our bombing should be those which we have concluded to be the most effective reply to German air attacks on Great Britain. If the greater danger seemed to be the success of the German advance by land, all our resources should be directed against the rear organisation and lines of communication of her advancing armies.

Problem of employment of our resources in counter-offensive

106. Assuming that Germany fails to gain a quick success, we should then come to a second phase when the force of German attacks was temporarily spent and we and our Allies might have the opportunity to develop our counter-offensive.

Possible course of the war

107. In Appendix V¹ we have summarised the general expectations, not only of our own but also of the French and other Continental staffs, as to the general lines upon which a major European war such as that we are considering might develop. It seems clear that our ability to develop our own industrial output of munitions and to restrict that of Germany, might well be the deciding factor in the later stages of the war; our plans, must, therefore, be influenced by this probability.

We anticipate that Germany's munition position would, at the beginning of the war, be stronger than that of the Allies, since she would start

¹ Not printed.

with her industries highly organised for war production and with considerable reserves of material in hand. The relative position of Germany and the Allies in this respect would have to be reversed before we could have good prospects in an allied counter-offensive. The intervention of Russia would go far towards making the Allied counter-offensive possible, provided that Italy and Japan continued neutral, and, while we cannot base our plans solely on a factor which is so uncertain, we should none the less be ready to exploit the opportunity which Russian intervention might afford.

For ultimate success in the later phases of the war we must, therefore, take measures for the security of our own existing war industries, for the development of additional industries where they might be least liable to enemy attack and for the curtailment of the German output.

To secure our existing industries we should have to effect the utmost possible increase in our A.A. defences of all kinds.

Additional war industries on a large scale would have to be developed in the remoter parts of the British Isles, and in the Dominions and Colonies where they would be immune from attack.

These measures could have little effect for many months, even under the conditions of urgent war development. By anticipating war in 1939 we have 3 pre-war years in which to initiate the measures.

It would be the task of our Navy to continue to curtail the import of raw materials into Germany and to protect our own shipping bringing supplies to this country, that of our Air Force ultimately to attack with the object of curtailing the output of Germany's war industry, and that of the Army to co-operate with both French and Belgians in preparation for a counter-offensive on land.

Air

108. We have assumed that so long as we are much more vulnerable than Germany and also have a smaller air striking power for the purpose of decision in air warfare, we may be forced to direct our initial air offensive towards trying to reduce the scale of German air attack quickly by counter-attacks on her air striking organisation. Such action is, however, a purely defensive strategy, and, since we cannot apply effective pressure on Germany until we attack her vulnerable points, it is essential that at least a proportion of our air striking force should take the offensive against such objectives as soon as possible. When this occurs we shall in effect have reached phase two and our air action will be the first step in the preparation for a counter-offensive.

Economic Pressure

109. By the combined action of our Navy, our Air Force and our diplomatic and commercial influence upon Neutrals we could develop economic pressure upon Germany. Economic pressure takes effect slowly—in the past its effects have developed more slowly than expert analysis has foretold—but it remains one of the most powerful influences which this country can exercise in war. The measures by which economic pressure

could be exercised have been reviewed in this paper. In Part II (C)¹ we have shown that if war against Germany continued for a period of some years, economic pressure effectively maintained would probably prove decisive. No other form of naval action seems to hold a prospect of decisive success against Germany.

Army

110. The situation of the Allied land forces on the Continent at the close of the first phase would vary very widely with the course Germany had adopted in her initial offensive. Had that offensive been directed against Great Britain, the simultaneous land operations might have been on a limited scale; had it been directed against France, the whole of the German resources would have been employed on the Continent and operations would then have been on a very large scale.

Whichever had been the case, our task during a second phase would be to co-operate with the French and Belgian armies to prepare for a counter-offensive on land. Our intervention on land would help to bring the divergent strategic interests of France and Belgium into accord and to co-ordinate the operations of their armies. We only, of the three Allies, might be able in the course of time to bring into the field mobile mechanized forces on a scale which would make a counter-offensive possible.

To fulfil our role our plans must be made to move the Field Force with the minimum of delay into an area in Northern France, or in Belgium where direct co-operation with French and Belgian forces would be possible. Our subsequent contingents would strengthen the Force and assist it to maintain a stabilized position until sufficient mobile mechanized formations could be brought into the field. The superior position which Germany seems likely to occupy in respect of munition production in 1939, makes it seem probable that the Allied forces would have to resist and defeat a renewed German offensive before we could ourselves launch our counter-offensive; but this eventual counter-offensive on land remains a measure without which the Allies may not be able to gain a successful decision.

PART IV. POLICY FOR THE
CONDUCT OF THE WAR

111. We have shown that in 1939 Germany's war preparations are likely to be considerably more advanced than will be the case in Great Britain or France. We concluded that, if war occurred, Germany would endeavour to exploit her preparedness by a rapid victory—within a few months: and that the Allies would have no means of winning quickly. In fact, the Allies would have to rely on establishing a decisive economic and industrial advantage to give them a commanding superiority in war resources over Germany, a process likely to take years rather than months. The Allies must, therefore, plan for a long war.

112. We consider that Germany's initial offensive would be aimed

¹ Not printed.

either to knock out Great Britain quickly or to knock out France and Belgium quickly. Success by Germany in either course would be disastrous to Great Britain. During the period of Germany's initial offensive every resource of this country must be directed to holding off the attack until it has spent its force. Since our action to this end must vary according to the course adopted by Germany, we must have alternative policies prepared for our land and air forces. Our Naval policy will be the same in either case: i.e., to secure our sea communications to the ports of this country, and with France if required; to guard our coasts against seaborne raids; and to apply economic pressure against Germany from the outset by cutting off her seaborne supplies. Our marked naval superiority should ensure the security of our sea communications against German naval attack, although initial losses to our trade must be expected. The effects of economic pressure are bound to be slow.

113. If Germany's initial offensive aims at knocking out Great Britain, the following principles must govern the employment of our land and air forces:

- (a) Our land forces must take every possible step to defend the country from air attack and maintain confidence, law and order among our civil population before attempting to fulfil any other role.
- (b) Our air forces must be employed with the object of defeating the German air attacks on this country during this phase.

Success in this phase will depend largely on our Allies co-operating with their air forces to reduce the scale of German air attack on Great Britain.

114. If Germany's initial offensive aims at knocking out our continental allies, the following principles must govern the employment of our land and air forces:

- (a) Our land forces must give immediate support on the continent, with a view to ensuring co-operation between the French and Belgians, and stemming the German advance.
- (b) Our air forces must be employed with the object of defeating German attacks against France.

115. After Germany's initial offensive is held, we must be prepared for the war to enter a second phase during which our object must be to intensify the development of our industrial output, especially of aircraft and munitions, and to restrict that of Germany. Economic pressure must be continuously applied to Germany by Naval and Air Forces, and by diplomatic and commercial influence upon neutrals. This is the only form of pressure that our superior naval forces can apply: a powerful pressure, but slow in operation.

As and when our defences and other counter-measures have reduced the scale of German air attack to bearable proportions, our Air forces can attack objectives whose destruction will reduce the German war potential. Such action will directly contribute to the pressure we can exert against the German war effort.

On land we shall have to provide subsequent contingents to strengthen our Field Force, in co-operation with the French and Belgians, and main-

tain a stabilised position until mobile mechanized formations can be brought into the field. We may be faced with a renewed German offensive until the Allies can launch a counter-offensive: but this eventual counter-offensive on land may be an essential measure in enabling the Allies to gain a successful decision.

116. To sum up, we are faced by an enemy who has fully prepared for war on a national scale, has superiority in air and land forces, and possesses the initiative. In these circumstances we must be prepared to face an attempted knock-out blow aimed either at ourselves or our Allies. In either case we must concentrate our initial efforts on defeating this attempt, which, if in the form of air attack on Great Britain, may well subject us over a period to a strain greater than we have ever experienced. If this can be successfully accomplished, we must thereafter rely on our industrial and economic power, backed by the resources of the Empire, eventually to bring a counter-offensive against Germany.

(Sgd.) T. S. V. PHILLIPS
R. F. ADAM
A. T. HARRIS

APPENDIX 5

Aide-Memoire by Sir Thomas Inskip, Minister for Co-ordination of Defence, for the Secretary of State for Air, 9th December 1937

IN connection with my inquiry into the future programmes of our Defence Services I have been devoting much thought to the proposals which you have prepared for my consideration.

The position in which I find myself is one of no small difficulty. The Treasury give most cogent reasons for not increasing our expenditure above the lower limits discussed in the Chancellor of the Exchequer's Memorandum. I hope to obtain some reduction in the provision made by the War Office for the Expeditionary Force, but I am not yet in a position to know what this will amount to, and some part of it, at any rate, will be absorbed by additional expenditure on anti-aircraft defences.

As regards the Air Force I am satisfied that the present programme as represented in Scheme F. does not meet the case, but I am not satisfied that Scheme J. is one which I can recommend as it stands.¹

I approach the question from the point of view of our general policy and strategy in a war with Germany.

The Report of the Chiefs of Staff Sub-Committee on Planning for a War with Germany was based on the general conception that Germany is likely to be the aggressor and will endeavour 'to exploit her superior preparedness by trying to knock out Great Britain rapidly, or to knock out France rapidly, since she is not well placed for a long war in which the Sea Powers, as in the past, are likely to have the advantage'.² I think we all believe this conception to be a correct one. If Germany is to win she must knock us out within a comparatively short time owing to our superior staying-power. If we wish our forces to be sufficient to deter Germany from going to war, our forces—and this applies to the air forces as much as to the other Services—must be sufficiently powerful to convince Germany that she cannot deal us an early knock-out blow. In other words, we must be able to confront the Germans with the risks of a long war, which is the one thing that they cannot face.

Looking at the matter from this point of view, I cannot take the view that our Air Force must necessarily correspond in numbers and types of aircraft with the German Air Force. I cannot, therefore, persuade myself that the dictum of the Chief of the Air Staff that we must give the enemy as much as he gives us is a sound principle. I do not think that is the proper measure of our strength. The German Air Force, as I have pointed out, must be designed to deliver a knock-out blow within a few weeks of the

¹ *Authors' note:* For schemes F and J, see App. 7.

² *Authors' note:* This Report of the Chiefs of Staff was based on the appreciation of the Joint Planning Sub-Committee, 26th October 1936, Appendix 4 above.

outbreak of war. The *role* of our Air Force is not an early knock-out blow—no-one has suggested that we can accomplish that—but to prevent the Germans from knocking us out. Our weapon of victory is not only the Royal Air Force, developed as the war goes on to a high degree of striking power, but, as in the late war, a combination of economic pressure and striking force.

It has occurred to me, therefore, that we ought to consider whether our Air Force programme could not be re-cast on somewhat different lines. Please do not think for a moment that I am driving my ideas to the extreme logical conclusion that we ought to have nothing but Fighters at the outset of a war. That would be an absurdity. My idea is rather that in order to meet our real requirements we need not possess anything like the same number of long-range heavy bombers as the Germans. The Air Staff have often pointed out in their Memoranda that in a mere slogging match, bomber against bomber, we are at a disadvantage, for the reason that the targets in the United Kingdom are comparatively concentrated, whereas the German targets are comparatively scattered. I gather that this aspect would be accentuated if Germany should respect the neutrality of Belgium, since our aircraft would have to go a long way round in order to reach the most vulnerable German targets in the Ruhr, the Rhineland and the Saar. It seems to me that what we want to do in the first weeks of a war is to knock out as many German aeroplanes as we can, with a view to upsetting the *morale* of their Air Force. After that we can adopt a more offensive *role*, which I should hope might be based not on this country but on French or possibly even Belgian territory, from which the distances to the vulnerable German regions mentioned above are shorter.

Of course I am not suggesting that our Air Force should at the outset of a war consist only of defensive aircraft. I am not even suggesting an alteration in the ratio between bombers and [fighter] aircraft.¹ My idea is rather that the numbers of heavy bombers should be reduced. From the Report of the Chiefs of Staff already quoted I gather that the view of the Chiefs of Staff is that, failing some other favourable target, the policy for bombers should be one of 'inflicting direct casualties upon the German bomber aircraft either in the air or upon the ground'. The Chiefs of Staff Committee are under no illusions as to the limitations of attacks on aerodromes. They admit that aerodromes and the enemy's striking force are 'not a very satisfactory target for air attack', and their recommendation is made *faute de mieux* 'as the most immediate method of reducing, however inadequately, the scale of enemy air attack'. I am not opposing this policy, but I do suggest that, given the probability that the German anti-aircraft defence both in the air and on the ground will be very powerful and that they are likely to use 'shadow' aerodromes the precise positions of which we do not know, this policy is likely to be both costly and comparatively ineffective. In the passages I have quoted, however, the Air Staff seem to contemplate the alternative of trying to inflict casualties on the Germans in the air rather than on the ground. They must come to this country to damage us. They are likely to concentrate on great centres, such as London, which provide

¹ The word 'fighter' was inserted in pencil before aircraft.

an irresistible target. In fact, it would seem in accordance with strategical principle that the decisive place and the decisive time for the concentration of our own air forces would be somewhere over our own territory at the outset of a war. Have you considered the possibility of using our own bombers to supplement our fighters in this respect? In other words, of giving the Germans a surprise by confronting them with a much larger defending force than they expected? I am not suggesting that the bombers would necessarily use the same tactics or weapons as the fighters. I seem to have seen suggestions in some of the proceedings of the Technical Committees that special light bombs might be designed for aircraft to use against aircraft.

Quite apart from this possibility, however, the general suggestion I want to make is that, without loss of efficiency for our own purposes, we might substitute a larger proportion of light and medium bombers for our very expensive heavy bombers. In doing this we should, it is true, reduce in some degree our power of hitting Germany at the outset of a war. I assume, however, that we should still be able to deal them some nasty blows, even from the outset, against the nearer points in German territory. We should, of course, possess some heavy bombers which could drop the heaviest loads of bombs, and others which would drop smaller loads. I presume that the German population would not be able to distinguish very clearly between the heavy load and the light load. If the attack came they would always fear the worst. The moral effect, therefore, need not necessarily be very much reduced. And after the first stage of the war, when we had repulsed the enemy's attacks, I should hope, as already indicated, that we might be able to deliver decisive blows from Continental territory against the vulnerable targets of the Ruhr, the Rhineland and the Saar.

The point I want to put to you, therefore, is as to whether you can devise a revised programme based on the conception that at the outset of a war our first task is to repulse a knock-out blow within the first few weeks, trusting thereafter to defeat the enemy by a process of exhaustion, resulting from our command at sea, in the later stages.

That plan, of course, involves the creation of a much larger potential for the manufacturers of aircraft than we possess at present. I suggest, therefore, that your plan should include the provision in time of peace of shadow factories, or whatever plans you consider best adapted to the purpose. If the provision of these factories would enable you to reduce the amount of your war reserves and so limit expenditure in that direction, so much the better.

APPENDIX 6

Western Air Plans 1st September 1939

Index Number	Subject	Department(s) mainly responsible for action	Remarks
W.A.1	AIR FORCE PLANS Plans for attack on the German Air Striking Force, and its maintenance organisation (including aircraft industry).	AIR MINISTRY	Targets plotted and Operation Orders in draft form for approval of C.-in-C.
W.A.1(b)	Action against certain major aerodromes in the north-west corner of Germany.	AIR MINISTRY	Operation Orders prepared by Bomber Command.
W.A.2	Plans for reconnaissance in co-operation with the Navy in Home Waters and the eastern Atlantic.	AIR MINISTRY Admiralty	Coastal Command mobilisation to war stations has been concerted in liaison with the Admiralty with a view to squadrons being in the right position for co-operation in trade protection and reconnaissance. This applies both to present and final plans.
W.A.3	Plans for close co-operation with the Navy in convoy protection in Home Waters and the eastern Atlantic.	AIR MINISTRY Admiralty	ditto ditto
W.A.4	Plans for the attack of German military rail, canal and road communications. W.A.4(a). Attack on rail and road communications in W. Germany in a concentration period.	AIR MINISTRY	(a) Appreciation of this problem tends to shew that at the outset of war the German Army would be concentrated in position before operations began. German rail, road and canal communications in the West are at present the subject of close study by the War Office and Air Ministry. Discussions are now proceeding between the British and French General and Air

Western Air Plans 1st September 1939—*Continued*

Index Number	Subject	Department(s) mainly responsible for action	Remarks
W.A.4 (contd.)	W.A.4(b). Attack to delay a German invasion of southern Holland, Belgium and France.		<p>Staffs as to the best points for attack should a German concentration in the West take place during war and not, as to be expected, preceding declaration of war.</p> <p>(b) Discussion is proceeding between the British and French General Air Staffs with a view to the collaboration of Bomber Command in this plan, should it be put into execution at the outbreak of war. Consideration is being given to methods of operational control, intelligence and organisation, and the selection of such targets as can be foreseen in advance.</p>
W.A.5	<p>Plans for attacking German manufacturing resources.</p> <p>W.A.5(a). The attack of German war industry.</p> <p>W.A.5(b). The attack of the RUHR and its effect on the military lines of communication in western Germany</p> <p>W.A.5(c). Attack on Germany's war resources of oil.</p>	AIR MINISTRY	<p>(a) Operation Orders numbered 8, 9 and 10, issued to Groups.</p> <p>(b) This plan follows on W.A.5(a) except in so far as night operations are concerned. No action required at present for day attacks. Night attacks for this plan differ from W.A.5(a) and Operation Orders for night attack, W.A.5(b), are being prepared.</p> <p>(c) B.C. Operation Orders numbered 11, 12 and 13, have been issued to Groups.</p>

Western Air Plans 1st September 1939—Continued

Index Number	Subject	Department(s) mainly responsible for action	Remarks
W.A.6	Plans for attacking Italian manufacturing resources.	AIR MINISTRY	This number was originally reserved for plans for attack on the enemy's aircraft industry. W.A.1 now includes the aircraft industry and W.A.6 is therefore being reserved for Italian industrial plans, when prepared.
W.A.7	Plans for counter-offensive action in defence of sea-borne trade in co-operation with the Navy, i.e. attack on the Fleet or on the bases of enemy surface, submarine and air forces operating against our trade.	AIR MINISTRY Admiralty	(a) B.C. Operation Order, number 7, issued to Groups. Amendment being issued to bring up to date with latest requirements. (b) Operation Orders for this plan were being prepared at Bomber Command Headquarters on 31.8.39.
	W.A.7(a). Attack on WILHELMSHAVEN		
	W.A.7(b). Limited attack with air forces alone on WILHELMSHAVEN		
W.A.8	Plans for attack on specially important depots or accumulations of warlike stores other than air, in enemy country.	AIR MINISTRY	No information in peace. This plan would have to be prepared in war in the light of information obtained by reconnaissance.
W.A.9	Plans for putting the Kiel Canal out of action.	AIR MINISTRY	A plan has been prepared but can only be put into execution when the 1,000-lb. bomb becomes available.
W.A.10	Plans for the destruction of enemy shipping and facilities in German mercantile ports—precedence to be given to the Baltic.	AIR MINISTRY Admiralty	This plan is not really practicable until Bomber Command is equipped with a larger percentage of long-range aircraft. An air targets appreciation exists

Western Air Plans 1st September 1939—*Continued*

Index Number	Subject	Department(s) mainly responsible for action	Remarks
W.A.10 (contd.)			and will form the subject of an operational appreciation when the equipment of Bomber Command permits.
W.A.11	Plans for attack on forests.	AIR MINISTRY	Plan W.A.11 was formerly a plan for attacking enemy manufacturing resources outside the RUHR, RHINELAND and SAAR. This industrial plan is now embodied in W.A.5 and the number W.A.11 has been allotted to attack on forests.
W.A.12	Plans for attacking the German Fleet or a section thereof at sea.	AIR MINISTRY Admiralty	Bomber Command Operation Instruction number 8, being Standing Instructions for this plan, have been prepared. These Instructions were agreed between Bomber and Coastal Commands on 28.8.39.
W.A.13	Plans for attack on enemy's headquarter and administrative offices in Berlin and elsewhere.	AIR MINISTRY	No appreciation has been prepared for this plan which does not at the moment appear sufficiently attractive.
W.A.14	Plans for dropping propaganda leaflets.	AIR MINISTRY Foreign Office Stationery Office	Bomber Command Operation Instructions, Nos. 9 and 10, have been re-drafted to give effect to latest decision, and issued to Groups.
W.A.15	Plans prepared in concert with the Naval Staff for operations against enemy shipping by 'M' Mine.	AIR MINISTRY Admiralty	
W.A.16	Buoyancy mine attack against German waterways.	AIR MINISTRY Admiralty	

Authors' note: These are the numbers given to the W.A. plans at the beginning of the war. Some of them were subsequently re-numbered. See App. 8 (1).

APPENDIX 7

Comparison of Expansion Schemes of Aircraft Strength, 1934-39¹

	Pre-expansion Strength on 31.3.34	Scheme 'A'		Scheme 'C'		Scheme 'F'		Scheme 'H'		Scheme 'J'		
		31.3.39	November 1933 Approved July 1934	Metropolitan 31.3.37 Overseas 31.3.39	April 1935 Approved May 1935	May 1935 Approved February 1936	31.3.39	January 1937 Partial approval only ² February 1937	31.3.39	As soon as possible after 1939	October 1937 Not approved December 1937	31.3.41
Date for completion												
Date of reference to C.I.D., etc.												
Date of Cabinet rejection or approval												
METROPOLITAN:												
Bombers	Sqdns. 28 I.E. 316	Sqdns. 41 I.E. 476	Sqdns. 68 I.E. 816	Sqdns. 68 I.E. 990	Sqdns. 85 I.E. 1,589	Sqdns. 90 I.E. 1,659	Sqdns. 90 I.E. 1,442	Sqdns. 90 I.E. 1,442	Sqdns. 90 I.E. 1,442	Sqdns. 90 I.E. 1,442	Sqdns. 90 I.E. 1,442	Sqdns. 90 I.E. 1,442
Fighters	13 156	28 336	35 420	30 420	34 476	34 476	34 476	34 476	34 476	34 476	34 476	34 476
Torpedo-Bombers		2 24	2 24	2 32	2 42	2 42	2 42	2 42	2 42	2 42	2 42	2 42
General Reconnaissance (Landplane)		4 48	7 126	7 126	7 126	7 126	7 126	7 126	7 126	7 126	7 126	7 126
General Reconnaissance (Flying-boat)	4 15	4 16	6 36	6 36	6 36	6 36	6 36	6 36	6 36	6 36	6 36	6 36
Army Co-operation	5 60	5 60	5 90	11 132	11 132	11 132	11 132	11 132	11 132	11 132	11 132	11 132
Total Metropolitan	50 547	84 960	123 1,512	124 1,736	145 2,422	145 2,422	145 2,422	145 2,422	150 2,492	158 2,987	158 2,987	158 2,987
OVERSEAS	24 265	27 292	27 292	37 468	27 348	27 348	27 348	27 348	37 468	45 644	45 644	45 644

¹ Authors' Note: The details of Scheme 'M' have been added to a document prepared by the Air Ministry in 1938.

² Approval given to purchase and prepare the necessary aerodromes; to continue to recruit and train pilots and semi-skilled personnel to extent of full Scheme 'F' capacity, and to train full number of skilled men required for Scheme 'H' up to maximum number of apprentices obtainable.

³ Includes 4 squadrons for Trade Defence.

Comparison of Expansion Schemes of Aircraft Strength, 1934-39—Continued

	Scheme 'K'		Scheme 'L'		Scheme 'M'			Eventual (possibly 31.1.42)
	31.3.41	31.3.40	31.3.41	31.3.40	31.3.39	31.3.40	31.3.41	
Date for completion	January 1938	March 1938	31.3.41	31.3.40	31.3.39	31.3.40	31.3.41	
Date of reference to C.I.D., etc. Date of Cabinet rejection or approval	Not approved March 1938	Approved with authority for expenditure only up to 31.3.40 April 1938			Approved 17 November 1938			
METROPOLITAN:								
Bombers	Sqdns. I.E.	Sqdns. I.E.	Sqdns. I.E.	Sqdns. I.E.	Sqdns. I.E.	Sqdns. I.E.	Sqdns. I.E.	Sqdns. I.E.
Fighters	77 1,360	73 1,352	77 1,360	73 1,352	57 812	70 1,352	82 1,360	85 1,360 ¹
Torpedo-Bombers	38 532	38 608	38 608	38 608	40 638	40 640	50 800	50 800
General Reconnaissance (Landplane)	*13 245	*13 245	*13 245	*13 245	2 24	—	—	—
General Reconnaissance (Flying-boat)	6 36	6 36	6 36	6 36	10 162	13 245	13 245	13 245
Army Co-operation	11 132	11 132	11 132	11 132	6 36	6 36	6 36	6 36
Total Metropolitan OVERSEAS	145 2,305 37 468	141 2,373 37 468	145 2,381 37 468	145 2,381 37 468	214 1,780	138 2,381	160 2,549	163 2,549

¹ All heavy bombers.

* Includes 4 squadrons for Trade Defence.

SECTION III

Bombing Directives

1940-1945

INTRODUCTION

OWING to the somewhat complicated nature of the bombing directives, this section requires a longer note of introduction. The procedure for issuing bombing directives was not rigid and at various stages of the war changed. The documents printed here represent a selection from materials of differing provenance. Though some instructions of a different nature have been included, the majority of the directives written before January 1943 were sent on behalf of the Air Staff to the Commander-in-Chief, Bomber Command, in the form of letters. These directives, as was sometimes mentioned or implied in the opening paragraph, often followed discussions of bombing policy by the Chiefs of Staff¹ and generally, though not invariably, they had received the prior approval of the Defence Committee. In a few specially important cases, a direct ruling by the Prime Minister or a decision by the War Cabinet was mentioned.²

In January 1943 a new situation arose from the readiness of the United States Eighth Air Force to mount an attack upon Germany and the decision of the Casablanca Conference that Sir Charles Portal, under the Combined Chiefs of Staff, should be responsible for the strategic direction of the Combined Bomber Offensive. The so-called Casablanca directive of 21st January 1943,³ therefore, took a form which was quite different from the earlier documents. The responsibility for the directives now lay with the Combined Chiefs of Staff and that for passing them on to the two commanders with the necessary explanations with Sir Charles Portal. It will be seen, however, that subsidiary directives continued to be sent from time to time under what was approximately the old system.

A further change was reflected in the directive of 17th April 1944⁴ when, for a time, the responsibility was vested in the Supreme Allied Commander, General Eisenhower. Finally, in September 1944, a new system was introduced in which Sir Charles Portal and General Arnold shared the responsibility on behalf of the Combined Chiefs of Staff. This was explained in a directive of 14th September 1944.⁵ That system was applied to the four main directives of the final period of the war, which, in so far as Bomber Command was concerned, must be considered with the supplementary letters sent by the Deputy Chief of the Air Staff to the Commander-in-Chief.

Thus, some of the factors which at various stages of the war influenced the form and content of the directives will be clear. Another important

¹ e.g. consider the directive of 15th January 1941 (see below, p. 132) in relation to the Chiefs of Staff report of 7th January 1941 (see below, p. 188).

² e.g. 9th March 1941 (Prime Minister's ruling) and 13th November 1941 (War Cabinet decision). See below, pp. 133 and 142. It should be noted that the W.A. plans were developed and often re-numbered after the outbreak of war. The designations referred to in the early directives do not therefore necessarily correspond with those given in Appendix 6 which shows the position on the eve of the war.

³ See below, p. 153.

⁴ See below, p. 167.

⁵ See below, p. 170.

factor was the view of the Commander-in-Chief as, for example, can be seen by comparing the draft with the final version of the *Pointblank* directive.¹ A further indication of the same factor can be obtained by consulting the correspondence with the Commander-in-Chief on the ball-bearing plan which is printed in Section IV.²

¹ See below, pp. 155 and 158.

² See pp. 245-253.

APPENDIX 8

Directives to the Air Officer Commanding-in-Chief, Bomber Command

(i)

*13th April 1940. Air Commodore J. C. Slessor (Director of Plans)
to Air Marshal C. F. A. Portal*

Sir,

I am directed to inform you that in consequence of the new situation created by the German invasion of Scandinavia it has been necessary to review our major air plans. The following decisions have accordingly been made.

2. There are two *hypotheses*:

- A. The Germans do not invade the Low Countries but authority for unrestricted air action is given.
- B. Germany invades Holland and/or Belgium.

Hypothesis A

3. Plan W.A.8 will be implemented.¹ In view however of the lack of suitable bases in France for the operation of our heavy bombers, and also of the proposed employment of at least a proportion of No. 5 Group for minelaying operations (Plan W.A.15), the area to be covered by our heavy bombers should be limited in the first instance to a zone north of Lat. 51° N. (i.e. including both the Ruhr and the industrial area around Leipzig).

4. The force at your disposal will be Nos. 3, 4 and a proportion of 5 Groups and, if the situation on the Western Front permits, units of the A.A.S.F. In the latter contingency it is suggested that the A.A.S.F. might patrol part of the southern area as well as undertaking the bombardment operations referred to in para. 10 of Bomber Command Operation Instruction No. 26.²

5. The objectives in order of priority are:

- (a) Identifiable oil-plants (List C.1, Plan W.A.6).
- (b) Identifiable electricity plants, coking plants and gas works (List 1, Plan W.A.5(a)).
- (c) Self-illuminating objectives vulnerable to air attack (List D.1 and D.2, Plan W.A.8).

¹ *Authors' note:* W.A.8 was the plan for night attack upon Germany. The draft Air Ministry appreciation was sent to Bomber Command on 31st January 1940. It showed that the object of the plan was 'primarily by means of night operations to produce an immediate dislocation of German war industry'.

² *Authors' note:* Issued on 9th April 1940.

6. In addition, if the operation is authorised in the immediate future, harassing action by patrol aircraft should be directed particularly to the main German ports on the Baltic.

Hypothesis B. If Germany invades Holland and/or Belgium.

7. Under this hypothesis, it is intended to initiate attacks on vital objectives in Germany, directed in the first instance against targets in the Ruhr area in order to cause the maximum dislocation on the lines of communication of a German advance through the Low Countries.

This plan will be known as Plan W.A.4(c).

It will be put into effect immediately a German invasion of either Holland or Belgium begins. Aircraft may therefore be routed direct across the Low Countries.

8. The objectives for attack will be:

- (a) Troop concentrations—the co-operation of heavy bombers in this action is already provided for by the allocation of 2 Whitley squadrons under the control of B.A.F.F. (the objectives are detailed in B.A.F.F. signal No. North Ops. 102 dated 12/4).¹
- (b) Communications in the Ruhr, i.e. the marshalling-yards listed in Annex A to this letter.¹
- (c) The oil-plants in the Ruhr (Vide Annex A, and List C.1. Plan W.A.6).

9. The force at your disposal will be Nos. 3, 4 and 5 Groups, less the two Whitley squadrons allotted to the B.A.F.F.

10. The operations of our heavy bombers are to be confined mainly to night action in order to conserve our force, but dusk or dawn attacks may be carried out at your discretion. (If you consider an attack on oil objectives before nightfall would be advantageous—the object being to set them alight and thus facilitate subsequent night operations—you will no doubt undertake it.)

11. The principal weight of attack should be directed against the oil-plants; the attack of marshalling-yards being confined to harassing action (vide A.M. letter dated 19/2/40).¹ In the event of it being impossible to identify the oil plants, or to attack them with sufficient accuracy, any self-illuminating or identifiable targets, such as coke-ovens, may be selected. Some possible targets in this category are listed in Annex A.

12. You should be prepared to undertake this operation as a sustained effort although you will appreciate that, as operations develop, it may be necessary either to divert certain squadrons to deal with closer objectives west of the Rhine or to extend the operations to embrace other night objectives as in Plan W.A.8.

13. Long-delay-action bombs may be used in either of these operations. (Vide A.M. letter dated 12th April, 1940.)¹

(Sgd.) J. C. SLESSOR

¹ Not printed.

[A postscript was added in manuscript:]

It should be understood that neither of these operations will be initiated without executive order from the Air Ministry.

(Initialed) J. C. S.

(ii)

30th May 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal A. S. Barratt, Air Officer Commanding-in-Chief, British Air Forces in France, repeated to Air Marshal C. F. A. Portal

Sir,

I am directed to inform you that the Chief of the Air Staff has reviewed the policy for the employment of the Bomber Force in the present situation.

2. As you are aware, both the medium and heavy bomber squadrons have been employed at maximum intensity for the past week and it is imperative that some reduction in their effort should be made in order that the force can be maintained at its present operational strength and efficiency.

3. As regards the medium squadrons of No. 2 Group, I am to say that they will continue for the present to be employed primarily in support of the land operations. It has been decided, however, that in view of their recent intensive operations and the high rate of wastage incurred, the Group must now operate for a period on a reduced scale of effort while the squadrons refit and assimilate and train their new crews. I am therefore to request that you will explain to the French High Command that the Blenheim Squadrons will only be capable of a limited effort in the immediate future, concerting closely with the A.O.C.-in-C. Bomber Command to ensure that their operations are conducted in the most economical manner possible.

4. As regards the heavy bomber force, not only the need for conserving their effort but the passing of the current moon phase has made it necessary to review the general policy for their employment. In the absence of moonlight, experience proves that the heavy bombers cannot operate with sufficient accuracy against road objectives and defiles in the forward area to make an effective contribution to the land situation by this means. Moreover, the more important road defiles, such as the crossings of the Meuse, are now so heavily defended with searchlights as to make precision bombing impossible.

5. On the other hand, it is thought that attacks on railway objectives, moving trains and marshalling yards, will continue to be effective particularly on clear nights, and it is felt that these operations now form the most important contribution the striking force can make against the enemy's lines of communications.

6. I am accordingly to say that it has been decided to continue to employ a proportion of the available effort on these operations and you should forward any requirements of the French High Command in this connection to the A.O.C.-in-C., Bomber Command as heretofore.

7. It is proposed that the remaining effort available at sustained rates should now be transferred to the industrial districts of Germany on a modified form of Plan W.A.8. The primary object of the operations will be to cause the continuous interruption and dislocation of industry, particularly in those areas within range where the German aircraft industry is concentrated—namely, the Hamburg–Bremen, Ruhr and Frankfurt areas. The actual objectives for attack will be at the discretion of the A.O.C.-in-C., Bomber Command, and will depend largely on their being self-illuminating or otherwise identifiable through their being alongside water or other geographical features.

8. I am to request that you will explain the foregoing policy to the French High Command. It is, of course, understood that in the event of a further critical situation arising in the land battle the whole available effort of the air striking force would again be placed in your support.

(Sgd.) W. S. DOUGLAS

(iii)

4th June 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal C. F. A. Portal

Sir,

I am directed to inform you of the policy which it has been decided should govern the operations of your Command during the coming phase of the war.

2. You will realise that in present circumstances when the initiative rests with the enemy, our strategical policy is liable to be deflected by the turn of events from the course we should like it to follow. There seems little doubt that the next development of German strategy will be a further offensive against France, whose army and air forces have been gravely weakened by the reverses of the past three weeks.

3. The French Government and High Command have appealed in the strongest terms for the greatest possible degree of British air support in the coming battle. It is not at present possible to give them further fighter support. As far as bombers are concerned, however, it is the policy of H.M. Government that, while all possible pressure on objectives in Germany should be continued up to the opening of the next phase of the land battle, once that battle is joined it will be necessary to give priority to operations in support of the French land forces. Any squadrons not employed in this way should continue to attack objectives in Germany.

4. At the same time, every effort will be made to avoid uneconomical and ineffective use of your Command merely with the object of affording moral support to the French. You will no doubt agree that the strenuous

and gallant efforts of your squadrons against objectives in collaboration with the land battle since the 10th May have not always had results commensurate with the effort exerted. We shall, therefore, do everything possible to persuade the French that their cause can best be served by the proper employment of your Command against really suitable and profitable objectives, even if those objectives are not in the immediate zone of the land battle.

5. Subject to the above you should regard your primary aim as being to complete the offensive against German oil resources on Plan W.A.6, but you should be prepared at short notice to divert at least a high proportion of your effort to collaboration in the defensive battle on land. Some slight modification in Plan W.A.6 may be desirable, since recent investigation has led to the conclusion that, if the immediate oil resources available to Germany can be reduced within the next two or three months by from 300,000 to 500,000 tons, the enemy's position in August of this year should become extremely critical. This points to the desirability for the destruction of above-ground stocks of oil wherever they can be found and, in general, to some adjustment of the plan to a rather shorter term basis than that on which it is now framed. Further details on this head will be communicated to you very shortly.

6. Recent developments, moreover, have made it necessary in general to take a shorter term view than formerly, and for this reason also it is desirable, as far as is possible consistent with your primary aim, to dislocate the German aircraft industry by attacks on such bomber and fighter assembly factories as may be within your range. You should, therefore, allot these factories as alternative objectives and, by suitable routing of raids and occasional attack, should endeavour to cause continuous interruption and dislocation to the German aircraft industry.

7. It is realised that it is extremely difficult to identify and attack the oil objectives in the absence of adequate moon conditions. During the remaining dark nights, therefore, you should continue as at present to bring about continuous interruption and dislocation of German war industry, particularly in those areas within range where the aircraft industry is concentrated, namely, the Hamburg, Bremen, Ruhr and Frankfurt areas. The oil targets should be selected as first objectives, alternative objects being aircraft factories, and after that any self-illuminating targets or targets which are otherwise identifiable.

8. In this connection your attention is directed to the principles laid down in paragraph 3 of the new Bombardment Instructions, attached as Appendix 'A'.¹ In no circumstances should night bombing be allowed to degenerate into mere indiscriminate action, which is contrary to the policy of His Majesty's Government.

9. The employment of the medium bombers in this connection is dealt with in paragraph 14 below.

10. Since operations in the absence of moon cannot be expected to be as effective as in moonlight conditions, you should, as far as possible, conserve the energies of your Command during the dark period, so that you

¹ Not printed.

may be able to exert the maximum possible effort when the moon conditions return.

11. Should there be a period of comparative inactivity before the resumption of the enemy offensive on land you should therefore confine operations against enemy land forces in France to the minimum, and should only employ your squadrons in this way when really favourable objectives are revealed by reconnaissance. A.O.C.-in-C., B.A.F.F., is being instructed accordingly.

12. If and when, however, the enemy renews his assault upon the French Army, objectives of this nature must have priority, and their selection will continue to be made by the A.O.C.-in-C., B.A.F.F., in consultation with the French High Command. Air Marshal Barratt is, however, being requested to impress upon the French Command that attacks on columns of troops and transport, or on the movement of supplies by road, is not an effective or economical method of employing heavy bombers at night. Attack on rail movement and the dislocation of supply by the bombing of selected points in the enemy's railway system, such as marshalling yards, is probably the most effective contribution that can be made to the dislocation of the enemy's effort on land. You will, however, be aware that by far the most formidable threat to the French Army is constituted by the German heavy armoured divisions. If really reliable information can be obtained from reconnaissance of the location of these divisions, and in particular of their petrol and supply echelons or of areas where they may be lying up at night for rest and maintenance, a heavy attack at night may have really useful results, provided the area concerned is one that can be located and accurately identified at night.

13. The employment of medium bomber squadrons by day against troop movements again is liable to involve losses quite incommensurate with the results achieved unless the objectives are selected with great care and the attack can be carried out within a reasonably short time of the information being received by reconnaissance. On the other hand, recent experience has shown that if medium bombers can be brought into action quickly against clearly defined objectives, and can be afforded adequate fighter support, their action in a critical situation may have very valuable results. Even during the earlier stages of the invasion there were several occasions on which delay was imposed on the enemy which proved of great value to the army, though in the absence of adequate fighter support it could only be effected at an almost prohibitive rate of loss. In the more recent operations in the Dunkirk area, however, very useful results were obtained and relatively little loss incurred, since some fighter support was available and the German fighters were largely employed on the protection of their own bombers.

14. Medium bombers should be able to afford a further important contribution to the land battle by drawing off enemy fighters from the battle zone. You are authorised to employ your Blenheim squadrons by day to attack any objectives that you may select, within the bounds of the Bombardment Instructions, with the exception that, for the present naval dock yards and vessels under construction are not to be attacked. You will no doubt select as your first objectives those whose destruction will con-

tribute most directly to your primary aim as set out in paragraph 5 above. You may, however, at your discretion, allot alternative targets of any nature covered by the Bombardment Instructions (with the exception noted above), whether in Germany or in occupied territory, having due regard in the latter to the need for avoiding, as far as possible, undue risk to the lives of French, Dutch or Belgian civilians.

15. Instructions regarding action against objectives in Italy in the event of that country entering the war against us are being issued separately. It is realised that this project will involve a substantial diversion of the effort of the Wellington Group. It is, however, a diversion that may well have results of the highest importance in itself as well as containing enemy air forces that would otherwise be free to operate against us in the Mediterranean area.

16. You should bear in mind throughout that the Bomber force, and particularly the medium bombers, may have to play a most important part in repelling an invasion of this country.

(Sgd.) W. S. DOUGLAS

(iv)

20th June 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal C. F. A. Portal

Sir,

I am directed to confirm the conclusions reached at the conference with the Chief of the Air Staff yesterday, 19th June, 1940, and to say that, in the present situation, it has been decided that the primary offensive of the Air Striking Force must be directed towards those objectives which will have the most immediate effect on reducing the scale of air attack on this country.

2. I am accordingly to request that you will direct your operations on the following lines.

Aircraft Industry

3. In order to gain the most immediate effect on the output of aircraft from the German aircraft industry, the objectives listed in List I of Appendix 'A'¹ to this letter should be attacked as your first priority targets. Supplementary to these objectives, you should also direct attacks on to the equipment depots given in List II of Appendix 'A', subject to it being ascertained by reconnaissance that these depots are in operation.

Communications

4. Information continues to show that the Germans are experiencing great difficulty in maintaining supplies in the forward occupied areas. It is considered that a portion of your effort should therefore continue to be

¹ Not printed.

directed on to objectives in the German system of railway and canal communications.

5. As regards the railways the principal focus of attacks should be on the marshalling yards in the Ruhr and Cologne areas, (in particular the main marshalling yard at Hamm), with the derailling of trains on the main railway routes westwards as subsidiary tasks.

6. You have already been given a directif (Air Ministry letter dated 8th June 1940)¹ to destroy the aqueducts carrying the Dortmund–Ems Canal over the River Ems near Munster. In addition you should attack the shaft lock at Minden (Target M.39) and the aqueduct at Minden (Target M.53). Once the destruction of these targets has been achieved, it should not be necessary to direct further attacks against the canal system at the present time. You should be prepared, however, to undertake ‘W’ mining in the Dortmund–Ems and Mittelland Canals if it has been found impossible to destroy these targets.

‘G’ Reconnaissance

7. You should continue to employ one squadron of Hampdens on ‘gardening’ in accordance with the instructions contained in Air Ministry signal dated 3rd June, 1940.²

Oil

8. Subject to these primary tasks, you should continue to attack oil plants and stocks in Western Germany and in German occupied territory as opportunity offers. As stocks of oil available to Germany decrease the problems of distribution will cause increasing difficulty in the deployment and operation of the German armed forces. It is particularly important, therefore, that all major stocks of oil in the newly occupied territories should be destroyed before they can be utilised to support the military and civil administrations in those areas.

9. As regards the oil objectives in Germany, the priority list of targets remains as in List I, Plan W.A.6, as re-issued on 16th June, 1940.³ Information on the more important stocks of oil in the recently occupied territories will be passed to your headquarters from time to time. Two of the most important, at Nyborg and Fredericia in Denmark, have been included as targets numbers 32 and 43 in the revised list of oil objectives in Plan W.A.6 referred to above.

Destruction of Crops and Forests

10. It is now known that the harvest prospects in Europe are very poor and may be as much as 25% below normal. Coupled with the conditions in France and the Low Countries resulting from the recent operations, it seems probable that a very serious shortage of food may be felt in Europe this winter. The time to attack crops in Germany is within the next two or three weeks, and the new ‘pellet’ incendiary will be available in quantity

¹ Not printed.

² *Authors’ note:* This referred to the laying of mines in German coastal waters.

³ Not printed.

early in July. You should be prepared to distribute these 'pellets' over selected areas in Germany immediately after the current moon phase and a separate directif, forwarding a map of the suggested areas, will be sent to you in the immediate future.

11. As you are aware, there are extensive areas of coniferous forests in Germany which are believed to be extremely vulnerable to incendiary attacks at this time of the year. Some of these areas are in the vicinity of important military objectives and aerodromes, where a forest fire might have valuable results in dislocating German military and industrial activities apart from the moral effect. A separate note and map of the suggested areas will be sent to you in the course of the next few days in order that you may examine the possibility of undertaking incendiary attacks during the dark period.

Employment of the Medium Bombers

12. The employment of the medium bombers should be co-ordinated with these main operations. As an additional task, they are to be employed—when favourable opportunities offer and reliable information is available,—in the attack of enemy occupied aerodromes in the north-west of France and in the Low Countries on the lines indicated in Air Ministry signal dated 9th June, 1940.¹

13. It is desired that you should continuously reconnoitre these forward areas with the object of identifying those aerodromes at which German air forces are concentrated and, in conjunction with the Air Officer Commanding-in-Chief, Fighter Command, keep them under a harassing scale of attack, with the objects both of destroying as many enemy aircraft as possible, and of forcing them to withdraw to aerodromes further in the rear and thus reducing their effective operational effort against this country.

14. In connection with these operations, now that no further information from France will be forthcoming, it is recognised that you will have to rely increasingly on your own reconnaissance for the proper fulfilment of these tasks. The possibility is accordingly being examined of allocating to your Command one of the strategical reconnaissance squadrons which formed part of the Air Component. You will be informed as soon as a decision on this matter has been taken.

15. Finally, as notified to you in the last paragraph of Air Ministry letter numbered as above, dated 4th June, 1940, you should be prepared at short notice to divert the bomber force, and particularly the medium bombers, to the attack of an invading enemy force at the ports of departure and subsequently at sea or at the points of landing in this country.

(Sgd.) W. S. DOUGLAS

¹ *Authors' note:* Not printed. This referred to the destruction of German aircraft especially on the ground.

(v)

4th July 1940. Air Vice-Marshal W. S. Douglas (*Deputy Chief of the Air Staff*) to Air Marshal C. F. A. Portal

Sir,

I am directed to refer to Air Ministry letters of 20th and 29th¹ June 1940, and to the conversation today between yourself and the Deputy Chief of the Air Staff, and to say that a review of our bombing policy in the present situation has been made, as a result of which I am to request that you will direct your operations in the immediate future in accordance with the following revised directive.

Attack on enemy ports and shipping

2. It is now considered desirable as a first priority to intensify our attacks on enemy ports and shipping against the threat of invasion. Your offensive should include the following objectives:

- (i) Shipping in the port of Kiel including a further attack on the Scharnhorst; an attack on the Deutschland or other capital ships at Kiel; and attacks on special shipping and landing craft reported concentrated in the port. A separate report on these concentrations, with photographs, is being forwarded to your Headquarters today.
- (ii) Docks at Hamburg, including 'Bismarck' as one of the objectives.
- (iii) Docks at Bremen.
- (iv) Rotterdam and other ports in Holland at which concentrations of shipping and barges are reported.
- (v) Naval bases at Wilhelmshaven and Brunsbuttel.

'G' Reconnaissance

3. A larger effort of No. 5 Group should now be concentrated on 'gardening', the effort of at least three squadrons being employed. Attacks should be directed in particular against the Kiel Canal, Kiel Bay and the Belts. (It is particularly desired that a large number of mines should be laid in the Kiel Canal.) The programme should be co-ordinated with the A.O.C.-in-C. Coastal Command.

Aircraft Industry and Aerodromes

4. Your offensive against objectives in the aircraft industry and aerodromes should be continued in accordance with para. 3 of Appendix A¹ of Air Ministry letter dated 20th June 1940.

Oil

5. Subject to these primary tasks, you should continue to attack oil plants and stocks in Western Germany and in German-occupied territory as opportunity offers, in accordance with paras. 8 and 9 of Air Ministry letter dated 20th June 1940.

¹ Not printed.

6. In the present situation attacks on railway and canal communications in Germany and on forests, as laid down in paras. 4, 5 and 11 of Air Ministry letter dated 20th June 1940 should be discontinued. You should however proceed with your arrangements for the attack of crops with the new incendiary 'pellet' in accordance with para. 10 of Air Ministry letter dated 20th June 1940 and subsequent verbal decisions agreed with the Air Staff.

Employment of the medium bombers

7. The first priority tasks of the medium bombers should now be the attack of barges and small craft on the canals and ports in Holland and Belgium. In addition, attacks on concentrations of shipping reported in Norwegian ports should be undertaken as opportunity offers. These operations should be co-ordinated with the Air Officer Commanding-in-Chief, Coastal Command.

8. In second priority the medium bombers should be employed in co-ordination with the main operations against objectives in Germany and German-occupied territory, particularly against the aircraft industry and oil refineries and stocks.

9. Attacks should also be directed against concentrations of aircraft on aerodromes in north-west France and Belgium, in conjunction with the Air Officer Commanding-in-Chief, Fighter Command, as and when these are reported by reconnaissance or other intelligence sources.

10. The photographic reconnaissance ordered in Air Ministry signal of 26th June 1940¹ should be discontinued.

11. The instructions contained in paragraph 15 of Air Ministry letter dated 20th June 1940 continue to apply, and should be borne in mind.

(Sgd.) W. S. DOUGLAS

(vi)

13th July 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal Sir Charles Portal

Sir,

I am directed to inform you that the Air Staff has considered the bombing policy for the coming moon-phase and, in general, has decided that your main offensive should be directed towards objectives the destruction of which will reduce the scale of air attack on this country, and that your only diversion should be a comparatively small effort against communications.

2. In the course of their review, the Air Staff came to the conclusion that attacks on industrial objectives have hitherto been too dispersed and that, in consequence, few objectives have sustained sufficient damage to put them out of action for any length of time. During this moon phase

¹ Not printed.

therefore, you are requested to direct a greater weight of attack on fewer targets with a view to complete destruction rather than harassing effect.

3. I am therefore to request that you will direct your operations in the immediate future in accordance with the following revised directive, which you will observe includes a total of only 15 primary targets.

Aircraft Industry

4. To gain the most immediate effect on the output of aircraft, the five aircraft depots and the five airframe assembly factories in List I of Appendix 'A'¹ to this letter should be destroyed. In this connection, your attention is drawn to paragraphs 27-31 of Plan W.A.1, in which the conclusion is drawn that 140 five-hundred lb. bombs should be aimed at each factory in order to complete its destruction. While in no way suggesting that this scale should be rigidly adhered to, it is nevertheless an indication of the weight of attack which the Air Staff has in mind.

Oil

5. The reduction of Germany's oil resources will not have an immediate effect on the activity of the G.A.F., but the effect when felt will be permanent. Moreover, as your operations have shown, oil targets are very vulnerable and do not call for as great an expenditure of effort as factories. While the Alumina plants which were included in the Air Staff directives of 20th June and 4th July are probably of equal significance to the aim in view, it is considered that oil plants are more profitable objectives for night attack during the present phase.

6. Your night objectives in the second priority should therefore be the five oil plants in List II of the Appendix.¹

Communications

7. The undamaged aqueduct of the pair north of Munster is the most important target in this category and the Air Staff feels that a determined effort should be made to put it out of action and thus complete the satisfactory results which have already been achieved against this double objective. Apart from this one objective however the weight of attack on communications should be light. They might well be included only as 'last resort' objectives, and it is desired to specify only the following:

The Shaft-Lock	}	at Minden
The Aqueduct		„ „

Mining

8. The effort of three squadrons should continue to be devoted to these operations.

Employment of Medium Bombers

9. The employment of the medium bombers should be co-ordinated with these main operations as far as possible. Their primary role however must be to attack any large concentrations of barges or shipping which are

¹ Not printed.

reported to have been collected for an invasion of this country, and any advance aerodromes which are known to be carrying a sufficiently large concentration of aircraft to make attack worth while. Such effort as can be spared from these primary tasks should be directed against the three oil targets in occupied French territory, enumerated in List III of the Appendix.¹

10. Finally, I am to request that you will be prepared, at short notice, should the occasion arise, to divert the whole of the bomber force to the attack of an invading force at the ports of departure and subsequently at sea or at the points of landing in this country.

(Sgd.) W. S. DOUGLAS

(vii)

24th July 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal Sir Charles Portal

Sir,

I am directed to refer to your Headquarters letter dated 16th July 1940² and to confirm the conclusions reached at the conference on bombing policy with the Vice Chief of the Air Staff on 22nd July, 1940.³ I am to say that, so long as there is no indication of a change in the general strategic situation, it has been decided that the primary offensive of the Air Striking Force should continue to be directed in the main towards reducing the scale of air attack on this country, and that you should accordingly direct your operations on the general lines suggested to you in Air Ministry letter, numbered as above, dated 20th June, 1940, subject to the following considerations.

2. Operations against the G.A.F. and the aircraft industry

In first priority the objectives listed in Appendix 'A' to this letter³ should be attacked whenever suitable conditions permit. In addition, attacks may be directed at your discretion against concentrations of aircraft on enemy-occupied aerodromes as reported by reconnaissance or other sources of information.

3. Operations against oil plants and stocks in Germany and German-occupied territory

Recent reports and information have confirmed that oil is the weakest link in Germany's war economy, and I am to say that the destruction of Germany's oil resources remains the basis of the main offensive strategy directed towards the reduction and dislocation of German war potential.

¹ Not printed.

² *Authors' note:* In this letter Sir Charles Portal had pointed out some of the operational difficulties of 'attempting to adhere at all closely to these latest directions', i.e. those of 13th July.

³ Not printed.

I am to draw your attention to paragraph 8 of the Air Ministry letter quoted above and to say that evidence continues to accumulate which emphasises the importance of destroying oil stocks whenever and wherever a favourable opportunity occurs.

4. For your main offensive, the priority list of objectives remains as in List 1, Plan W.A.6, as re-issued on 16th June, 1940. At Appendix 'B' is an additional list of stocks of oil known to exist in the territories recently occupied by Germany. It is realised that some of these targets are relatively small and may be difficult to locate, but it is thought that they may prove useful objectives for periodical attack as opportunity offers. I am to add that a similar list of targets has been sent to the Air Officer Commanding-in-Chief, Coastal Command, and to request that your operations against these targets may be co-ordinated with his Headquarters.

5. *Communications*

As agreed at the conference with the Vice-Chief of the Air Staff, a moderate scale of effort should continue to be directed against objectives in the system of railway and canal communications in Germany. It is already accepted that these operations may be extended to barge traffic and other shipping in the canal systems in the Low Countries and Northern France. Authority is now being sought to include attacks on railway communications in these territories, and an appreciation on this subject will be forwarded to your Headquarters as soon as this authority has been received.

6. *Mining*

The effort of three squadrons should for the present continue to be employed on these operations.

7. *Destruction of forests*

When suitable weather conditions obtain, attacks may be resumed against forest areas in Germany in accordance with the directives forwarded to your Headquarters in Air Ministry letters dated 24th and 26th June, 1940.¹ Among the areas suggested in the attachments to those letters, it is felt that the Harz Mountains would provide a valuable focus for a concentrated attack both from the material and psychological standpoints.

8. In this connection, I am to say that consideration has been given to the possibility of utilising the existing stocks of incendiary 'pellets' in conjunction with normal bombing operations in order to take advantage of the diversions and alarms which may be caused through these potential sources of fire scattered over a wide area. It is considered that, when the weather is dry, there is a reasonable chance of a number of 'pellets' starting fires on the extensive stretches of heath land and similar ground which is widespread throughout Western Germany, and thus adding to the demoralising and psychological effects of our operations. Authority is being sought for the employment of the 'pellets' in this way and you will be notified immediately this is obtained.

¹ Not printed.

9. *Alternative objectives*

It is appreciated that, although the objectives in Plans W.A.1 and W.A.6 now given to you as the primary targets for your operations are numerous and widespread, it may be necessary for you to have a further list of objectives for use as alternatives when, for any reason, these primary targets cannot be located or identified. An examination is now being made in conjunction with the various Intelligence authorities with a view to drawing up a further list of objectives, geographically distributed west of 11° East, selected primarily for their intrinsic industrial and psychological values. This list will be forwarded to you, with a short appreciation indicating the factors which have been taken into account in their selection, as soon as possible.

10. *Anti-invasion operations*

Finally, I am to say that the instructions contained in paragraph 15 of the Air Ministry letter referred to above, dated 20th June, 1940, continue to apply and should be borne in mind. In this connection, I am to suggest that the shipping located at Hamburg, as reported in the P.R.U. Interpretation Report No. 162, and especially the 'Europa' and 'Bremen', should be considered for attack in the immediate future.

(Sgd.) W. S. DOUGLAS

(viii)

*30th July 1940. Air Commodore J. C. Slessor (Director of Plans)
to Air Marshal Sir Charles Portal*

Sir,

I am directed to refer to Air Ministry letter dated 24th July 1940, and to forward the attached lists A, B and C¹ of alternative objectives which have been compiled as the result of the examination referred to in paragraph 9 of that letter.

2. First in order of intrinsic value, after the objectives included in the current directive, comes Power. At the time Plan W.A.5 was written it was not clearly understood that serious damage to any one power plant would cause a considerable reduction in industrial output. It has now been clearly established that, however efficient the grid system may be, it is normally impossible to make up the full loss of power from other stations and that the destruction of one or more big power stations would therefore be very effective in dislocating local services. It is, accordingly, considered that, if any power stations can be located by night—and reports suggest that the big thermic power stations can be so located—then they are recommended as alternative targets of the first importance. As a consequence of the German capture of the French iron industry, the coking plants in the Ruhr lose somewhat in value and should be placed second in

¹ Not printed.

priority to electric plants. The most important power objectives in Germany are listed by areas in Plan W.A.5, List I. To this list three more plants should now be added as shown in List 'A' attached.¹

3. It is appreciated that on numerous occasions it may be impossible to locate any power objective. Lists B and C have,¹ therefore, been drawn up to supplement List 'A'. They include a number of large targets of considerable intrinsic value in the armament, explosive and chemical groups. The order of the objectives in each list is not necessarily the order of their intrinsic industrial value, because not only is it very difficult to adjudge as between plants in different categories, but also because it is realised that your selection of alternative targets must be related to the situation of your primary targets. The more important objectives in these lists are, however, marked with an asterisk.

All objectives in these lists are west of the line Hamburg–Hanover–Kassel–Stuttgart and are dispersed geographically as widely as possible. Additions will be made as penetration increases with the lengthening nights.

(Sgd.) J. W. BAKER, Group Captain
for Director of Plans

(ix)

*21st September 1940. Air Vice-Marshal W. S. Douglas (Deputy
Chief of the Air Staff) to Air Marshal Sir Charles Portal*

Sir,

I am directed to refer to Air Ministry letter numbered as above, dated 24th July, 1940, and to say that certain features of our bombing policy have recently been reviewed in the light of the future strategical situation and of the latest information available on the effect of our air offensive in Germany.

Anti-Invasion Operation

2. In the immediate future, while the imminent threat of invasion remains, the greater part of the bomber effort must continue to be employed against anti-invasion objectives. It is not possible to give specific details of the targets to be attacked in this connection, as their selection will depend on reconnaissance and other information and must continue to be dealt with daily by telephone or signal as heretofore. It may be stated, however, that the primary aim of your operations will be to destroy the major concentrations of barges, small craft and merchant vessels at the enemy ports with the secondary object of so harassing the facilities and communications within and adjoining the ports as to dislocate the enemy's means of mounting and despatching the expeditions.

3. It is possible that, with a continuance of the present unfavourable

¹ Not printed.

weather, the existing imminent risk of invasion may shortly recede. Moreover, even in present circumstances, it is considered desirable that a proportion of your effort should continue to be employed against objectives in Germany. As an indication of what is intended, I am to suggest that the Whitley Group might be reserved for the attacks on Germany, the remainder of your force being employed on the anti-invasion offensive until the situation clarifies and it is possible to transfer additional effort on to the major plans. It has accordingly been decided to send you this revised directive now so that advantage can be taken to attack the selected objectives as opportunities occur.

Operations against the German Aircraft Industry

4. During the past three months, our offensive against the German aircraft industry has been designed to cause the most immediate reduction in the scale of effort of the German Air Force against this country. Now that the enemy's invasion preparations are believed to be completed and our principal offensive is being directed against his concentrations of shipping and ports, it is felt that our attacks on the aircraft industry in Germany can no longer have any immediate effect on the present situation. The objectives given in Appendix 'A' ¹ to the above-quoted Air Ministry letter have accordingly been reviewed in order to decide what may be the best method of most directly affecting the German aircraft industry on a rather longer term policy which might have its effect on the German Air Force during the coming winter and early months of 1941.

5. In the light of the information available on the success so far achieved, it is considered that our attacks on the German aluminium plants have already resulted in a shortage of these products in Germany and, if continued, are likely seriously to affect the aircraft industry as a whole in the near future.

6. In conjunction with our offensive against these objectives, it is now considered that the more economical and effective way in which to dislocate and curtail the German production programme is by attacking certain of the key component factories the destruction of which will affect both the airframe and engine industries and will have a delayed but more lasting effect on the output of aircraft to the German Air Force.

7. The objectives selected for attack have accordingly been listed in Appendix 'A' ¹ to this letter and this should be substituted for that forwarded with Air Ministry letter numbered as above, dated 24th July, 1940.

Operations against the Enemy Submarine Industry

8. I am to inform you that the enemy submarine campaign in the north-western approaches has now assumed such serious proportions that, in addition to strengthening our attack on the operational submarines, it has become necessary to adopt a longer term policy against this menace. By agreement with the Admiralty it has been decided to abandon for the time being the mining operations referred to in paragraph 6 of Air Ministry letter numbered as above, dated 24th July, 1940, and to divert the effort

¹ Not printed.

of the three squadrons engaged to the enemy submarine organisation ashore. The objectives contained in Appendix 'B' to Plan W.A.7(c) have been reviewed, in consultation with the Naval Staff and it has been agreed that attack on the submarine building yards still offers the best chance of success in this offensive. In List I of Appendix 'B' ¹ to this letter are set out, in order of priority, those yards which are believed to be actively engaged in building, and I am to request that you will concentrate your offensive in this connection primarily on these targets.

9. In List II of Appendix 'B' are certain alternative targets. Two of these are additional yards which the Naval Staff are of opinion may also be engaged in submarine building. The third is the only factory known to be employed on producing batteries for submarines, and the fourth is the principal establishment for training submarine crews. The Naval Staff have requested that these objectives may also be attacked when suitable opportunities occur.

Communications

10. Evidence continues to accumulate that our sustained attacks against the enemy's railway and canal communications is having the anticipated effect of dislocating the enemy's supply systems both in the industrial and strategical spheres. As the shortage of material increases and distribution in the quantities required over the extensive areas now under Germany's control becomes more difficult, there is little doubt that this is one of the most important contributions that our bombing can make to Germany's economic disruption. The list of marshalling yards on the enemy railway systems in Germany have recently been reviewed and collated, so as to include those affecting supplies both to the Low Countries and Northern France and to Italy. A list of the objectives recommended for attack is attached as List I in Appendix 'C' ¹ to this letter and I am to suggest that, in addition to directing a moderate scale of efforts against the more important of these marshalling yards, it might be possible to regard these objectives as last-resort targets in Germany in preference to aerodromes. It is probable that, if winter conditions such as obtained last year recur, the effect of the cumulative dislocation on the enemy railway system may have very far reaching results. In this connection, it is hoped also that it will soon be possible to extend the night operations of the more experienced Blenheim crews against these communication objectives when suitable conditions prevail.

Operations against Germany's Oil Resources

11. This directive does not in any way affect the view that the destruction of Germany's oil resources should remain the basis of our longer term offensive strategy directed towards the disruption and dislocation of the German war potential. The objectives in List I to Plan W.A.6, as reissued on 16th June, 1940, should continue to be regarded as the basis for our offensive against Germany's oil resources, subject to such modifications as

¹ Not printed.

have been and will be made from time to time in the light of information on the destruction caused and the success achieved by our attacks.

Operations against Berlin

12. Although there are no objectives in the Berlin area of importance to our major plans, it is the intention that attacks on the city and its environs should be continued from time to time when favourable weather conditions permit. The primary aim of these attacks will be to cause the greatest possible disturbance and dislocation both to the industrial activities and to the civil population generally in the area. After a close analysis of the objectives available and of the results achieved by the German attacks on London it is considered that not only the quickest but most lasting and effective means of dislocating the life of the community would be by the attack of sources of power serving the city. Electricity and gas plants are accordingly selected as the primary targets for attack, and have been listed in Appendix 'D' ¹ to this letter. It will be noted that one special target has been included with this list—namely the factory at Hennigsdorf at which electric cables and similar equipment are manufactured and the successful destruction of which would cause still further dislocation in the electrical services resulting from the attacks on the primary power targets.

(Sgd.) W. S. DOUGLAS

(x)

30th September 1940. Air Ministry to Bomber Command

Reference Air Ministry letter of 21/9 paragraphs 2 and 3.² Although enemy concentrations of shipping in Channel ports remain, it is considered that imminence of invasion in present weather conditions has somewhat receded.

In these circumstances authority now given (particularly when weather conditions are unsuitable for invasion) to transfer increased effort of heavy bombers additional to Whitleys on to objectives in Germany in accordance with directions in above quoted letter. As regards invasion ports, Havre, Antwerp and Rotterdam considered most important ports for attack by heavies when conditions suit. Lorient for anti-submarine offensive to include power station if identifiable and Tirpitz now in floating dock at Wilhelmshaven also requested by Admiralty for attack when opportunity offers.

Request you continue be prepared transfer whole effort anti-invasion targets at short notice.

¹ Not printed.

² See p. 124.

(xi)

30th October 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse

Sir,

I am directed to inform you that, with the approach of winter and the likelihood that major operations in the European theatre will be confined to the air offensive which can be developed by our own and the enemy air forces, it is considered that our bombing policy should once again be reviewed with the particular aim of examining the extent to which we can achieve a more decisive effect, both in the material and moral spheres by a greater concentration of our offensive air attacks.

2. In recent weeks, under the imminent threat of invasion and of the German Air Force, disposed along the whole length of the seaboard opposite our coasts, our attacks have inevitably been employed primarily against those objectives designed to counter the threat of invasion and to reduce the scale of air attack against this country. The result has been a widespread dispersion of our effort in which small progress has been made with the destruction of targets in our main Oil Plan and our attacks have not been sufficiently concentrated to achieve that psychological effect which can only derive from very heavy material damage through closely concentrated attacks.

3. Now that it seems likely that the enemy has, at least temporarily, abandoned the intention to invade this country, the time seems particularly opportune to make a definite attempt with our offensive to affect the morale of the German people when they can no longer expect an early victory and are faced with the near approach of winter and the certainty of a long war.

It has accordingly been decided to make a temporary change in our policy and to concentrate our effort on two principal objects.

- (a) First, I am to request that you will regard the objectives in the Oil Plan as your primary targets for attack when favourable conditions obtain, particularly during the eight to ten days of moonlight when it can be expected that opportunities for the precise bombing and destruction of these targets will most frequently occur. When for any reason you do not consider that profitable attacks can be made against oil targets under the above conditions, your next choice of primary objectives should be made from the aluminium plants and component factories as listed in their order of priority in Appendix 'A'¹ to Air Ministry letter, numbered as above, dated 21st September, 1940. Failing suitable objectives from this list you should detail targets from the lists given in order of priority in appendices¹ forwarded with Air Ministry letter dated 30th July, 1940.

¹ Not printed.

- (b) Secondly, I am to suggest that, if bombing is to have its full moral effect it must on occasions produce heavy material destruction. Widespread light attacks, if there are never any heavy attacks, are more likely to produce contempt for bombing than fear of it. I am, therefore, to say that, as an alternative to the attacks designed for material destruction against our primary objectives, it is desired that regular concentrated attacks should be made on objectives in large towns and centres of industry, with the primary aim of causing very heavy material destruction which will demonstrate to the enemy the power and severity of air bombardment and the hardship and dislocation which will result from it.

4. It is appreciated that, in the prevailing weather conditions and with the limited bomber force at your disposal, it may not be possible to undertake these latter attacks with any very great frequency. I am accordingly to say that your first aim should be to continue your attacks on Berlin whenever the weather conditions make it probable that the aircraft will get through. When such deep penetration is not possible, I am to request that you will undertake similar attacks on towns in central and western Germany with such regularity as you may find practicable. The broad lines on which it is suggested this policy might be put into effect are as follows:

- (i) The towns should be selected having regard to their size, distribution and the importance of the objectives they contain.
- (ii) As many heavy bombers as possible should be detailed for the attack, carrying high explosive, incendiary and delay-action bombs with perhaps an occasional mine. The aim of the first sorties should be to cause fires, either on or in the vicinity of the targets so that they should carry a high proportion of incendiary bombs. Successive sorties should then focus their attacks to a large extent on the fires with a view to preventing the fire fighting services from dealing with them and giving the fires every opportunity to spread.
- (iii) The objectives considered most suitable for these concentrated attacks are the sources of power, such as electricity generating stations and gas plants, and centres of communication; but where primary targets such as the oil and aircraft industry objectives are suitably placed in the centres of the towns or populated districts, they also might be selected.

5. In the intervening periods between these heavy attacks your effort should be continued against the primary objectives given, but should be spread over the widest possible area so as to take advantage of the fear induced by the concentrated attacks to impose A.R.P. measures with the resulting interruption of work and rest and the dislocation of industry.

Operations against Italy

6. In addition to these primary tasks for your offensive against Germany, I am to request that your offensive against objectives in Northern Italy may be continued whenever favourable conditions occur, in accordance with Air Ministry signal of 6th October, 1940.¹

¹ Not printed.

Operations against Marshalling yards

7. In connection with these primary plans, I am to say that it is desired to avoid, as far as possible, the diversion of our main bomber effort to subsidiary tasks, but it is still considered that a small effort can profitably be continued against the marshalling yards in Western Germany, as listed in Appendix 'C'¹ to Air Ministry letter numbered as above, dated 21st September, 1940.

Mining

8. The Admiralty is being approached with a view to obtaining their agreement to a reduction in the effort to be employed on mining during the phase in which it is desired to concentrate on these offensive plans. Until agreement is reached, however, it will be necessary to continue to employ the effort of three heavy squadrons on mining and, occasionally on the attack of submarine ship-building yards, in accordance with Air Ministry signal of 29th September, 1940.¹ In connection with the latter operations, I am to suggest that it would be of interest to try out the effect of the 'T.I.M.' mine against the yards. It is felt that this weapon might be particularly suitable for such operations because extensive damage might result if the mine exploded amongst the building slips, cranes, etc., on the quays, while if it fell into the water the tamped effect of the under-water explosion might damage the submarines or other shipping alongside.

Operations against Invasion Ports and Enemy Night Bomber Aerodromes

9. It is understood that it is desirable, from the training standpoint, for you to have authority to attack targets in the Low Countries and Northern France, against which crews can be sent to gain experience before penetrating deeper into Germany. In this connection I am to say that, although the likelihood of an enemy invasion has now considerably receded, it will be necessary to continue a moderate scale of attack against the enemy ports in occupied territory, so long as shipping concentrations remain and signs of preparations are still evident. The ports against which you should direct your principal attacks will be suggested to you by signal in the light of the situation prevailing and the information available from time to time. At the present time the ports of Rotterdam, Antwerp, Boulogne, Havre and Lorient are considered the most important, the last-named in connection with the anti-submarine offensive. I am to request that you will co-ordinate your attacks on these ports with the Air Officer Commanding-in-Chief, Coastal Command.

10. Finally, I am to request that until the air defences of this country begin to have more success against night bombers, a limited effort may be expended against the enemy night bomber aerodromes in Northern France at which our wireless interceptions or other information indicates that regular activity takes place. It seems probable that, with the approach of winter, the enemy bombers will be increasingly restricted to the larger and better quality aerodromes where runways have been constructed and blind landing facilities have been provided. This should not only result in

¹ Not printed.

greater congestion with the likelihood of occasional concentrations of aircraft being found but also in limiting the number of aerodromes which can be profitably attacked and so reducing the effort entailed.

11. It is suggested in the light of past experience that the most likely way of affecting the enemy night operations would be by carrying out some form of 'security patrol' over these aerodromes, particularly those to which the enemy bombers are returning, where lights to facilitate landing are most likely to be exposed. I am, therefore, to request that you will undertake these operations in accordance with such information as is received of the enemy's activities from time to time.

(Sgd.) W. S. DOUGLAS

(xii)

10th November 1940. Air Vice-Marshal W. S. Douglas (Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse

Sir,

I am directed to refer to Air Ministry letter of 30th October, 1940, and to say that, in order to avoid possible confusion or misunderstanding, it is considered necessary to clarify the references to primary targets in paragraph 3(a) of this letter.

2. I am to say that, during the phase covered by this directive when it is hoped to concentrate our air offensive more effectively on objectives in Germany, your only primary targets in the strict sense of the term should be those in the Oil Plan. All other objectives should be regarded as secondary and, as stated in the directive, should only be selected for attack when, for tactical or geographical reasons, you do not consider it is either possible or profitable to select objectives in the Oil Plan. Among these secondary objectives, priority should be given in making your choice to those targets in the aircraft industry as listed in Appendix 'A'¹ to Air Ministry letter numbered as above dated 21st September, 1940.

3. With regard to paragraph 8 of the directive, the Admiralty have now agreed that the effort to be employed on mining during this phase should be reduced to that of one squadron. This decision does not, of course, preclude you occasionally using a greater number of sorties on mining than is represented by this effort when you consider this desirable for training or making effective use of inexperienced crews.

(Sgd.) W. S. DOUGLAS

¹ Not printed.

(xiii)

*15th January 1941. Air Chief Marshal Sir Wilfrid Freeman
(Vice-Chief of the Air Staff) to Air Marshal Sir Richard Peirse*

Sir,

I am directed to inform you that the latest reports¹ and analysis on Germany's oil position reveals that the Axis Powers will be passing through their most critical period as regards their oil resources during the next six months. The main points brought out in the reports may be summarised as follows:

- (i) On the assumption that our present scale of air attack on the enemy's oil plants is maintained, their oil position may be causing them grave anxiety by the Spring of 1941.
- (ii) Unless our scale of attack is increased, the enemy's oil position will gradually improve after the end of March 1941 when the interruptions to the transportation systems due to the winter weather are reduced and Germany's planned re-organisation of the Roumanian supplies begins to take effect.
- (iii) If all possible measures to increase our scale of attack on the Axis oil resources are taken between now and the early summer of 1941 it may be possible to place the enemy in a most critical position.
- (iv) Although the stoppage of Roumanian supplies would be the biggest single blow to the Axis oil position, the destruction of the German synthetic oil plants alone would bring about a crisis.

2. A brief analysis of the statistics from which these conclusions are drawn is attached as Appendix 'A'² to this letter and it has now been accepted that the destruction of Germany's synthetic oil plants will reduce the enemy to such a shortage of oil within the next six months that there will be widespread effects on German industry and communications, while it is even probable that within this time an appreciable effect may be felt in the scale of effort of her armed forces.

3. In these circumstances, it has been decided that the sole primary aim of your bomber offensive, until further orders, should be the destruction of the German synthetic oil plants. A list of the objectives is attached as Appendix 'B'² to this letter. It will be seen that the targets are only 17 in number. The complete destruction of the first 9 of these would reduce Germany's internal production of oil by about 80%. It should accordingly be your principal object to ensure the destruction of these 17 plants by concentrating your offensive against them to the greatest possible extent that tactical and weather conditions permit, giving such priority as may be tactically possible to the 9 larger plants.

4. It is recognised that conditions of weather and visibility will limit the

¹ *Authors' note:* For the Chiefs of Staff report of 7th January 1941, see p. 188.

² Not printed.

occasions when it will be profitable to plan attacks against any of the 17 oil objectives. Under these conditions your offensive should be directed towards harassing the enemy's main industrial towns and communications and may include periodically heavy concentrations against the former to maintain the fear of attack. It would be advantageous if the towns selected for heavy attack included those connected with the oil industry—e.g. Magdeburg, Hanover, Bremen and Oppau. It is further recognised that, even in suitable weather, a number of aircraft detailed will be unable to locate their primary objectives. These aircraft should be given as alternative targets either industrial towns or railway communications.

5. Finally, I am to say that the only diversions from your operations outlined above will be:

- (i) invasion ports, when invasion is reported to be imminent,
- (ii) enemy naval forces, when specific instructions for the diversion of your forces to these targets are issued by the Air Ministry for action by you if weather conditions permit.

(Sgd.) W. R. FREEMAN

(xiv)

*9th March 1941. Air Chief Marshal Sir Wilfrid Freeman
(Vice-Chief of the Air Staff) to Air Marshal Sir Richard Peirse*

Sir,

I am directed to inform you that the Prime Minister has ruled that for the next four months we should devote our energies to defeating the attempt of the enemy to strangle our food supplies and our connection with the United States.

2. In the words of his directive, 'we must take the offensive against the U-Boat and the Focke Wulf wherever we can and whenever we can. The U-Boat at sea must be hunted, the U-Boat in the building yard or in dock must be bombed. The Focke Wulf, and other bombers employed against our shipping, must be attacked in the air and in their nests.'

3. Operations should, therefore, be directed against submarine and long range aircraft activities when circumstances permit, until the menace has been dealt with.

4. I am to say that this does not entirely exclude attacks on the primary objectives, given in the directive issued in A.M. letter dated 15th January 1941, against which you should continue to employ a proportion of your effort.

5. Attached at Appendix 'A' is a list of suggested targets connected with submarines and long range aircraft. Those considered of special importance are underlined in red. Priority of selection should be given to those in Germany which lie in congested areas where the greatest moral effect is likely to result.

6. You will appreciate that once a target has been selected it is

particularly desirable that it should be subjected to a succession of heavy attacks.

7. It is realised that priority in your selection of targets will have to be governed largely by tactical factors, and that targets such as DESSAU and Augsburg will be beyond effective range after the next moon period.

8. You will be informed regarding any special activity in submarine bases in occupied territory. The form of attack, i.e. whether by bombing or mining is left to your discretion.

(Sgd.) W. R. FREEMAN

APPENDIX 'A'

<i>Place</i>	<i>Description</i>	<i>Target No.</i>
KIEL	(i) Germania werft, probably 12 submarines building, also makes submarine engines	GR.3589
	(ii) Deutsche Werke, probably 10 submarines building	GR.3588
	(iii) Havaltdswerke Dockyard, probably 3 submarines building	GR.3594
BREMEN	(i) Deschimag, probably 10 submarines building	GR.3586
	(ii) Focke Wulf Factory (assembly)	GY.4772
VEGESACK	Vulcan werke, probably 8 submarines building	GR.3603
HAMBURG	(i) Blohm & Voss, probably 9 submarines building	GR.3587 and GY.4761
	(ii) Havaltds, probably 7 submarines building	GR.3584
AUGSBURG	Diesel Engine factory	GZ.2833
MANNHEIM	Diesel Engine factory	GR.3665
DESSAU	Ju.88 factory	GY.4670
LORIENT	Submarine bases in occupied territory	
ST. NAZAIRE		
BORDEAUX		
BORDEAUX-MERIGNAC	Focke Wulf aerodrome	Z.202
STAVANGER	Focke Wulf aerodrome	SN.25

(xv)

18th March 1941. Air Vice-Marshal A. T. Harris (Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse

Sir,

I am directed to refer to my letter of even reference dated 9th March 1941, and to say that on further consideration it has been decided to make certain alterations to the list of targets suggested in the appendix.

2. It is proposed to delete the Diesel factory at Augsburg, the Ju.88 factory at Dessau, and the aerodrome at Stavanger. The first two of these, though of high intrinsic importance, both lie at extreme range and it is improbable that more than one effective attack could be delivered against each of them during the April moon period. They are, moreover, difficult targets to find and there is little likelihood of doing appreciable damage to them by isolated attacks. Stavanger, besides being a distant target, is by its nature an uneconomical objective, nor can the presence of Focke Wulf aircraft be guaranteed on any one night.

3. It has been decided to add the following targets:

<i>Place</i>	<i>Target No.</i>	<i>Remarks</i>
(i) KOLN	GR.3672	Submarine battery and accumulator works.
(ii) KOLN	GN.3816	} Diesel engines for submarines.
	GR.3658	
(iii) HAGEN	GR.3683	Most important submarine battery factory.

The above are all in the Ruhr area and well within our reach. Apart from their industrial importance they are likely to be profitable from a psychological point of view.

(iv) STUTTGART	GR.3669	} Diesel engine for submarines.
	GY.4654	
(v) „	GB.3280	Bosch Ignition factory.
(vi) „	GB.3282	do.

4. It will be seen that the introduction of Stuttgart and the retention of Mannheim still leave two targets requiring penetration into Southern Germany. It is thought, however, that apart from their great industrial importance it may be well to include a limited number of targets selected geographically to allow for variations in weather and to impose A.R.P. measures over a wide area. Both are suitable as area objectives and their attack should have high morale value. They should, therefore, be considered while sufficient hours of darkness remain.

5. I am to request that you will amend the Appendix forwarded with the above quoted letter accordingly.

(Sgd.) A. T. HARRIS

(xvi)

9th July 1941. Air Vice-Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse

Sir,

I am directed to inform you that a comprehensive review of the enemy's present political, economic and military situation discloses that the

weakest points in his armour lie in the morale of the civil population and in his inland transportation system. The wide extension of his military activities is placing an ever-increasing strain on the German transportation system, and there are many signs that our recent attacks on industrial towns are having great effect on the morale of the civil population.

2. Subject, therefore, to para. 7 below, I am to request that you will direct the main effort of the bomber force, until further instructions, towards dislocating the German transportation system and to destroying the morale of the civil population as a whole and of the industrial workers in particular.

3. The principal targets selected to achieve this aim are described in detail in Appendix 'A', which is in effect a suggested outline of the method by which the plan should be executed. In choosing these targets the vital nature of the Ruhr-Rhineland industries, upon which in the main the whole of the German economic and military machine depends, has been borne in mind.

Railway Targets

4. The great bulk of heavy traffic on the Ruhr-Rhineland railway system passes through nine main railway centres. Serious dislocation of these centres resulting from continuous air attack would virtually isolate the Ruhr-Rhineland from the rest of Germany, from enemy occupied territories and from the present theatres of enemy operations. Weather conditions may frequently prevent the attack of these nine targets; for this reason a number of railway centres further afield but directly related to them have been included in the list of objectives (see Appendix 'A'). Should it be found that for reasons of weather and tactics a wider range of objectives is necessary to make the general plan effective, you will have at your disposal the services of Mr. R. R.¹ Brant of the Railway Research Service to advise you on the selection of additional targets.

5. Most of the railway centres listed in Appendix 'A' lie in congested industrial areas and near concentrations of workers' dwellings. These objectives are therefore to be considered as suitably located for obtaining incidental effect on the morale of the industrial population. Moreover, the dislocation of the railway system will serve further to disturb the normal life of the community and will consequently have an indirect effect on the morale of the population, even when they are not subject to direct attack.

Inland Waterways and Road Transport

6. Appendix 'A' also includes objectives connected with the inland waterways and road transport system. The direct attack of roads has been ruled out owing to their tactical unsuitability as bombing targets. It has been decided to attempt the destruction of the two principal synthetic rubber plants at Schopau and Huls, in which almost the whole of the enemy rubber industry is concentrated. This will have far reaching effects on road transportation generally.

¹ *Authors' note:* The initials 'R. R.' are changed to 'E. D.' in pencil on the document, the correct initials.

Diversions

7. It is recognised that it will on occasions be necessary to make diversionary attacks on objectives, the destruction of which is of immediate importance in the light of the current situation. In particular, important naval units at Brest and the submarine building yards and bases are to be attacked periodically, especially when this can be done without missing good opportunities of bombing the primary targets, and when special opportunity offers or necessity may require. Other diversionary attacks will be ordered when necessary.

(Sgd.) N. H. BOTTOMLEY

APPENDIX 'A'

OUTLINE PLAN OF ATTACK ON
GERMAN TRANSPORTATION AND MORALE

1. It is accepted as a principle in this plan that the successful attack of a specific target at night can only be undertaken in clear moonlight. It follows therefore, that for approximately $\frac{3}{4}$ of each month it is only possible to obtain satisfactory results by heavy, concentrated and continuous area attacks of large working class and industrial areas in carefully selected towns.

It is further accepted that it is a matter of the greatest difficulty to find selected towns on moonless nights unless they lie on or near water, and failure to deliver the maximum weight of attack results in dispersion of effort and loss of the desired moral effect.

SELECTION OF TARGETS

PRIMARY TARGETS

2. *Specific Railway targets, suitable for attack on clear moonlight nights only.*

<i>Target</i>	<i>Remarks</i>
A. HAMM	{ The most important and largest railway centre in Germany. Heavy traffic between the Ruhr and N.W. Germany, also on the main line between N. Germany and Holland. Heavy traffic between the Ruhr and Central Germany. Heavy traffic between the Ruhr and Central and S.E. Germany.
B. OSNABRUCK	
C. SOEST	
D. SCHWERTE	
E. COLOGNE (KALK NORD)	} Large proportion of the rail traffic between the Ruhr, the Low Countries, France, S.W. Germany and Italy. Largest internal rail-water transshipment port in Europe.
F. COLOGNE (GEREON)	
G. DUISBURG (HOCHFELD SUD)	
H. DUSSELDORF (DERENDORF)	
J. DUISBURG-RUHRORT	

These 9 railway centres form a ring round the Ruhr-Rhine area and

their complete stoppage would virtually isolate the area, i.e. the stoppage of A, B, C and D would effectively prevent traffic movement between the Ruhr and North, Central and Eastern Germany. The stoppage of E, F, G, H would effectively prevent traffic movement between the Ruhr, the Low Countries, France, and Italy. The extended lines of communication reaching to East and South-East Europe and Russia, to Libya, and to Spain would also be affected directly or indirectly.

Thus the nine bottlenecks fall into two separate groups of inter-related railway centres, namely:

- (i) Hamm, Osnabruck, Soest, Schwerte.
- (ii) Cologne (Kalk Nord and Gereon), Dusseldorf (Derendorf), Duisburg (Hochfeld Sud), Duisburg-Ruhrort.

Stoppage at any one centre can thus be relieved by the diversion of traffic through another point in the same group. The worst dislocation will, therefore, result from the stoppage of all the centres in one group before the other group is dealt with, and attacks should be carried out on this principle so far as tactical conditions allow.

3. *Targets on water suitable for concentrated and continuous area attack on moonless nights.*

Targets E. to J. in para. 2 above are all suitable for attack on moonless nights as they lie in congested industrial towns, where the psychological effect will be the greatest. Notes of their importance from this point of view are given below.

COLOGNE (EAST AND WEST BANK)

Important centre of industry and rail, river communications.
Pop. 940,000

DUSSELDORF

Important centre of the West German steel and machine industry, also railway centre. Pop. 520,000

DUISBURG

Important industrial area with railway centre in the middle of the target.

DUISBURG-RUHRORT

A large industrial area including the largest inland port in Europe, and rail communications on a similar scale. Pop. 450,000 (combined with **DUISBURG**).

The fact that these towns can be suitably attacked on moonless nights does not, however, reduce the importance of attacking the railway centres they contain on moonlight nights, as indicated in para. 2 above.

4. *Inland canal and river targets connecting RUHR, RHINE area to North-West, Central and Southern Germany.*

Targets:

- (A) Dortmund-Ems; and Ems-Weser canals.
- (B) River Rhine.

Canals. The most suitable points for bombing attacks of these canals are the raised banks lying to the North of the Ruhr, where it is believed there is no A.A. or balloon barrage to interfere with low level approach. A map showing stretches of raised banks is attached, marked 'A', together with a full description of each one.¹ Some additional interference with traffic on the canals can be carried out by attacks on strings of barges. One of the most important factors in the attack on these canals is the element of surprise. It will, therefore, be necessary to detail a force sufficiently large to complete this operation in one attack.

River Rhine. A mine, suitable for attack on river traffic is under development, and detailed information regarding suitable points for attack, is now being collated and will be supplied when the weapon is nearing completion.

5. Road Transport

The greatest interference with road transport can be achieved by reducing the German output of synthetic rubber, on which the Germans are almost entirely dependent. The only two main factories producing this commodity are at:

- (A) SCHOPAU
- (B) HULS

The importance of these targets is increased in view of the Russian campaign. The early destruction of the plant at HULS, which is in easy range, might have an immediate influence on operations in the Russian theatre.

SECONDARY TARGETS

6. *Targets selected for attack when weather conditions are unsuitable over the Primary Targets, also to prevent too great a concentration of A.A. and night fighter defences in the Ruhr-Rhine area.*

- A. Hamburg
- B. Bremen
- C. Hanover
- D. Frankfurt
- E. Mannheim
- F. Stuttgart

7. WEIGHT OF ATTACK ON RAILWAY CENTRES

Experience of the light attacks delivered from time to time in this country has shown that the repercussions amount to little more than temporary inconvenience and have no serious or lasting effect on the railway system in general. If, therefore, the required damage is to be done and serious dislocation to be caused it is essential to ensure that a high tonnage of bombs actually falls in the area of the railway centre.

In the opinion of the railway experts the dropping of 50-100 bombs (say 15 tons) on any one of the railway centres listed in para. 2 is likely to lead to a complete stoppage for a period of at least one week and to cause

¹ Not printed.

widespread dislocation and delay to a degree which cannot be accurately predicted, but may extend to weeks or months.

The following calculations are included as a guide for deciding upon the force required to do the required damage. They are based on the 'Law of Probability', and are supported by practical evidence of results in England and Germany. The following assumptions have been made.

- (i) That 90 aircraft will actually reach and bomb the selected railway centre.
- (ii) That the average load per aircraft is approximately $1\frac{1}{2}$ tons.
- (iii) That the average aiming error is 600 yards.

On this basis it may be expected that approximately 100 bombs will fall in the target area and that approximately 50 will hit vulnerable points within it:

Aircraft attacking target	90
Bombs aimed	
(H.E. 500 lb. equivalents)	675
(Incendiary 4 lb.)	11,250
Bombs calculated to fall in target area	
H.E.	112
Incendiary	1,874
H.E. bombs calculated to hit vulnerable points	56

The use of approximately 10 per cent delay action bombs is recommended in view of the difficulties experienced by the railway authorities from the small number of similar bombs dropped in England, especially if set to explode at frequent intervals and so prevent or seriously interfere with fire fighting, repair and general traffic organisation.

(xvii)

30th August 1941. Air Vice-Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse

Sir,

I am directed to refer to Air Ministry letter numbered as above dated 9th July 1941, and to say that the extension of your operations under this Directif against small towns on the main railway routes, on the lines discussed between your Senior Air Staff Officer and the Director of Bomber Operations, is approved.

2. I am to attach as an appendix¹ to this letter a short appreciation on the railway routes from Western Germany to the eastward in which the principal routes are listed and 21 selected towns on them are suggested for attack. I am to say that the aim of your attacks should be twofold. On the material side, it is felt that, by attacking a number of towns on the same route on the same night it should be possible so to dislocate traffic as to

¹ Not printed.

cause a serious, even though temporary, breakdown in the communications. From the morale standpoint, by extending our attacks to the smaller towns, it is felt that the more widespread experience of the direct effect of our offensive may have considerable value. Moreover, the operations should have the tactical advantage of enabling our attacks to be made in less heavily defended areas and of forcing on the enemy a wider dispersion of their defences.

3. I am accordingly to request that you will consider the possibility of directing your operations on those lines when conditions are favourable, during the current moon phase with a view to continuing them if results suggest that they may be a profitable variation to your attacks on your primary targets.

(Sgd.) N. H. BOTTOMLEY

(xviii)

11th September 1941. Air Commodore J. W. Baker (Director of Bomber Operations) to Air Marshal Sir Richard Peirse

Sir,

I am directed to refer to Air Ministry letter of even reference dated 30th August, and to add the following information.

2. There are two additional routes running from Frankfurt and Stuttgart respectively, both leading to Leipzig. Although these routes are not of sufficient importance to justify any degree of priority as railway targets their point of intersection, namely Schweinfurt has a peculiar importance of its own.

3. Schweinfurt is one of the principal centres of the Ball Bearing industry. It is believed to produce 70% of the Bearings required for aircraft A.F.V.'s and M.T. The destruction of the Ball Bearing Industry would therefore make a valuable contribution to the Transportation plan in so far as road transport is concerned.

4. I am accordingly to request you to add the town of Schweinfurt (population 40,000) to the list of towns given in paragraph 3 of Appendix 'A'¹ to my above-quoted letter.

(Sgd.) J. W. BAKER

(xix)

27th October 1941. Air Vice-Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse

Sir,

I am directed to refer to paragraph 7 of Air Ministry letter numbered as above dated 9th July, 1941, and to say that, in view of the importance of

¹ Not printed.

hampering the German submarine construction programme at the present time, it is necessary to give high priority, as far as weather conditions allow, to the ports of Kiel, Hamburg, Bremen and Wilhelmshaven.

2. I am accordingly to request that, whenever the weather conditions are such that you decide to concentrate your attack on North-West Germany, you will detail as your objectives such targets in these ports as you consider most likely to achieve the above object. You will doubtless also maintain your present principle of following up a successful attack with subsequent concentrations as closely spaced as weather conditions permit.

3. I am to add that the operational submarine bases at Brest and Lorient are also important in the existing situation but further directions will be sent you as soon as a diversion of your present scale of effort on Brest to Lorient or other submarine bases on the west coast of France seems justified.

(Sgd.) N. H. BOTTOMLEY

(xx)

*13th November 1941. Air Vice-Marshal N. H. Bottomley
(Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse*

Sir,

I am directed to inform you that the War Cabinet have had under consideration the intensity of air operations recently undertaken in Bomber and Fighter Command. They have stressed the necessity for conserving our resources in order to build a strong force to be available by the spring of next year. It is requested that you will have this principle in mind in planning operations generally in the future.

2. Whilst it was realised that in vital operations heavy losses must be faced it was considered undesirable in present circumstances and in the course of normal operations that attacks should be pressed unduly especially if weather conditions were unfavourable or if aircraft were likely to be exposed to extreme hazard.

(Sgd.) N. H. BOTTOMLEY

(xxi)

*10th December 1941. Air Vice-Marshal N. H. Bottomley
(Deputy Chief of the Air Staff) to Air Marshal Sir Richard Peirse*

Sir,

I am directed to refer to Air Ministry signal of to-day's date¹ which places the highest priority for Bomber Command operations on the des-

¹ Not printed.

truction of enemy capital ships, and to request that you will prepare plans immediately for daylight bombing operations against the enemy cruisers in Brest. The operation is to be undertaken by heavy aircraft escorted by fighter aircraft.

2. I am to say that the general plan of operation is to be jointly concerted with the aim of destroying the enemy ships or so damaging them as to ensure their neutralisation for a considerable period. The plan should have due regard to the need for incurring the minimum loss to our own forces.

3. I am to draw attention to the importance of the enemy R.D.F. screen now known to be well-established and in full operation. I am to suggest that among the primary factors which may have to be considered is the warning now available to the enemy by this means, and the most effective measures to defeat it.

4. Finally I am to request that before these operations are implemented an agreed plan may be submitted at an early date for the consideration of the Chief of the Air Staff.

(Sgd.) N. H. BOTTOMLEY

(xxii)

14th February 1942. Air Vice-Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Marshal J. E. A. Baldwin (Acting Air Officer Commanding-in-Chief, Bomber Command)

Sir,

I am directed to refer to Air Ministry letter dated 4.2.42,¹ and to say that, in order to enable you to make your offensive fully effective on the introduction of TR 1335² equipment on operations, it has been decided that the principle of conservation of your forces, laid down in Air Ministry letter dated 13.11.41, should be modified. You are accordingly authorised to employ your effort without restriction, until further notice, in accordance with the following directions. Clearly this does not warrant pressing your attacks if weather conditions are unfavourable or if your aircraft are likely to be exposed to extreme hazards.

2. In the opinion of the Air Staff, the introduction of TR.1335 will confer upon your forces the ability to concentrate their effort to an extent which has not hitherto been possible under the operational conditions with which you are faced. It is accordingly considered that the introduction of this equipment on operations should be regarded as a revolutionary advance in bombing technique which, during the period of its effective life as a target-finding device, will enable results to be obtained of a much more effective nature.

¹ Not printed.

² *Authors' note: i.e. Gee.*

3. The period in which this device can be used as an aid to target location and blind bombing will be governed by the ability of the enemy to develop counter-measures when the secret of its nature and operations has been disclosed. Much will depend on the security measures observed in its employment and the care taken by air crews to ensure the destruction of the apparatus and to avoid mentioning or discussing it in the event of their aircraft being forced down over enemy territory. It is unlikely, however, that under the best possible conditions this period will exceed six months from the date of its introduction. It is accordingly of first importance to exploit the advantages it confers to the full. The maximum effort possible having due regard to weather and other hazards should be exerted throughout the period it is thus available, and particularly in the first few weeks of your operations.

4. In addition to the foregoing primary factor, a resumption of your offensive at full effort is considered desirable for the following reasons:

- (i) This is the time of year to get the best effect from concentrated incendiary attacks.
- (ii) It would enhearten and support the Russians if we were to resume our offensive on a heavy scale, while they were maintaining so effectively their own counter-offensive against the German armies.
- (iii) The co-incidence of our offensive with the Russian successes would further depress the enemy morale, which is known already to have been affected by the German armies' reverses on the Eastern Front.

5. In accordance with these principles and conditions, a review has been made of the directions given to you in Air Ministry letter dated 9.7.41, and it has been decided that the primary object of your operations should now be focussed on the morale of the enemy civil population and in particular, of the industrial workers. With this aim in view, a list of selected area targets (taking account of the anticipated range of the TR.1335 equipment) is attached in Annex 'A' to this letter. An additional list of targets beyond this range, which can be attacked when conditions are particularly favourable and when a correct assumption of the accuracy and powers of concentration obtainable with the equipment has been made, are also included in Annex 'A'.

6. You will note that Berlin has been included amongst the latter targets. In this case, your operations should be of a harassing nature, the object being to maintain the fear of attack over the city and to impose A.R.P. measures. The scale of effort and tactics employed should be designed to incur the minimum casualties and for that reason they should be undertaken at high altitude even if this entails carrying reduced bomb-loads. Apart from these particular operations against Berlin, the cardinal principle which should govern your employment of TR.1335 from the outset, should be the complete concentration on one target until the effort estimated to be required for its destruction has been achieved. Estimates of the scales of attack required are given in Annex 'C'.

7. Essen is the most important of the selected primary targets, and by attacking it first, the maximum benefit should be derived from the element of surprise. I am to suggest, therefore, that this should be selected as your

initial target for TR.1335 operations, to be followed by attacks against the remaining priority areas listed in Annex 'A'.

8. When experience in the employment of TR.1335 has proved that, under favourable conditions, effective attacks on precise targets are possible, I am to request that you will consider the practicability of attacking first, the precise targets within TR.1335 range and, later, those beyond this range listed in Annex 'B'.

9. During the estimated effective life of TR.1335 as a target-finding and blind bombing device, it will not be possible to equip more than a relatively small proportion of your force. It is, therefore, of the first importance that tactical methods to assist the remainder of the force to achieve concentration, both when the target is capable of being illuminated and under blind bombing conditions, should be studied, developed and applied to the maximum possible extent. In this connection I am to remind you of the principles and scales of attack with incendiary weapons laid down in Air Ministry letter dated 25.10.41.¹

10. Apart from your primary offensive on the above lines, I am to say that the following additional commitments will still have to be met from time to time:

- (i) Attacks on factories in France are to be undertaken as notified to you in Air Ministry letter dated 5.2.42.¹ If a favourable opportunity for the initial attack on the Renault plant has not occurred before you begin operations with the TR.1335 equipment, attacks on the French factories are to be carried out only when weather conditions are particularly favourable and at the same time are unsuitable for the concentrated bombing of targets in Germany within this Directif.
- (ii) The operations of No. 2 Group are to continue to be governed by the directions in Air Ministry letter dated 25.11.41¹ bearing in mind the commitment for army air support as stated in para 7 of that letter.
- (iii) Periodical support for the operations planned by the Adviser of Combined Operations will be required in accordance with the directions issued to you in Air Ministry letter dated 21st December, 1941.¹

11. Finally, I am to say that, although every effort will be made to confine your operations to your primary offensive, you should recognise that it will on occasions be necessary to call upon you for diversionary attacks on objectives, the destruction of which is of immediate importance in the light of the current strategical situation. In particular, important naval units and the submarine building yards and bases may have to be attacked periodically, especially when this can be done without missing good opportunities of bombing your primary targets.

(Sgd.) N. H. BOTTOMLEY

¹ Not printed.

ANNEXE 'A'

TO AIR MINISTRY LETTER DATED 14.2.42

PRIMARY INDUSTRIAL AREAS

(Within TR.1335 range—350 miles from Mildenhall)

Central (Ruhr) area

Essen (Transportation and heavy industries)
 Duisberg (Transportation and heavy industries)
 Dusseldorf (Transportation and general industries)
 Cologne (Transportation and general industries)

ALTERNATIVE INDUSTRIAL AREAS

(Within T.R.1335 range—350 miles from Mildenhall)

Northern (coastal) area

Bremen (Naval dockyards)
 Wilhelmshaven (Naval dockyards)
 Emden (Naval dockyards)

ALTERNATIVE INDUSTRIAL AREAS

(Involving deeper penetration beyond TR.1335 range)

Northern

Hamburg (Naval and general shipbuilding)
 Kiel (Naval dockyards)
 Lubeck (Baltic port) (Industrial and armament centre)
 Rostock (Heinkel factories)

Central

Berlin (General industries)
 Kassel (Locomotive industry)
 Hanover (Rubber manufacture)

Southern

Frankfurt (Chemical and general engineering)
 Mannheim (Transportation, chemical and general engineering)
 Schweinfurt (Ball bearings)
 Stuttgart (General, electrical and precision engineering)

ANNEXE 'B'

TO AIR MINISTRY LETTER DATED 14.2.42

PRECISE TARGETS

Within TR.1335 Range

<i>Operational Number</i>	<i>Detail</i>	<i>Remarks</i>
G S 162	Chemische Werk Huls Synthetic rubber	Producing approximately 20% of Germany's total rubber supply.
G O 1236	Quadrath (Fortuna) Power Station	Production capacity 250,000 kw.
G O 1237	Goldenberg Werk, Koln (Knapsack) Power Station	Largest steam power plant in Europe. Production capacity 500,000 kw.
G O 1428	Brauweiler (Koln) Switching and Transformer Station	Outdoor transformer and switching station controlling 1,500,000 kw. of plant output. Controls the flow of power from South into Ruhr-Rhineland.
G O 1128	Gersteinwerk (Stockum) Power and Switching Station	150,000 kw. Steam Station. Also controls flow power from East in Ruhr-Rhineland.
G Q 1509	Gelsenberg-Benzin A.G. Gelsenkirchen (Nordstern) Synthetic oil	Annual output 390,000 tons fuel.
G Q 1537	Hydrierwerke Scholven Gelsenkirchen A.G. (Buer)	Annual output approximately 300,000 tons fuel.
G Q 1510	Union Rheinische Braun- kohln Wesserling	Annual output 240,000 tons fuel.

Outside TR.1335 Range

G S 153	Bunawerke Schopau (Mer- seburg) Synthetic Rubber	Produces approximately 30% Germany's total rubber supply.
G Z 2805	V.D.M. Frankfurt Hed- dernheim	Leading German airscrew manufacturers and aircraft components.
G B 3280	Robert Bosch—Stuttgart- Fuerbach	Most important factory in Germany making dynamos, injection pumps and magnetos.
G Q 1515	I.G. Farben Leunawerke (Merseburg) Synthetic Oil	Annual output 480,000 tons fuel and large capacity fixation of nitrogen.

ANNEXE 'C'

TO AIR MINISTRY LETTER DATED 14.2.42
ESTIMATED WEIGHT OF ATTACK FOR DECISIVE DAMAGE

1	2	3	4	5	6	7
Selected Area	Size of total area (sq. miles)	Size of built-up area (sq. miles)	Size of central vulnerable area (sq. miles)	Pop. of total area	Wt. of attack required on a basis of 7 tons per sq. mile and 50% efficiency	Wt. of attack required on a basis of 1 ton per 800 pop. and 50% efficiency
A. Essen	70	25	9	650,000	1,000 tons	1,600 tons
B. Duisberg	55	16	3	440,000	800 tons	1,100 tons
C. Dusseldorf	62	18	3	500,000	850 tons	1,200 tons
D. Cologne	100	30	5	750,000	1,400 tons	1,800 tons

(xxiii)

5th May 1942. Air Vice-Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Marshal A. T. Harris

Sir,

I am directed to refer to Air Ministry letter of the 14th February, 1942, in regard to the policy governing bomber operations over Germany.

2. Whilst the primary aim of your operations must remain the lowering of the morale of the enemy civil population and in particular that of the workers in industrial areas vital to the enemy's war effort, every effort consistent with this aim should be made to reduce the output of aircraft factories, and particularly those producing fighter aircraft.

3. The outcome of the critical operations on the Russian Front will depend very largely on the enemy's ability to maintain in operation a certain strength of fighter aircraft. Similarly the success of our own attempts at Combined Operations on the Continent will be crucially affected by the number of fighter aircraft with which the enemy can oppose us.

4. By reason of the heavy strain imposed on the enemy, especially by the fighting in Russia, the German Air Force is now weaker than it has been at any time previously in the war. This applies particularly to his fighter strength. It is important that we should make every effort to prevent recovery and further weaken his fighter forces. The 'Circus' operations were recently intensified to this end. It would be most advantageous if the results of these 'Circus' operations could be supplemented by night bomber operations under the current directive.

5. I am therefore to request that in your choice of alternative targets

within this directive you will give special consideration to the attack of Bremen, Kassel, Frankfurt and Stuttgart. Similarly, when considering the attack of precise targets under Annex 'B', first priority should, for the time being, be placed on GZ. 2805 (propellers) and GB. 3280 (Injection pumps).

6. Finally, I am to invite your comments as to the feasibility of attacking the following aircraft factories of which the locality and estimated monthly production are indicated:

Target No.	Name of Factory	Locality	Estimated Monthly Production
GY. 4752	Messerschmitt	Augsburg (Bavaria)	30 Me.109 plus 80 Me.110
GY. 4828	Messerschmitt	Regensburg („)	60 Me.109 plus 30 Me.110
GY. 4825	Erla	Leipzig	80 Me.109
GY. 4818	Wiener-Neustadter Works	Wiener-Neustadt (Austria)	70 Me.109 plus possibly 25 Me.110
GY. 4793	Arado	Warnemunde	60 Me.109

These factories, together with those at Kassel and Bremen, are responsible for nearly all the output of fighter aircraft in the Reich.

(Sgd.) N. H. BOTTOMLEY

(xxiv)

25th May 1942. Air Vice-Marshal N. H. Bottomley (Assistant Chief of the Air Staff (Operations)) to Air Marshal A. T. Harris

Sir,

I am directed to refer to Air Ministry letter dated 5th February, 1942,¹ and to say that approval has been given to the attack of selected industrial plants in German occupied countries, in addition to France, with similar objects to those indicated to you in paragraphs 1 and 5 of the foregoing letter. In particular, it is desired that these operations should give substance to the policy of the Political Warfare Executive which aims at discouraging the nationals of enemy occupied countries from working in German controlled factories.

2. Eight targets have accordingly been selected and these are fully described in the attached dossier. The selection of these targets has been based upon:

- (i) Economic importance.
- (ii) Ease of identification.
- (iii) Situation in relation to built-up areas to achieve the maximum moral effect with the minimum of casualties.

¹ Not printed.

Copies of this dossier are forwarded:¹ further copies may be obtained from Air Ministry A.I.3(c), (Air Liaison).

3. In authorising the attack of these special targets, I am to emphasise the need for observing the principles which have hitherto attached to the attack of other targets in enemy occupied countries. Such attacks must be planned with the object of avoiding, as far as possible, loss of life to the inhabitants of the areas attacked. It is appreciated that the location of certain of the selected targets is such that some loss of life is bound to occur, but no effort should be spared to keep this to an absolute minimum. In carrying out these attacks the following conditions are to be observed:

- (i) The attacks are to be made only under favourable weather conditions.
- (ii) Experienced crews only are to be employed.
- (iii) Bombs are not to be released in the target area unless the target can be clearly identified on the bomb run.

The fact that all the targets, with the exception of those in Norway and Denmark, are within effective T.R.1335 cover should materially assist in fulfilling these conditions.

4. I am to add that these targets should be regarded as supplementary to the list of targets issued with my letter quoted above and to request that in the first instance you will attack one target in each country as soon as opportunity permits, giving special priority to Eindhoven.

(Sgd.) N. H. BOTTOMLEY

(xxv)

20th July 1942. Air Vice-Marshal N. H. Bottomley (Assistant Chief of the Air Staff (Operations)) to Air Marshal Sir Arthur Harris

Sir,

I am directed to refer to Air Ministry letter dated 5th February, 1942,¹ and to inform you that subject to the strict observance of the conditions referred to below, authority is given for night bombing attacks against the following additional targets in Occupied France:

- (i) The Schneider Armament and Locomotive Works at Le Creusot—Z.186.
- (ii) The Citroen Automobile Engine and Lorry Works, Quai de Javel (Paris) Z.284.

2. As a result of the successful attacks against the first three targets in paragraph 2 of the above-mentioned letter, the order of priority of industrial targets in France has been reviewed.

3. Apart from the Armament Works at Le Creusot, which is of sufficient importance to warrant special consideration, it has been decided

¹ Not printed.

that the effort devoted to French targets should now be focussed on plants associated with the French armoured fighting vehicle and motor transport industry.

4. In accordance with this principle, the following targets have been selected for attack:

- (i) The Citroen Plant, Quai de Javel (Paris)—Z.284.
- (ii) The Gien Ordnance Depot—Z.594.

5. In Air Ministry letter dated 25th May, 1942, authority was given for the attack of the Ford & General Motor Works (Z.851 and Z.852) at Antwerp. From the economic standpoint it would be of value if the attack of these plants could be associated as closely as possible with attacks on the plants referred to in the preceding paragraph. Thus, should a successful attack be carried out against any of these four targets, the importance of attacking the remainder will be proportionately increased.

6. I am to request, therefore, that you will consider industrial targets in France in the following revised order of priority:

- (i) Le Creusot,
- (ii) Citroen,
- (iii) Gien,

and that any attack on the two latter plants should be associated if possible, with attacks on the Ford and General Motor Works in Antwerp.

7. While the attack of all these targets is governed by the principles which have already been laid down for the attack of targets in occupied countries, it is pointed out that the Schneider Works and the Citroen Plant, in particular, are in the closest proximity to built-up areas. Any night attack launched against them entails the political risk of political embarrassment which should not be taken unless conditions justify firm confidence in the success of the operation. Accordingly night attacks against these two targets are to be governed by the following conditions:

- (i) Only reliable and experienced crews are to be employed.
- (ii) The attacks are to be made only under favourable weather conditions.
- (iii) Bombs are not to be released within the target area unless, on the bombing run, the target is definitely identified.

(Sgd.) N. H. BOTTOMLEY

(xxvi)

*3rd September 1942. Air Vice-Marshal N. H. Bottomley
(Assistant Chief of the Air Staff (Operations))
to Air Marshal Sir Arthur Harris*

Sir,

I am directed to inform you that recent evidence has emphasised the importance of the synthetic oil plant at Poelitz. The latest report by the

J.I.C. Technical Sub-Committee concludes that the Axis no longer has enough oil to fight the Russians on the present scale, maintain operations in other theatres and provide for an efficient war industry. In an intelligence commentary on the report, the German oil position has been pictured as a highly stretched web which does not fail to cover the framework entirely, but which is so exactly cut to size that if the framework is pulled out at one place it must be relaxed at another.

2. The Sub-Committee's report shows good grounds for the belief that the Poelitz hydrogenation plant is now being fed entirely with oil and, under these conditions, its total production of aviation petrol, motor petrol and diesel oil will greatly exceed any other synthetic oil plant in the world. If this plant were to cease operations only for a short time, the resulting disorganisation in enemy supply plans is likely to have immediate repercussions in the field. This is of special significance at the present moment when it is logical to suppose that a large part of the fuel required to meet the Russian offensive in the Central area will be drawn from this plant.

3. In the circumstances, I am to request that you will add this plant to the list of objectives included in Appendix 'B' to your main directive forwarded under Air Ministry reference dated 14th February, 1942. In addition, I am to suggest that, when conditions favour the selection of a target in the Stettin area, an operation against this plant might be combined with one on the port area, the importance of which to the German effort in the Russian campaign was represented to you in Air Ministry letter dated 16th September, 1941.¹

(Sgd.) N. H. BOTTOMLEY

(xxvii)

*14th January 1943. Air Vice-Marshal N. H. Bottomley
(Assistant Chief of the Air Staff (Operations))
to Air Marshal Sir Arthur Harris*

Sir,

I am directed to refer to para. 11 of my letter dated 14th February, 1942, and to my signal of 19th November, 1942¹ and to say that, as a result of the recent serious increase in the menace of the enemy U-boat operations, the War Cabinet has given approval to a policy of area bombing against the U-boat operational bases on the west coast of France.

2. A decision has accordingly been made to subject the following bases to a maximum scale of attack by your Command at night with the object of effectively devastating the whole area in which are located the submarines, their maintenance facilities and the services, power, water, light,

¹ Not printed.

Authors' note: For a directive of 21st November 1942 dealing with the attack on ball-bearings, see App. 19 (i).

communications, etc. and other resources upon which their operations depend. The order of priority of importance of the bases is as follows:

Lorient
St. Nazaire
Brest
La Pallice.

3. To give effect to this decision, I am to request that you will initially undertake such an operation on the heaviest scale against Lorient. When you are satisfied that the desired object has been achieved and before operations are continued against the remaining bases, the results of the attacks on Lorient will be analysed and reviewed in the light of the evidence available from photographic reconnaissance and such other sources of information as may be obtained.

4. Subject to the following provisos I am to request that you will undertake this operation on first priority at the earliest possible date. The operations are not to prejudice:

- (i) Any attack which you may be planning to undertake against Berlin.
- (ii) Any concentrated attack which suitable weather may enable you to direct against important objectives in Germany and Italy. So far as concerns Germany such concentration can be reckoned as two hundred sorties or more.

5. A copy of this letter is being sent to the Commanding General Eighth Air Force.

(Sgd.) N. H. BOTTOMLEY

(xxviii)

21st January 1943. Combined Chiefs of Staff Directive for the Bomber Offensive from the United Kingdom¹

Your primary object will be the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened.

2. Within that general concept, your primary objectives, subject to the exigencies of weather and of tactical feasibility, will for the present be in the following order of priority:

- (a) German submarine construction yards.

¹ *Authors' note:* This 'Directive to the appropriate British and United States Air Force Commanders to govern the operation of the British and United States Bomber Commands in the United Kingdom' was approved by the Combined Chiefs of Staff at Casablanca on 21st January 1943 and became known as the Casablanca directive. It was sent under cover of a letter dated 4th February 1943 by Air Vice-Marshal Bottomley to Sir Arthur Harris. The covering letter stated that this directive 'replaces the general directive' of 14th February 1942.

- (b) The German aircraft industry.
- (c) Transportation.
- (d) Oil plants.
- (e) Other targets in enemy war industry.

The above order of priority may be varied from time to time according to developments in the strategical situation. Moreover, other objectives of great importance either from the political or military point of view must be attacked. Examples of these are:

- (i) Submarine operating bases on the Biscay coast. If these can be put out of action, a great step forward will have been taken in the U-boat war which the C.C.S. have agreed to be the first charge on our resources. Day and night attacks on these bases have been inaugurated and should be continued so that an assessment of their effects can be made as soon as possible. If it is found that successful results can be achieved, these attacks should continue whenever conditions are favourable for as long and as often as is necessary. These objectives have not been included in the order of priority, which covers long-term operations, particularly as the bases are not situated in Germany.
- (ii) Berlin, which should be attacked when conditions are suitable for the attainment of specially valuable results unfavourable to the morale of the enemy or favourable to that of Russia.

3. You may also be required, at the appropriate time to attack objectives in Northern Italy in connection with amphibious operations in the Mediterranean theatre.

4. There may be certain objectives of great fleeting importance for the attack of which all necessary plans and preparations should be made. Of these, an example would be the important units of the German Fleet in harbour or at sea.

5. You should take every opportunity to attack Germany by day, to destroy objectives that are unsuitable for night attack, to sustain continuous pressure on German morale, to impose heavy losses on the German day fighter force and to contain German fighter strength away from the Russian and Mediterranean theatres of war.

6. Whenever Allied Armies re-enter the Continent, you will afford all possible support in the manner most effective.

7. In attacking objectives in occupied territories, you will conform to such instructions as may be issued from time to time for political reasons by His Majesty's Government through the British Chiefs of Staff.

(xxix)

*16th February 1943. Air Vice-Marshal N. H. Bottomley
(Assistant Chief of the Air Staff (Operations))
to Air Marshal Sir Arthur Harris*

Recent events on the Russian front have made it most desirable in the opinion of the Cabinet that we should rub in the Russian victory by further attacks on Berlin as soon as conditions are favourable. The C.A.S. wishes you to act accordingly.

(xxx)

6th April 1943. Air Vice-Marshal N. H. Bottomley (Assistant Chief of the Air Staff (Operations)) to Air Chief Marshal Sir Arthur Harris

Sir,

I am directed to refer to Air Ministry letter dated 14th January, 1943, and subsequent communications on the subject of heavy scale area attack of submarine bases, and to inform you that after consideration of the results so far achieved, it has been decided that the employment of your main bomber effort in this form of attack is for the present to be discontinued. The effort thus released is to revert as far as possible to the attack of targets in Germany.

2. I am to request, however, that you will continue to direct night attacks of a harassing nature against the Biscay U-boat bases when suitable opportunities occur. You may find it profitable to employ freshman crews in these attacks with a view to their obtaining operational experience.

3. I am to add that the Commanding General, 8th Air Force is being requested to attack the submarine base installations by day and, in particular, the vulnerable point in the U-boat servicing system at Lorient, when the weather is unsuitable for bombing Germany.

(Sgd.) N. H. BOTTOMLEY

(xxxi)

*Draft Directive 3rd June 1943. Air Vice-Marshal N. H. Bottomley
(Assistant Chief of the Air Staff (Operations))
to Air Chief Marshal Sir Arthur Harris*

Sir,

I am directed to refer to Directive dated 21st January, 1943, issued by the Combined Chiefs of Staff and forwarded to the Commanding General,

Eighth Air Force and the Air Officer Commanding-in-Chief, Bomber Command under cover of Air Ministry letter dated 4th February, 1943.¹ This directive contained instructions for the conduct of the British and American bomber offensive from this country.

2. In paragraph 2 of the directive, the primary objectives were set out in order of priority, subject to the exigencies of weather and tactical feasibility. Since the issue of this directive there have been rapid developments in the strategical situation which have demanded a revision of the priorities originally laid down.

3. The increasing scale of destruction which is being inflicted by our night bomber forces and the development of the day bombing offensive by the Eighth Air Force has forced the enemy to deploy day and night fighters in increasing numbers on the Western Front. Unless this increase in fighter strength is checked we may find our bomber forces unable to fulfil the tasks allotted to them by the Combined Chiefs of Staff.

4. In these circumstances it has become essential to check the growth and to reduce the strength of the day and night fighter forces which the enemy can concentrate against us in this theatre. To this end the Combined Chiefs of Staff have decided that first priority in the operation of British and American bombers based in the United Kingdom shall be accorded to the attack of German fighter forces and the industry upon which they depend.

5. The general responsibilities allocated to the bomber forces in the original directive issued by the Combined Chiefs of Staff (of 21st January, 1943), still hold. The list of objectives, as modified by the Chiefs of Staff is now as follows:

Intermediate objective:

German fighter strength

Primary objectives:

German submarine yards and bases

The remainder of the German aircraft industry

Ball bearings

Oil (contingent upon attacks against Ploesti from the Mediterranean)

Secondary objectives:

Synthetic rubber and tyres

Military motor transport vehicles

I am therefore to request you to direct your combined forces to the following tasks in particular in the immediate future:

- (i) the destruction of German air-frame, engine and component factories and the ball-bearing industry on which the strength of the German fighter force depend;
- (ii) the general disorganisation of those industrial areas associated with the above industries;
- (iii) the destruction of those aircraft repair depots and storage parks

¹ Not printed.

within range, and on which the enemy fighter force is largely dependent;

- (iv) the destruction of enemy fighters in the air and on the ground.

A list of targets appropriate to the above tasks is attached at Appendix 'A'.¹ This list will be amended from time to time as necessary.

6. Consistent with needs of the air defence of the United Kingdom, the British fighter forces will be employed to further this general offensive by:

- (i) the attack of enemy aircraft in the air and on the ground;
(ii) the provision of support necessary to pass bomber forces through the enemy defensive system with the minimum cost.

7. American fighter forces will be employed in accordance with the instructions of the Commanding General Eighth Air Force in furtherance of the bomber offensive and in co-operation with the fighter forces of Fighter Command.

8. The allocation of targets and the effective co-ordination of the forces involved is to be ensured by frequent consultation between the Commanders concerned. To assist this co-ordination a joint operational planning committee has been set up. The suggested terms of reference under which this committee is to operate have been outlined in Air Ministry letter dated 18th May, 1943.¹ The Air Ministry and Eighth Air Force representatives on this committee will be available to assist on matters concerning the strategic, economic and political aspects of target selection.

9. It is emphasised that the reduction of the German fighter force is essential to our progression to the attack of other sources of the enemy war potential and any delay in its prosecution will make the task progressively more difficult.

10. In so far as is possible, targets should be chosen on the basis of the directness and immediacy of their contribution to the weakening of German fighter strength. A successful attack against major targets within any inter-dependent group of objectives will warrant a continuation of attacks against the remaining targets in that category even under conditions of increasing cost.

11. This latter principle applies in an outstanding manner to attacks directed against the ball-bearing industry upon which the German Air Force is critically dependent.

12. During this phase of operations it is necessary to direct the maximum effort against the submarine construction yards and operating bases when tactical and weather conditions preclude attacks upon objectives associated with the German Fighter Force. A list of these targets is attached at Appendix 'B'.¹

(Sgd.) N. H. BOTTOMLEY

¹ Not printed.

(xxxii)

10th June 1943. Air Vice-Marshal N. H. Bottomley (Assistant Chief of the Air Staff (Operations)) to Air Chief Marshal Sir Arthur Harris¹

Sir,

I am directed to refer to Directive dated 21st January, 1943, issued by the Combined Chiefs of Staff and forwarded to the Commanding General, Eighth Air Force and the Air Officer Commanding-in-Chief, Bomber Command under cover of Air Ministry letter dated 4th February, 1943.² This directive contained instructions for the conduct of the British and American bomber offensive from this country.

2. In paragraph 2 of the directive, the primary objectives were set out in order of priority, subject to the exigencies of weather and tactical feasibility. Since the issue of this directive there have been rapid developments in the strategical situation which have demanded a revision of the priorities originally laid down.

3. The increasing scale of destruction which is being inflicted by our night bomber forces and the development of the day bombing offensive by the Eighth Air Force have forced the enemy to deploy day and night fighters in increasing numbers on the Western Front. Unless this increase in fighter strength is checked we may find our bomber forces unable to fulfil the tasks allotted to them by the Combined Chiefs of Staff.

4. In these circumstances it has become essential to check the growth and to reduce the strength of the day and night fighter forces which the enemy can concentrate against us in this theatre. To this end the Combined Chiefs of Staff have decided that first priority in the operation of British and American bombers based in the United Kingdom shall be accorded to the attack of German fighter forces and the industry upon which they depend.

5. The primary object of the bomber forces remains as set out in the original directive issued by the Combined Chiefs of Staff (dated 21st January, 1943) i.e.:

‘the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened’.

6. In view however, of the factors referred to in para. 4 the following priority objectives have been assigned to the Eighth Air Force:

Intermediate objective:
German Fighter strength

¹ *Authors' note:* This became known as the *Pointblank* Directive.

² Not printed.

Primary objectives:

German submarine yards and bases

The remainder of the German aircraft industry

Ball bearings

Oil (contingent upon attacks against Ploesti from the Mediterranean)

Secondary objectives:

Synthetic rubber and tyres

Military motor transport vehicles

While the forces of the British Bomber Command will be employed in accordance with their main aim in the general disorganisation of German industry their action will be designed as far as practicable to be complementary to the operations of the Eighth Air Force.

7. In pursuance of the particular requirements of para. 6 above, I am to request you to direct your forces to the following tasks:

- (i) the destruction of German air-frame, engine and component factories and the ball-bearing industry on which the strength of the German fighter force depend
- (ii) the general disorganisation of those industrial areas associated with the above industries
- (iii) the destruction of those aircraft repair depots and storage parks within range, and on which the enemy fighter force is largely dependent
- (iv) the destruction of enemy fighters in the air and on the ground

The list of targets appropriate to these special tasks is in Appendix 'A' forwarded under cover of Air Ministry letter dated 4th June, 1943.¹ Further copies of this list, which will be amended from time to time as necessary, will be forwarded in due course.

8. Consistent with the needs of the air defence of the United Kingdom, the forces of the British Fighter Command will be employed to further this general offensive by:

- (i) the attack of enemy aircraft in the air and on the ground
- (ii) the provision of support necessary to pass bomber forces through the enemy defensive system with the minimum cost.

9. American fighter forces will be employed in accordance with the instructions of the Commanding General, Eighth Air Force in furtherance of the bomber offensive and in co-operation with the forces of Fighter Command.

10. The allocation of targets and the effective co-ordination of the forces involved is to be ensured by frequent consultation between the Commanders concerned. To assist this co-ordination a combined operational planning committee has been set up. The suggested terms of reference under which this Committee is to operate is outlined in Air Ministry letter dated 10th June, 1943.¹

11. It is emphasised that the reduction of the German fighter force is

¹ Not printed.

of primary importance; any delay in its prosecution will make the task progressively more difficult. At the same time it is necessary to direct the maximum effort against the submarine construction yards and operating bases when tactical and weather conditions preclude attacks upon objectives associated with the German Fighter Force. The list of these targets is in Appendix 'B'¹ forwarded with the Appendix 'A' referred to in paragraph 7 above.

(Sgd.) N. H. BOTTOMLEY

(xxxiii)

3rd September 1943. Air Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Chief Marshal Sir Arthur Harris

Sir,

In accordance with the decision of the Chiefs of Staff at their Meeting I am directed to forward to you the following extract from [their conclusion] dated 24th August, 1943, which contains the final agreed summary of conclusions reached by the Combined Chiefs of Staff in the course of their meetings at Quebec:

'The Bomber Offensive

10. The progressive destruction and dislocation of the German military, industrial and economic system, the disruption of vital elements of lines of communication, and the material reduction of German air combat strength by the successful prosecution of the Combined Bomber Offensive from all convenient bases is a prerequisite to "Overlord" (barring an independent and complete Russian victory before "Overlord" can be mounted). This operation must therefore continue to have highest strategic priority.'

(Sgd.) W. F. DRY,
Group Captain for D.C.A.S.

xxxiv)

14th January 1944. Air Marshal N. H. Bottomley (Deputy Chief of the Air Staff) to Air Chief Marshal Sir Arthur Harris

Sir,

I am directed to refer to a demi-official letter written to you by the Deputy Chief of the Air Staff on 17th December, 1943,¹ and to your

¹ Not printed.

reply dated 20th December, 1943¹ which expresses your views on the question of night attack of Schweinfurt.

2. This strategic policy, which has been agreed by the Combined Chiefs of Staff, is being implemented in accordance with the Combined Bomber Offensive plan as stated in Air Ministry letter dated 10th June, 1943. Under this plan, the American strategic bombers are directed primarily to the attack of selected industries. In addition to pursuing this main aim of the general disorganisation of German industry, your Command is committed to direct its operations, as far as is practicable, against industrial centres associated with those industries selected for precise attack by the American bomber forces.

3. The British and American Air Staffs firmly believe in this strategy, which is based on the destruction of selected key industries known to be vulnerable and vital in the enemy's war effort. In arriving at a decision as to which industries should be selected for attack, all possible sources of information available to the British and American Governments have been utilised. The authoritative and comprehensive nature of the examination in regard to the enemy's ball-bearing industry is exemplified in the report, a copy of which is attached to this letter.¹ In view of the most secret information which is contained in this report, I am to request that this document be safe-guarded most securely and be returned as soon as you have examined it.

4. It is confirmed and emphasised that the closest co-ordination is essential to the successful prosecution of the Combined Bomber Offensive and that without it, the reduction of the German fighter strength which is a prerequisite to the launching of 'Overlord' as well as to the effective conduct of 'Pointblank' may not be achieved in the time available.

5. I am accordingly to request that you adhere to the spirit of the directive forwarded in Air Ministry letter dated 10th June, 1943, and that you attack, as far as practicable, those industrial centres associated with the German fighter air-frame factories and ball-bearing industry.

6. It is particularly important that you should do your utmost to destroy at as early a date as possible, the town of Schweinfurt and the ball-bearing factories which it contains. One-third of the town's population is employed in the ball-bearing industry; the 'de-housing' of the town and the infliction of heavy casualties amongst those workers would, in itself, be a valuable contribution. It is realised that tactical difficulties are involved, but it is believed that the task is not beyond the present operational capabilities of your Command with the navigational aids now available, and in any case it is impossible to accept that the successful bombing of any German town within range is impracticable until it has been tried, if necessary several times.

7. I am to request, therefore, that early consideration be given to the ways and means of destroying this target in particular and that you attack it in force on the first opportunity when weather and other conditions allow, and that you continue to attack it until it is destroyed or until alternative directions are issued.

¹ Not printed.

8. Whilst first priority must now be accorded to the destruction of Schweinfurt, high priority must also be given to the destruction of those towns associated with the assembly of fighter aircraft, particularly, Leipzig, Brunswick, Gotha and Augsburg.

(Sgd.) N. H. BOTTOMLEY

(xxxv)

28th January 1944. Air Ministry to Bomber Command

For the attention of the A.O.C. in C. Commanding General and A.C. in C. respectively.¹

Until a further ruling has been given by the Combined Chiefs of Staffs it has been decided that to ensure best possible use of short time before 'OVERLORD' maximum effort of strategic bomber forces is to be concentrated upon key installations in the German fighter aircraft industry and ball-bearing industries, and the towns associated with these key installations.

2. First and equal priority is to be given to the following. Single and twin-engined fighter air-frame and component production and ball-bearing production.

3. For day attack the individual order of priority of targets is as follows. Allocations to theatres are indicated in each case but these are not to be regarded as rigid and exclusive.

4. *Fighter aircraft*

1.	U.K.	Erla (Leipzig)	Me.109	Heiterblick Mockau Abtnaudorf	GY.4796 GY.4825A GY.4847
2.	U.K. & Med.	Messerschmitt (Regensburg)	Me.109	Prufening	GY.4828A
3.	U.K.	Focke Wulf	F.W.190	Kreising Posen	GY.4863 GH.630C
4.	Med.	Messerschmitt	Me.410	Augsburg	GY.4752A
5.	U.K.	Gothaer	Me.110	Gotha	GY.4765
6.	U.K.	Junkers	Ju.88	Bernburg Halberstadt Aschersleben	GY.4835 GY.4822 GY.4818
7.	U.K.	Messerschmitt (Brunswick)	Me.110	Wilhelmitor Neupetritor	GY.4775 GY.4842
8.	U.K.	Arado	FW.190	Tutow	GU.4155
9.	U.K.	Fiesler	FW.190	Kassel Waldau	GY.4809A
10.	Med.	Steyr Works	Me.109	Steyr	GN.3834
11.	Med.	Messerschmitt (Wiener Neustadt)	Me.109	Fischamend	GY.4850
12.	U.K.	Siebel	Ju.88	Schkeuditz	GY.4806
13.	Med.	Manfred Weiss	Me.410	Szigetszentmiklos (Budapest)	BH.93
14.	Med.	Heinkel	He.219	Schwechat	GY.4855

¹ *Authors' note:* i.e. Sir Arthur Harris, General Spaatz and Sir Trafford Leigh Mallory.

5. *Ball-Bearings.* (In equal priority with fighter aircraft.)

1.	U.K. & Med.	Schweinfurt	K.G.F. V.K.F.	Werke I.	GZ.2707A GZ.2707E
2.	U.K.	Erkner (Berlin)	V.K.F.		GZ.2714
3.	Med.	Steyr	Steyr Werke (2 plants)		GN.3834A GN.3834B

Targets 1, 2 and 3 are of equal priority.

4.	U.K.	Leipzig	D.F.K. ¹		GZ.2703
5.	U.K.	Stuttgart (Bad Canstatt)	V.K.F.		GZ.2704

Targets 4 and 5 are of equal priority after 1, 2 and 3.

6.	U.K.	Wuppertal	Jaegar		GZ.2701
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6. The R.A.F. Bomber Command, in so far as is practicable, is to direct its effort to the attack of selected towns associated with certain of the above key installations. Whenever possible aiming points and line of approach are to be selected to include best chance of destroying these key installations. The R.A.F. Bomber Command is to accord first priority in its operations to the attack of the following objectives:

1. Schweinfurt
2. Leipzig
3. Brunswick
4. Regensburg
5. Augsburg
6. Gotha

These are listed in order of priority for attack.

7. The Jaegar ball-bearing factory at Wuppertal is to be given first priority for 'OBOE' and G.H. attacks.

8. This signal is repeated to the A.C. in C. M.A.A.F. so that at his discretion the strategic employment of Mediterranean night bomber force may be applied in accordance with foregoing principles.

9. Berlin. When conditions are not suitable for the above priority objectives R.A.F. Bomber Command and Eighth Air Force are to attack Berlin whenever weather and tactical conditions are suitable for such attacks.

10. 'CROSSBOW' Targets. When conditions are suitable 'POINT-BLANK' operations take first priority for precise attacks by Eighth Air Force and supporting operations of A.E.A.F. When conditions are not suitable for 'POINTBLANK' operations the Eighth Air Force should make full scale attacks on 'CROSSBOW' targets under suitable conditions.

11. Foregoing priorities supersede all previous instructions on this subject.

¹ *Authors' note:* Presumably D.K.F., *Deutsche Kugellager Fabrik.*

(xxxvi)

17th February 1944. Air Ministry to Bomber Command

1. The following directive for the revision of target priorities of the Combined Bomber Offensive has now been approved by the Combined Chiefs of Staff. This supersedes the directive issued under cover of Air Ministry letter dated 10th June 1943. The target schedules issued as appendices to that letter remain in force subject to amendments which have been and will continue to be issued from time to time. First priority objectives are as stated in our [directive] dated 28th January which remains in force. Amendments to list of first priority objectives contained in [it] will be signalled as necessary.

2. Directive is as follows. Begins:

(1) *Mission*. Your overall mission remains 'the progressive destruction and dislocation of German military industrial and economic system, the disruption of vital elements of lines of communication and material reduction of German air combat strength by successful prosecution of Combined Bomber Offensive from all convenient bases.'

(2) *Objective*. Under this general mission, objectives of Bomber Command R.A.F. and U.S.S.A.F.E. are:

(A) Primary objective, the German Air Force. Depletion of German Air Force with primary importance upon German fighter forces by all means available including attacks against following precision targets and industrial areas and facilities supporting them:

(1) *Equal First Priority*. German S/E fighter airframe and airframe component production. German T/E fighter airframe and airframe component production. Axis controlled ball-bearing production.

(ii) *Second Priority*. Installations supporting German fighter air forces.

(B) Other objectives:

(i) 'CROSSBOW'. Operations by all means available will be taken to neutralise threats developing under 'CROSSBOW'.

(ii) *Berlin and Other Industrial Areas*. Attacks should be delivered upon Berlin or other important industrial areas by both Bomber Command, R.A.F., and U.S.S.A.F.E. (latter utilizing blind bombing technique as necessary) whenever weather or tactical conditions are suitable for such operations and unsuitable for operations against the primary objective. Targets should be selected so as to cause maximum assistance in achieving primary aim of reducing strength of German Air Force.

(iii) *Targets in South Eastern Europe*. Attacks should be delivered by XVTH U.S. Army Air Force and by the Mediterranean Allied Air Forces upon cities, transportation targets and other suitable objectives in the Balkans and in the Satellite countries of South

Eastern Europe, whenever weather or tactical conditions prevent operations against 'POINTBLANK' objectives or in support of land operations in Italy.

(3) *Concept.* Overall reduction of German air combat strength in its factories, on the ground and in the air through mutually supporting attacks by both strategic air forces pursued with relentless determination against same target areas or systems so far as tactical conditions allow, in order to create the air situation most propitious for 'OVERLORD' is immediate purpose of Bomber Offensive.

(4) *Co-ordination*

(A) Chief of the Air Staff, R.A.F., as agent for Combined Chiefs of Staff is charged with co-ordination of Bomber Command, R.A.F. and U.S.S.A.F.E. operations.

(B) The Commanding General, U.S.S.A.F.E. is charged with co-ordination of operations of Eighth and XVTH U.S. Army Air Forces and shall give particular heed to integration of attack from Mediterranean complementary to those from United Kingdom upon these primary objectives.

(5) 'OVERLORD' and 'RANKIN'. Preparation and readiness for the direct support of 'OVERLORD' and 'RANKIN' should be maintained without detriment to the Combined Bomber Offensive. Ends.

3. The Air C in C Allied Expeditionary Air Forces has been instructed by S.C.A.E.F. to provide such assistance in the execution of this directive as is possible without detriment to his preparations for 'OVERLORD'. The Air C in C M.A.A.F. has been instructed by Allied C in C Mediterranean to provide such assistance in the execution of his directive as is possible without detriment to the prosecution of the campaign in Italy.

(xxxvii)

4th March 1944. Air Vice-Marshal W. A. Coryton (Assistant Chief of the Air Staff (Operations)) to Air Chief Marshal Sir Arthur Harris

TARGETS FOR ATTACK BY
BOMBER COMMAND IN MOONLIGHT PERIODS
PRIOR TO 'OVERLORD'

Sir,

I am directed to inform you that a review has been made of targets for attack by Bomber Command during the present and forthcoming moonlight periods. The purpose of this review is to provide targets, the attack of which is most likely to be of assistance to 'Pointblank' and 'Overlord' either through the actual destruction of supplies and equipment of use to the enemy or by providing opportunity to obtain experience of the

effects of night attack of airfields, communication centres and ammunition dumps, before operation 'Overlord'.

TARGETS FOR ATTACK BY MAIN FORCE

Industrial Targets in Germany

2. I am to draw your attention to the outstanding importance of Friedrichshafen which, owing to its situation relative to defended areas, you may consider as suitable for attack by the main force during moon-light periods. A copy of a joint appreciation by the Ministry of Economic Warfare and Air Ministry Intelligence on the importance of this town is attached at Appendix 'A'.¹ You will note that the majority of German tank engines, tank gears and gear boxes are produced within the town area. Apart from its importance in the production of Radar equipment, the destruction of this complex would thus be of direct assistance to 'Overlord'. I am to request that you will make every effort to attack the town of Friedrichshafen during the March moon period.

Industrial Targets in Occupied Countries

3. I am to state that there are now outstanding no industrial targets of primary importance in Occupied Countries, the destruction of which can be regarded as paying big dividends in the general weakening of the German war effort. However, a number of targets of secondary importance have been selected. Certain of these targets are small, and incidentally near populous areas. It will, therefore, be necessary to limit the size of the attacking force in certain cases. At Appendix 'B'¹ are details of:

- (i) The targets suitable for attack by unrestricted numbers of the main force, and
- (ii) Those suitable for attack by not more than say fifty aircraft.

Attacks in preparation for 'Overlord'

4. To provide data for the final detailed planning of 'Overlord' and in order to contribute materially to the requirements of 'Overlord' during periods when 'Pointblank' night operations are not practicable, attacks should be carried out against the following railway objectives using a ground marking technique.

Trappes	(Z.431)	Marshalling yard.
Aulnoye	(Z.599)	Marshalling yard.
Le Mans	(Z.444)	Marshalling yard.
Amiens/Longeau	(Z.446)	Marshalling yard (north eastern aiming point only).
Courtrai	(ZB.886)	Marshalling yard (south western lobe of marshalling yard only).
Laon	(Z.604)	Marshalling yard (north western lobe of marshalling yard only).

Other railway targets will subsequently be detailed when the 'Overlord' plan is finally formulated.

¹ Not printed.

Airfields

Montdidier (Z.745)

This airfield is the main centre for the enemy 'Pathfinder' bombers employed against this country. It is a well established base suitable for bombers or fighters. Its dislocation would cause considerable embarrassment to the enemy.

Ammunition Dumps

Maintenon, near Chartres.

This is the largest G.A.F. bomb and ammunition dump in Northern France.

TARGETS FOR ATTACK BY 617 SQUADRON

5. Targets suitable for precision attack by No. 617 Squadron are detailed in Appendix 'C'¹. The destruction of any of these targets will contribute directly to the reduction of the G.A.F.

6. It is considered that the foregoing will provide you with a sufficient number of targets for the March, April and May moonlight periods. I am to state, however, that the targets outlined in this directive are subject to amendment from time to time. This directive cancels all previous directives and signals allocating targets for attack by Bomber Command in moonlight periods.

(Sgd.) W. A. CORYTON

(xxxviii)

17th April 1944. Directive by the Supreme Commander to U.S.S.T.A.F. and Bomber Command for support of 'Overlord' during the preparatory period

OVERALL MISSION

1. The overall mission of the strategical Air Forces remains the progressive destruction and dislocation of the German military, industrial and economic system, and the destruction of vital elements of lines of communication. In the execution of this overall mission the immediate objective is first the destruction of German air combat strength, by the successful prosecution of the Combined Bomber offensive. Our re-entry on the Continent constitutes the supreme operation for 1944; all possible support must, therefore, be afforded to the Allied Armies by our Air Forces to assist them in establishing themselves in the lodgment area.

PARTICULAR MISSION

2. The first pre-requisite of success in the maintenance of the combined

¹ Not printed.

Bomber offensive and of our re-entry on the Continent is an overall reduction of the enemy's air combat strength and particularly his air fighter strength. The primary role of our Air Forces in the European and Mediterranean theatres is, therefore, to secure and maintain air superiority.

3. Our armies will also require the maximum possible assistance on the ground preparatory to the actual assault. This can best be given by interfering with rail communications, particularly as affecting the enemy movements and concentrations in the 'OVERLORD' area. A further Directive covering the employment of the strategical air forces during the assault period and the succeeding land operations will be issued in due course.

4. The particular mission of the strategical air forces prior to the 'OVERLORD' assault is:

- (a) To deplete the German air force and particularly the German fighter forces, and to destroy and disorganise the facilities supporting them.
- (b) To destroy and disrupt the enemy's rail communications, particularly those affecting the enemy's movement towards the 'OVERLORD' lodgment area.

U.S.S.T.A.F.

5. Under this particular mission objectives allotted to the U.S.S.T.A.F. are as follows, in present order of priority:

- (i) *Primary objective:* The German Air Force with primary importance upon German fighter forces by all means available, including attrition in the air and on the ground, and attacks against the following precision targets and industrial areas and facilities supporting them:

Equal first priority:

- (a) German single engine fighter airframe and airframe component production.
- German twin engine fighter airframe and airframe component production.
- Axis-controlled ball bearing production.

Second priority:

- (b) Installations supporting German fighter air forces.

Third priority:

- (c) German bomber air forces and installations supporting them.

- (ii) *Secondary objective:* The enemy rail transportation system.

6. The list of targets best calculated to achieve the primary objective will be passed to the Supreme Commander by the Air Ministry. The list of targets chosen to achieve the secondary objective and the relative priorities accorded them at present will be issued separately. These priorities will be adjusted from time to time in accordance with the situation.

7. Whenever weather or tactical conditions are unsuitable for visual

attack of the primary objectives, attacks will be delivered by blind bombing technique on BERLIN or other important industrial areas. Targets will be selected so as to further the aims of attrition of the German fighter force, and the dislocation of the enemy's transportation system.

R.A.F. BOMBER COMMAND

8. In view of the tactical difficulties of destroying precise targets by night, R.A.F. Bomber Command will continue to be employed in accordance with their main aim of disorganising German industry. Their operations will, however, be designed as far as practicable to be complementary to the operations of the U.S.S.T.A.F. In particular, where tactical conditions allow, their targets will be selected so as to give the maximum assistance in the aims of reducing the strength of the German Air Force, and destroying and disrupting enemy rail communications. A list of targets chosen to achieve these objectives, and showing the relative priorities accorded them at present, will be issued separately. These priorities will be adjusted from time to time in accordance with the situation.

TARGETS IN S.E. EUROPE

9. The order of priority of objectives for the employment of the strategic air forces operating in the MEDITERRANEAN and South East EUROPE is as follows:

- (i) Emergency requirements of the Battle of ITALY.
- (ii) The objectives set out in para. 5 above.
- (iii) Targets in the BALKANS of great political and military importance.

10. In order to take advantage of favourable opportunities to attack targets of great political and military importance in S.E. EUROPE, the order of bombing priority given in para. 9 above may be altered when the situation warrants, and when results of the highest importance may be expected therefrom. The Commanding General, U.S.S.T.A.F. will be kept informed of changes in the political and military importance of these objectives as affecting the priority of bombing tasks generally, and will be given timely warning of attacks against such targets in order to enable proper coordination between 15th Air Force and 8th Air Force operations.

OTHER OBJECTIVES

11. Other objectives of great or fleeting importance may present themselves and orders will be issued accordingly. Where possible, the necessary plans and preparations for these have been made. An example of this is the attack of important units of the German Fleet in harbour or at sea.

'CROSSBOW'

12. The responsibility for neutralising threats from 'CROSSBOW' is laid on the Air Commander-in-Chief, A.E.A.F. Where necessary, he may call for assistance from the strategical air forces in the UNITED KINGDOM

through the Deputy Supreme Allied Commander, who will issue the necessary instructions.

S.O.E. OPERATIONS

13. All S.O.E. Operations undertaken by units of Bomber Command and U.S.S.T.A.F. will be in accordance with the requirements of the Supreme Allied Commander, and orders will be issued accordingly from time to time.

POLITICAL ASPECTS OF TRANSPORTATION PLAN

14. The political aspects of this plan, as affecting the French, will be kept under continuous supervision, with especial reference to the casualties to the civilian populations involved.

REVISION OF DIRECTIVE

15. This Directive will be subject to review after 'OVERLORD' is established on the Continent.

By Command of General Eisenhower.

(Sgd.) W. B. SMITH
Lieutenant General, GSC,
Chief of Staff¹

(xxxix)

14th September 1944. To Deputy Chief of the Air Staff, Air Marshal Sir Norman Bottomley, and to Commanding General, United States Strategic Air Forces in Europe, General Carl Spaatz, from Chief of the Air Staff, Marshal of the Royal Air Force, Sir Charles Portal, and Commanding General, United States Army Air Forces, General H. H. Arnold

CONTROL OF THE STRATEGIC BOMBER FORCES IN EUROPE DIRECTIVE

1. The Combined Chiefs of Staff have decided that executive responsibility for the control of the strategic bomber forces in Europe shall be vested in the Chief of the Air Staff, R.A.F. and the Commanding General, United States Army Air Forces, jointly.

2. The Deputy Chief of the Air Staff, R.A.F., and the Commanding General, United States Strategic Air Forces in Europe, are designated as representatives of the Chief of the Air Staff, R.A.F., and the Commanding General, United States Army Air Forces, respectively, for the purpose of providing control and local co-ordination through consultation.

¹ *Authors' note:* The copy sent to Bomber Command was counter-signed by Air Vice-Marshal J. M. Robb, Deputy Chief of Staff (Air).

3. The overall mission of the strategic air forces is the progressive destruction and dislocation of the German military, industrial and economic systems and the direct support of land and naval forces.

4. Under this general mission you are to direct your attacks, subject to the exigencies of weather and tactical feasibility, against the systems of objectives and in the order of priority now established by the Supreme Commander, Allied Expeditionary Force. When you decide that changes in objectives or priorities are necessary, you will issue the necessary directives and inform the Chief of the Air Staff, R.A.F., and the Commanding General, United States Army Air Forces.

5. Objectives other than those covered in paragraph 4 above will be attacked in accordance with the following:

- (a) *Counter Air Force action.* As the result of air action against the production, maintenance and operation facilities of the German Air Forces (G.A.F.), its fighting effectiveness has now been substantially reduced. At the same time, our combined air strength has been vastly increased. In these circumstances we are no longer justified in regarding the G.A.F. and its supporting industry as a primary objective for attack. Our major effort must now be focussed directly upon the vital sources of Germany's war economy. To this end policing attacks against the G.A.F. are to be adjusted so as to maintain tactical conditions which will permit of the maximum impact upon the primary objectives. No fixed priority is, therefore, assigned to policing attacks against the G.A.F. The intensity of such attacks will be regulated by the tactical situation existing.
- (b) *Direct Support.* The direct support of land and naval operations remains a continuing commitment upon your forces. Upon call from the supreme commanders concerned either for assistance in the battle or to take advantage of related opportunities, you will meet their requirements promptly.
- (c) *Important industrial areas.* When weather or tactical conditions are unsuitable for operations against specific primary objectives, attacks should be delivered upon important industrial areas by both Bomber Command R.A.F. and U.S.St.A.F.E. (using blind bombing technique as necessary).
- (d) *S.O.E. operations.* All S.O.E./O.S.S. operations undertaken by units of R.A.F. Bomber Command and United States Strategic Air Forces in Europe will be in accordance with the requirements of the Supreme Allied Commanders, who will issue the requisite orders from time to time, under existing procedure.
- (e) *Attacks in support of the Russian armies.* Attacks in support of operations by the Russian armies should be delivered as prescribed from time to time by the Combined Chiefs of Staff.
- (f) *Fleeting targets.* There may be certain other targets of great but fleeting importance for the attack of which all necessary plans and preparations should be made. Of these, an example would be the important units of the German Fleet in harbour or at sea.

6. You are responsible that the operations of the strategic air forces are co-ordinated with the operations of the tactical air forces in the theatres.

(xl)

25th September 1944. Directive by Air Marshal Sir Norman Bottomley, Deputy Chief of the Air Staff, and General Carl Spaatz, Commanding General, United States Strategic Air Forces in Europe, for the Control of Bomber Forces in Europe¹

In accordance with instructions received from the Combined Chiefs of Staff, the overall mission of the Strategic Air Forces remains the progressive destruction and dislocation of the German military, industrial and economic systems and the direct support of land and naval forces.

2. Under this general mission you are to direct your strategic attacks, subject to the exigencies of weather and tactical feasibility, against the following systems of objectives.

First priority

- (i) Petroleum industry, with special emphasis on petrol (gasoline) including storage.

Second priority

- (ii) The German rail and waterborne transportation systems.
- (iii) Tank production plants and depots, ordnance depots.
- (iv) M.T. production plants and depots.

Counter Air Force Action

3. As a result of air action against the production, maintenance and operational facilities of the German Air Force, its fighting effectiveness has been substantially reduced. At the same time, our combined air strength has vastly increased. In these circumstances, we are no longer justified in regarding the German Air Force and its supporting industry as a primary objective for attack. Our major efforts must now be focussed directly on the vital forces of Germany's war economy. To this end, policing attacks against the German Air Force are to be adjusted so as to maintain tactical conditions which will permit of maximum impact upon the enemy. No fixed priority is therefore assigned to policing attacks against German Air Force. The intensity of such attacks will be regulated by the tactical situation existing.

Targets and Target Priorities

4. The list of strategical targets in paragraph 2 and 3, best calculated to achieve the aim, and the relative priorities accorded them, will be issued separately. These priorities will be adjusted from time to time in accordance with the situation.

¹ *Authors' note:* This directive was sent to Sir Arthur Harris with a covering letter of the same date, for which see (xli).

Direct Support

5. The direct support of land and naval operations remains a continuing commitment.

Important Industrial Areas

6. When weather or tactical conditions are unsuitable for operations against specific primary objectives, attacks should be delivered on important industrial areas, using blind bombing technique as necessary.

S.O.E. Operations

7. All S.O.E./S.I.S. operations will be in accordance with existing instructions and procedure.

Co-ordination

8. The procedure as at present established for the co-ordination of operations between the various Air Forces will continue.

(xli)

*25th September 1944. Air Chief Marshal Sir Norman Bottomley,
Deputy Chief of the Air Staff, to Air Chief Marshal Sir Arthur Harris*

Sir,

I am directed to inform you that the Combined Chiefs of Staff have recently decided that executive responsibility for the control of the strategic bomber forces in Europe shall be vested in the Chief of the Air Staff, Royal Air Force and the Commanding General, United States Army Air Forces, jointly.

2. Furthermore they have designated the Deputy Chief of the Air Staff and the Commanding General, United States Strategic Air Forces in Europe as representatives of the Chief of the Air Staff and the Commanding General, United States Army Air Forces, respectively, for the purpose of providing control and local co-ordination through consultation.

3. This change in the responsibility for the direction of your operations takes effect forthwith. In accordance with instructions issued by the Combined Chiefs of Staff your strategical operations will until further orders be governed by the directive which is attached to this memorandum.¹ This directive is also being issued to the Commanding General, Mediterranean Allied Air Forces and the Commanding General, Eighth Air Force.

4. With regard to the direct support of land operations you are to meet promptly the requirements of the Supreme Commander, Allied Expeditionary Force either for assistance in the battle or to take advantage of related opportunities. You are responsible that the operations of your

¹ *Authors' note:* The document, however, is in the form of a letter.

forces in close support of land operations are properly co-ordinated with the operations of the Tactical Air Forces in the theatre. In this matter you are to consult as necessary with the A.C.-in-C., Allied Expeditionary Air Force who will normally co-ordinate air action in accordance with ground force requirements.

5. With regard to the support of naval operations, the responsibility for the air attack of enemy shipping within range of shore based aircraft in the U.K. rest primarily with the Air Officer Commanding-in-Chief, Coastal Command. The strategical air forces may however be called upon to assist, in which circumstances the Air Officer Commanding-in-Chief, Coastal Command will co-ordinate offensive action by Coastal Command with that of other forces taking part in the operation. The general principles of responsibility, as set out in [a] Bomber Command operational instruction, remain unchanged. The question of detailed procedure is being examined by A.O.C.-in-C., Coastal Command and the instructions will be amended in consultation with you.

6. There may be certain other targets of great but fleeting importance which may present themselves, and orders will be issued accordingly. Where possible, however, the necessary plans and preparations for these should be made. An example of this is the attack of important units of the German Fleet in harbour or at sea.

(Sgd.) N. H. BOTTOMLEY

(xlii)

*13th October 1944. Air Marshal Sir Norman Bottomley
(Deputy Chief of the Air Staff)
to Air Chief Marshal Sir Arthur Harris*

Sir,

OPERATIONS 'HURRICANE I' AND 'HURRICANE II'

I am directed to inform you that while the overall mission of the strategic air forces and the general order of priority of targets remains as indicated in the directive under Air Ministry letter dated 25th September, 1944, it has been decided in agreement with the Deputy Supreme Allied Commander and the Commanding General, U.S.St.A.F.E. to undertake special operations for the following purposes:

- (i) In order to concentrate bombing effort on the vital areas of the Ruhr. Outside the question of the great concentration of enemy economic and military resources in the Ruhr, the Supreme Commander has stated that our best opportunity of defeating the enemy in the West lies in striking at the Ruhr and the Saar.
- (ii) In order to demonstrate to the enemy in Germany generally the overwhelming superiority of the Allied Air Forces in this theatre.

This is to be done as soon as weather and other circumstances permit.

The common object of these demonstrations is to bring home to the enemy a realisation of this overwhelming superiority and the futility of continued resistance.

2. To achieve these purposes two plans have been adopted:

- (i) 'HURRICANE I'
- (ii) 'HURRICANE II'

'HURRICANE I'

3. This plan provides for the concentration of effort in time and space against objectives in the Ruhr. The intention is to apply within the shortest practical period the maximum effort of the Royal Air Force Bomber Command and the VIIIth United States Bomber Command against objectives in the densely populated Ruhr. This plan is to be initiated on the first occasion when visual bombing conditions are favourable in that area but when they do not permit of visual bombing against the primary objectives (oil) elsewhere in Germany.

4. Targets for the VIIIth Bomber Command will be selected from the current priorities list of synthetic oil and benzole plants in the Ruhr area. The targets for the R.A.F. Bomber Command are to be areas selected from the undamaged parts of the major industrial cities of the Ruhr. The maximum tonnage is to be concentrated on these areas in order to achieve a virtual destruction of the areas attacked. If circumstances permit the XVth Bomber Command will operate simultaneously against targets in the Saar, Karlsruhe or Stuttgart areas.

5. The maximum effort will be made simultaneously by the Tactical Air Forces against enemy communications. Their object will be to push back enemy railheads. In order to contribute to the concentration of air power over the Ruhr targets selected will be as near to the Ruhr as circumstances permit.

6. The initial stage of this operation, which may require two days visual effort for its completion, is aimed at the maximum disorganisation of the Ruhr and the denial to the enemy of essential facilities and particularly its communications. Apart from the direct destruction caused, it is anticipated that administrative chaos will follow; in the present circumstances this will take a long time to resolve. The appearance of the concentrated bomber forces will affect the morale both of the Ruhr population and of the troops over which the mass of aircraft pass. The unprecedented impact of this new form of attack coupled with the belief that it will be repeated, may well cause a panic evacuation. With this latter end in view and subject to operational considerations, it may be preferable for Bomber Command attacks to be directed progressively from West to East.

7. Subsequent to the launching of 'HURRICANE I' the effect is to be maintained and if possible increased by directing to the Ruhr the maximum night and day bombing effort which can be made available from R.A.F. and VIIIth Bomber Commands. These operations will not,

however, be to the prejudice of any operations which can be delivered effectively on oil targets in Germany generally.

8. An Air Staff note outlining this plan in fuller detail is attached for your information.¹ In paragraph 9 (ii) and (iii) reference is made to attacks on the Dortmund-Ems and Mittelland Canals, on the railway viaducts near Bielefeld and Paderborn, and on the Sorpe Dam. These are all attacks which will contribute directly to the disorganisation of the Ruhr area. The Dortmund-Ems Canal has already been successfully attacked. I am to request you to proceed with the attack of the remaining objectives quoted above as soon as possible and to make such further attacks upon the Dortmund-Ems Canal as may be necessary to keep it out of action. Success in these attacks will contribute to the success of 'HURRICANE I' and of our military operations generally.

'HURRICANE II'

9. This plan provides for the maximum concentration of Allied air attacks against precise targets in Germany on the first occasion on which visual bombing conditions obtain over that country generally.

10. The maximum effort of R.A.F. Bomber Command, and the VIITH XVTH Air Forces will be directed, on the first day on which weather conditions permit, against the major oil targets throughout Axis Europe. Targets are to be selected from the current priority list.

11. The R.A.F. Bomber Command is to contribute to this plan by making a maximum effort against the Ruhr-Rhineland synthetic oil plants.

12. The Tactical Air Forces will simultaneously make a maximum effort against enemy rail communications with the object of forcing back his railheads.

EXECUTION OF 'HURRICANE I' AND 'HURRICANE II'

13. The Combined Operational Planning Committee in consultation with the Commanders concerned, will prepare detailed tactical plans for 'HURRICANE I' and 'HURRICANE II'.

14. I am to request that you will:

- (i) in agreement with the Deputy Supreme Commander and the Commanding General, U.S.ST.A.F.E. launch operation 'HURRICANE I', on the first occasion on which visual bombing conditions obtain over the Ruhr, but when weather conditions generally over Germany are unsuitable for operation 'HURRICANE II' or for the visual bombing of priority oil targets elsewhere in Germany,
- (ii) as soon as 'HURRICANE I' is initiated, continue to concentrate effort on the primary oil targets and undamaged industrial built-up areas in the Ruhr, in so far as weather and other relevant conditions allow
- (iii) on request from the Commanding General, U.S.ST.A.F.E. participate with maximum practicable effort in operation 'HURRICANE II'.

(Sgd.) N. H. BOTTOMLEY

¹ Not printed.

(xliii (a))

*1st November 1944. Air Marshal Sir Norman Bottomley
(Deputy Chief of the Air Staff)
to Air Chief Marshal Sir Arthur Harris*

(The comments of Sir Arthur Harris are printed in italic type.)

D.C.-in-C. Here we go round the Mulberry bush.

ATH

Sir,

I am directed to refer to Air Ministry letter dated 25th September, 1944, and to inform you that in view of the great contribution which the Strategic bomber forces are making by their attacks on the enemy petroleum industry and his oil supplies, it has been decided that the maximum effort is to be made to maintain and, if possible, intensify pressure on this target system. The petroleum industry, including storage, therefore, continues to hold the highest priority so as to prevent rapid recovery which would immediately be reflected in the enemy's strength and war economy.

2. In conjunction with, but subordinate to the offensive against oil targets, the maximum possible disorganization of the enemy's transportation system should be created, particularly in the Ruhr area.

3. In order that there shall be the minimum diversion of effort from these target systems, enemy tank production plants and depots, ordnance depots, M.T. production plants and depots have been deleted from the current directive. When the Supreme Commander considers that the situation is such as to warrant special attacks on these objectives, requests will be made in accordance with the procedure outlined in paragraph 4 of the letter quoted in paragraph 1 above.

4. With regard to attacks on important industrial areas, your attention is directed to the importance of the industrial, administrative and transportation systems of the Ruhr area, as affecting the enemy's war economy generally and as affecting the major land offensive which is planned by the Supreme Allied Commander. The special operation 'Hurricane I' was designed with these factors in mind. (See Air Ministry letter dated 13th October, 1944.)

*and with the
weather out
of mind!*

5. In order to meet the requirements indicated above, the instructions set out in Air Ministry letter dated 25th September, 1944, still stand except that as regards paragraph 4 you will now consult as necessary the Deputy

Supreme Allied Commander who will normally co-ordinate air action in accordance with ground force requirements. The directive issued under cover of that letter is however cancelled, and the attached directive No. 2 substituted. This directive is also being issued to the Commanding General, Mediterranean Allied Air Forces and the Commanding General, Eighth Air Force.

(Sgd.) N. H. BOTTOMLEY

(xliii (b))

1st November 1944. Directive No. 2 for the Strategic Air Forces in Europe

General Mission

In accordance with instructions received from the Combined Chiefs of Staff, the overall mission of the Strategic Air Forces remains the progressive destruction and dislocation of the German military, industrial and economic systems and the direct support of land and naval forces.

Priorities of Objectives

2. Under this general mission you are to direct your strategic attacks, subject to the exigencies of weather and tactical feasibility, against the following systems of objectives:

First priority

- (i) *Petroleum industry*, with special emphasis on petrol (gasoline) including storage.

Second priority

- (ii) *The German lines of communication*: (a) The operations of the Strategic Air Forces based in the United Kingdom are to be directed against enemy lines of communication, with particular emphasis upon the Ruhr. (b) Target lists will be issued from time to time for all Strategic Air Forces.

Important Industrial Areas

3. When weather or tactical conditions are unsuitable for operations against the systems of objectives mentioned above, attacks are to be delivered on important industrial areas with blind bombing technique as necessary. As far as operational and other conditions allow, these are to be directed so as to contribute to the maximum destruction of the petroleum industry and the dislocation of the target systems indicated above.

Targets and Target Priorities

4. The list of strategical targets in paragraphs two and three above, best calculated to achieve this aim, and the relative priorities accorded

them, will be issued separately. These priorities will be adjusted from time to time in accordance with the situation.

Counter Air Force Action

5. As a result of air action against the production, maintenance and operational facilities of the German Air Force, its fighting effectiveness has been substantially reduced. At the same time, our combined air strength has vastly increased. In these circumstances, we are no longer justified in regarding the German Air Force and its supporting industry as a primary objective for attack. Our major efforts must now be focussed directly on the vital sources of Germany's war economy. To this end, policing attacks against the German Air Force are to be adjusted so as to maintain tactical conditions which will permit of maximum impact upon the enemy. No fixed priority is therefore assigned to policing attacks against the German Air Force. The intensity of such attacks will be regulated by the tactical situation existing.

Direct Support

6. The direct support of land and naval operations remains a continuing commitment.

S.O.E. Operations

7. All S.O.E./S.I.S. operations will be in accordance with existing instructions and procedure.

Co-ordination

8. The procedure as at present established for the co-ordination of operations between the various Air Forces will continue.

(xliv (a))

*19th January 1945. Air Marshal Sir Norman Bottomley
(Deputy Chief of the Air Staff)
to Air Chief Marshal Sir Arthur Harris*

Sir,

I am directed to refer to Air Ministry letter dated 1st November, 1944, and to Directive No. 2 for the Strategic Air Force in Europe which accompanied it, and to inform you that some modification of that Directive has become necessary as a result of the growing threat of the G.A.F. Fighter Force to our Strategic bombing operations. A revised Directive, No. 3 is attached, which also includes a paragraph on the subject of the attack of targets in the enemy's U-boat organisation. This Directive supercedes Directive No. 2 which is now cancelled; it is being issued also to the Commanding General, Eighth Air Force and the Commanding General, Mediterranean Allied Air Forces.

S.A.O.—IV—N

2. It will be noted that the German Air Force and primarily its jet production, training, and operational establishments, now becomes a primary objective for attack. No fixed order of priority in relation to the petroleum industry and communications has been accorded to this target system, since operations against it are in effect security measures which must be adjusted from time to time in accordance with the development of the threat. This development can, however, only be checked effectively if offensive measures are initiated forthwith.

3. Attacks on the enemy's Petroleum Industry and his oil supplies are to be maintained and, if possible, intensified, with the object of reducing his oil production to a level appreciably lower than at present. This will impose upon the enemy a far more critical oil situation than he has so far experienced. Moreover, if this can be done while the enemy is engaged in extensive and wide-spread operations on the Eastern front it is likely to undermine rapidly his ability to resist the Russian advance.

4. With regard to para. 3 of the attached directive, a list of industrial area targets calculated to make the best contribution to our strategic aims has already been issued to you. This may be amended from time to time. The existence of this list does not preclude your attacking other industrial centres if conditions prevent operations against those specifically mentioned in the list. Your attention is directed particularly to the importance of the industrial, administrative and communications systems of the Ruhr area, as affecting the enemy's war economy generally, and as affecting particularly land operations on the Western Front. The special operation—'Hurricane I'—was designed with these factors in mind (see Air Ministry Letter dated 13th October, 1944).

5. With regard to the direct support of land operations, you are to meet promptly the requirements of the Supreme Commander, Allied Expeditionary Force, either for assistance in the battle or to take advantage of related opportunities. You are responsible that the operations of your forces in close support of land operations are properly co-ordinated with the operations of the Tactical Air Force in the theatre. In this matter you are to consult, as necessary, the Deputy Supreme Allied Commander who will normally co-ordinate your action in accordance with ground force requirements.

6. With regard to the support of the Naval operations, the responsibility for the air attack of enemy shipping within range of shore based aircraft in the U.K. rests primarily with the Air Officer Commanding-in-Chief, Coastal Command. The Strategic Air Forces may, however, be called upon to assist, in which circumstances the Air Officer Commanding-in-Chief, Coastal Command, will co-ordinate offensive action by Coastal Command with that of other Air Forces taking part in the operation. In this connection the general principles of responsibility and the detailed procedure, as set out in Bomber Command Operational Instruction apply.

7. With regard to para. 6 of the Directive referring to enemy submarine warfare, a priority list of the most profitable targets in the enemy's U-boat organisation, as supplied by the Admiralty, will be issued periodically by the Combined Strategic Targets Committee.

8. There may be certain other targets of great, but fleeting, importance, which may present themselves, and orders will be issued accordingly. Where possible, however, the necessary plans and preparations for these should be made; an example of this is the attack of important units of the German Fleet in harbour or at sea.

9. The foregoing instructions cancel those contained in the following letters:

dated 24th September, 1944.¹

dated 1st November, 1944.

dated 23rd December, 1944.

(Sgd.) N. H. BOTTOMLEY

(xliv (b))

15th January 1945. Directive No. 3 for the Strategic Air Forces in Europe

General Mission

1. In accordance with instructions received from the Combined Chiefs of Staff, the overall mission of the Strategic Air Forces remains the progressive destruction and dislocation of the German military, industrial and economic systems and the direct support of land and naval forces.

Priorities of Objectives

2. Under this general mission you are to direct your strategic attacks, subject to the exigencies of weather and tactical feasibility, against the following systems of objectives:

First priority

- (i) *Petroleum industry*, with special emphasis on petrol (gasoline) including storage.

Second priority

- (ii) *The German lines of communications*: The operations of the Strategic Air Forces are to be directed against enemy lines of communication: Those based in United Kingdom will place particular emphasis upon the Ruhr.

Important Industrial Areas

3. When weather or tactical conditions are unsuitable for operations against the systems of objectives mentioned above, attacks are to be delivered on important industrial areas with blind bombing technique as necessary. As far as operational and other conditions allow, these are to be directed so as to contribute to the maximum destruction of the petroleum industry and the dislocation of the target systems indicated above.

¹ *Authors' note*: Presumably 25th September was meant.

Counter Air Force Action

4. Largely as a result of the concentration of our strategic bomber effort on the enemy's petroleum industry and his communications system, and due to our preoccupations on the battle-front, we have allowed the G.A.F. to recover a great deal of its fighting strength. Moreover, the enemy has concentrated his efforts particularly on developing his fighter force at the expense of other branches of the G.A.F. In this effort to increase the efficiency of his fighter force, he has turned to the rapid development of jet fighters and there is every evidence of his intention to produce them on a large scale as early as possible.

5. Already he has a considerable number of these aircraft in operation. They are superior in speed and armament to our conventional fighters. As soon as they are available in sufficient numbers, and as soon as the enemy has developed suitable tactics for their efficient employment, they will doubtless be employed systematically against our strategic bombers. The conditions which are likely to confront the conduct of our strategic offensive in the near future are therefore serious, unless the enemy's production and employment of jet aircraft is checked in some way.

6. In addition, the employment of these aircraft over the battle-front will place our tactical air forces and the armies themselves at considerable disadvantage. This particularly applies to reconnaissance and to the employment of these aircraft in a ground attack role. It has therefore been decided that we shall employ the necessary amount of strategic effort to neutralise this grave threat. The G.A.F. and primarily its jet production, training and operational establishments now become primary objectives for attack.

Direct Support

7. The direct support of land and naval operations remains a continuing commitment.

Attack of Enemy U-boat Organisation

8. In view of the growing menace of the German U-Boat developments, it has been decided that certain objectives in the enemy's U-Boat organisation will be attacked whenever possible by marginal effort or incidental to operations covered by the preceding paragraphs in this directive.

S.O.E. Operations

9. All S.O.E./S.I.S. operations will be in accordance with existing instructions and procedure.

Targets and Target Priorities

10. The list of targets best calculated to achieve the aims set out above and the relative priorities accorded them, will be issued separately. These priorities will be adjusted from time to time in accordance with the situation.

Co-ordination

11. The procedure as at present established for the co-ordination of operations between the various Air Forces will continue.

(xlv (a))

5th May 1945. Air Marshal Sir Norman Bottomley (Deputy Chief of the Air Staff) to Air Chief Marshal Sir Arthur Harris

Sir,

I am directed to refer to Air Ministry letters dated 19th January, 1945 and 7th February, 1945¹ and to Air Ministry signal of February 11th,¹ all in relation to the employment of the strategic air forces in Europe.

2. In early April 1945, as a result of the extent to which the destruction and dislocation of the enemy's industrial and economic systems had already been achieved by Allied bomber attacks, and as a result of the advances of the Armies into Germany it was agreed with Supreme Allied Headquarters that the main mission of the strategic air forces had become that of direct assistance to the land campaign.

3. A provisional revised directive No. 4 was accordingly drawn up and submitted to the British Chiefs of Staff on the 16th April, 1945. This directive was approved by the British Chiefs of Staff and forwarded to the Combined Chiefs of Staff. Pending approval by the Combined Chiefs of Staff, it was agreed by the Deputy Supreme Commander, the Commanding General, U.S.ST.A.F.E. on behalf of General Arnold and by the Deputy Chief of the Air Staff on behalf of the Chief of the Air Staff that this directive should govern the operations of the strategic air forces in Europe, until further notice. This directive was not however issued to Bomber Command or to the American Strategic Air Forces in Europe.

4. The Combined Chiefs of Staff have now noted directive No. 4 as currently operative. A copy of this directive is attached and should replace directive No. 3 forwarded under Air Ministry letter dated 19th January, 1945, and subsequently amended by Air Ministry signal of 11th February, 1945.¹

(Sgd.) N. H. BOTTOMLEY

(xlv (b))

16th April 1945. Directive No. 4 for the Strategic Air Forces in Europe

General Mission

1. The main mission of the Strategic Air Forces is now to give direct assistance to the land campaign. Operations in support of the Russian

¹ Not printed.

Armies will be made only when specifically requested by the Russian High Command. The direct support of naval operations when necessary remains a continuing commitment.

Objectives

2. Under this general mission you are to direct your strategic effort, subject to the exigencies of weather and tactical feasibility, as follows:

- (a) *Against Oil supplies, with special emphasis on petrol (gasoline) including storage*
- (b) *Against Enemy lines of Communication*
- (c) *To such other missions as may be requested by the Supreme Commanders.*

Counter Air Force Action

3. Policing attacks against the G.A.F. will be continued to the extent necessary to ensure tactical conditions which will prevent effective interference with our ground and air operations.

Attack of Enemy U-boat Organisation

4. In view of the continuing menace of the German U-boat developments, certain objectives in the enemy's U-boat organisation will be attacked whenever possible by marginal effort or incidental to operations covered by the preceding paragraphs in this directive.

Targets and Target Priorities

5. The list of targets best calculated to achieve the aims set out above and the relative priorities accorded them will be issued separately. These priorities will be adjusted from time to time in accordance with the situation.

SECTION IV

British Documents

1941-1945

INTRODUCTION

IN this section are the texts of some of the most important memoranda and other documents concerning the manner in which Bomber Command was to be employed and a selection of the correspondence on the controversies to which it gave rise. They concern such matters as the revelation of the inaccuracy of the bombing in the early years of the war, the transition to area bombing and the reasons for attacking ball bearings, aircraft production, oil plants and communications. Others show the opinion held at various periods on the results of the offensive by the Air Staff, Bomber Command and civilian experts and observers.

APPENDIX 9

Report by the Chiefs of Staff on Air Bombardment Policy, 7th January 1941

WE desire to lay before the War Cabinet certain considerations which in our opinion call for a careful review of our air bombardment policy against Germany.

2. The first of these considerations arises out of the conclusions of the 5th Report by the Lloyd Committee,¹ which afford strong arguments for concentrating our air offensive on oil objectives, especially during the next six months.

3. The second of these is that a body of opinion favours concentration on other main alternatives, such as the enemy morale or navy.

4. Lastly, experience has emphasised that with a bomber force greatly inferior in strength to that of the enemy and with our objectives much more distant than those of the German bomber force, it is imperative that we should exert the greatest possible economy of force in the framing of our bomber policy. An analysis of our bomber effort in recent months has shown that its effectiveness has been seriously diminished by the diversity of the types of objectives which have been allotted to it.

For these reasons we are strongly in favour of selecting one primary aim for our limited bomber effort and of undertaking no material diversion from this aim.

5. We set out below a summary of the principal factors involved and of the arguments for and against each main group of targets.

6. The main alternative groups of targets are:

- (a) the German air force.
- (b) anti-invasion targets.
- (c) transportation.
- (d) industries.
- (e) morale.
- (f) naval objectives.
- (g) oil.

These are examined below.

The German Air Force

7. The reduction of the air threat to our industrial effort, particularly our aircraft industry, and to our ports and trade would undoubtedly be a considerable military asset and would assist us to develop our offensive powers.

With this in mind an exhaustive examination has been pursued continuously to determine the Key Points in the German air force and aircraft

¹ See Vol. I, pp. 159, 290.

industry. It has been found that, owing to the dispersion which the enemy has achieved throughout his air force and aircraft industry, attacks on aerodromes and other objectives are unprofitable. The only hopeful line of attack was against the aluminium factories. The acquisition by Germany of the French aluminium resources has, however, now rendered this also a much less profitable target. On a longer term view, the only means of breaking the power of the German air force and aircraft industry is by the attack on oil, an objective further discussed below.

8. The conclusion, therefore, is that we cannot, with our present strength, effect any appreciable reduction in the scale of air attack on this country in the next six months by concentrating our bomber effort on the German air force or the German aircraft industry.

Anti-invasion Targets

9. Invasion is a vital threat, which we must always be prepared to counter; but as the attack of the invasion ports is a purely defensive operation, it would not be justified until invasion is imminent. Moreover, no suitable objective is offered to our bombers until the enemy forces and shipping are concentrated for the attack.

Transportation

10. The cumulative effect of dislocating the German transportation system is one of the most important contributions that our bombing can make to Germany's economic disruption. This will be increased as the shortage of deficiency commodities increases and their distribution in the quantity required over the extensive areas now under Germany's control becomes more difficult.

11. The most profitable targets for attack are the focal points on the railways and certain points in the canal system. To achieve good effect by material damage experience has shown that a heavy sustained effort is required. It is impossible to achieve effective and lasting dislocation by this means at the relatively large number of focal points with the present strength of our bomber force. Furthermore, the development of coastwise shipping is to some extent relieving the transportation system of Northern Europe.

12. Although this type of target might at a later stage when greater strength is available prove a profitable objective, it does not at present justify its selection as the primary aim for the bomber force. Useful dislocation can, however, be achieved by harassing action over railway marshalling yards which can be done by aircraft failing to find their primary targets.

War Industries

13. The Air Staff's analysis shows that there are certain Key Points in the supply of electricity and gas to the main industrial areas, which, if destroyed, would practically bring the main German war industry to a standstill.

14. The objection to the attack of Power is that the targets are small and comparatively numerous, and do not generally lie in the centre of

largely populated areas where a conflagration might destroy them. While they might prove a practical objective for day attack, they are difficult to locate and hit by high-level bombing at night.

Since, therefore, night bombing is the only form of attack which our striking force can carry out economically at the present time, power does not appear suitable for selection as a primary aim.

Morale

15. The evidence at our disposal goes to show that the morale of the average German civilian will weaken quicker than that of a population such as our own as a consequence of direct attack. The Germans have been under-nourished and subjected to a permanent strain equivalent to that of war conditions during almost the whole period of Hitler's regime, and for this reason also will be liable to crack before a nation of greater stamina.

16. It can be argued that concentrated attacks on the main centres of population in Germany, making the maximum use of damage by fire, combined with harassing action in the interval between the main attacks, might comparatively quickly produce internal disruption in Germany. An incidental effect of this attack would be its repercussions on the morale of the German armed forces and on industrial production, and the stimulation of the morale of our own population.

17. While there is no doubt that concentration on this aim would produce appreciable results, there are equally strong reasons for believing that it would not be nearly so successful as might be expected. The first objection is that the Nazi Regime have already taken the most drastic measures in anticipation of attacks on morale. A rigid censorship is imposed which lessens, if it does not prevent, the spread of reports. Secondly, there is the very great area to be covered, the large number of targets to be attacked and the depth of penetration required. Moreover, our own experience indicates the local and transient effects of concentrated attacks on centres of population.

With a bomber force of the strength of that at present available to Germany this might be a practical objective. With our existing strength it is unlikely that we could achieve results on a sufficiently large scale to justify concentrating on this particular type of target.

18. Morale as a main target is one which it may prove profitable to turn to as a long-term objective for our expanded bomber force, and when the state of German morale is less robust than it is at the moment. We think that there is not sufficient justification to concentrate upon it with our present strength, although we believe that the undermining of enemy morale must be an aim which we must always keep in mind. We should, therefore, allot as alternative targets centres of industrial population which could be attacked by aircraft failing to find their primary objective.

Naval Objectives

These may be considered under two heads:

19. *Enemy Surface Forces.* Our naval forces are, at the present time,

operating under conditions of maximum strain. A very serious threat to our control of sea communications may arise if the Germans employ their fast Capital Ship units on the trade routes. If our bomber offensive were to put the enemy Capital ships out of action the effect would be felt immediately in our naval dispositions all over the world. Not only would more powerful hunting forces become available, but we should be able to concentrate greater light forces in the vital North-Western Approaches for the defence of trade.

20. The disadvantage of concentrating our bomber effort on this type of target arises primarily from the tactical difficulties of attacking it with success. Enemy forces at sea afford only a fleeting target, and when in harbour they are well defended by guns and searchlights. Situations may, nevertheless, arise when bombing effort to achieve damage or destruction may be justifiable. To damage the Capital Ship large bombs are necessary, and only a small number of such bombs can be carried in each attack. Moreover, the targets are situated in the most strongly defended areas in Germany and we have already experienced heavy casualties in endeavouring to destroy them. In addition, the large searchlight concentrations at the naval bases makes accurate bombing impossible. The probability of hitting is therefore very low.

21. *Submarine Objectives.* The best objectives for attack are the construction yards. The Germans have, however, carefully dispersed these targets over a wide area including the Baltic and French ports. They are small and uneconomical targets and, although a concentration of attack upon them would certainly lead to a slowing up of submarine output, the effect would not be considerable. We do not think that this would be the most profitable primary aim for the bomber force, but should any large concentrations of U-boats be reported, they would be well worth attacking.

22. We do not recommend that naval objectives should be a primary target, but favourable opportunities should not be lost for destroying or damaging naval units or concentrations of submarines.

Oil

23. The Fifth Report of the Lloyd Committee brings out the following points:

- (i) On the assumption that our present scale of attack on the enemy's oil is maintained, the enemy's oil position will be causing him grave anxiety by the Spring of 1941. Their greatest anxiety will be in respect of gas (Diesel) oil.
- (ii) After the end of March, if our scale of attack remains as at present, the enemy's oil position will gradually improve.
- (iii) If, however, we are able to increase our scale of attack by bombing, sabotage, and other means, between now and the Spring of 1941, we may be able to place the enemy in a most critical position.
- (iv) Although the stoppage of Roumanian supplies would be the biggest single blow to the German oil position *the destruction of his synthetic oil plants in Germany alone would bring about a crisis.*

24. If these deductions are agreed, it appears that the destruction of

Germany's synthetic oil plants will reduce Germany to such a shortage of oil within the next six months that there will be widespread effects on German industry and communications. It is even probable that within this time an appreciable effect may be felt in the scale of effort of her armed forces. This is particularly so, since a high proportion of the loss of oil we could inflict would fall on certain grades of oil which might then be almost unobtainable. Even if no interruption occurs to her Roumanian supplies this degree of shortage will be aggravated during the year since supplies other than from synthetic plants will not entirely keep pace with German consumption. The interruption of Roumanian supplies, in addition to the destruction of the synthetic plants might render Germany impotent before the end of 1941.

We wish to stress that we have based these conclusions on the assumption that the figures in the Lloyd Report are approximately correct.

25. Of all types of targets in the German war machine the oil supply is the most vulnerable and practical for air attack. The synthetic oil plants are comparatively large targets, few in number, to some extent self-destructive and mostly in areas which are at present less heavily defended than others. The main targets are only nine in number, namely, the major synthetic plants. The complete destruction of these nine plants alone would reduce Germany's internal production of oil by 83 per cent. The remainder of the synthetic production is at present derived from a further eight plants.

26. From our experience we estimate that if the destruction of these nine major and eight minor synthetic oil plants is made the primary aim, this could be achieved within a period of four months.

27. It can be argued that, if we do not succeed in destroying the nine major targets, or if we are unsuccessful in impeding the supplies of oil from Roumania, the enemy may escape a crisis in oil, and that, in this event, the effort which we have expended will not have contributed so much to his defeat as would a similar scale of attack directed against other primary targets.

28. We do not think this argument is justified. The limited number of targets to be attacked under this primary aim persuade us that there are good prospects of destroying them, provided that our plans are framed so as to produce the maximum concentration upon them whenever possible.

29. The attack on oil targets would not be incompatible with the attack on morale since certain of these targets are situated in industrial areas.

30. Our conclusion therefore is that synthetic oil plants should be our primary aim; if this is accepted operations should begin at the earliest possible date in order to take full advantage of the longer nights.

Recommendations

Subject to the acceptance of the 5th Report of the Lloyd Committee, we invite the War Cabinet to agree to an air bombardment policy on the following lines:

- (a) The primary aim of our bomber force during the next six months

should be the destruction of the German synthetic oil plants. We emphasise the importance of adhering to this aim until it is achieved.

(Since it will not be practicable, because of meteorological conditions, to make profitable attacks on oil targets every night, and since some aircraft detailed for oil targets will fail to find them, it is necessary to allot a secondary aim.)

- (b) The secondary aim will be the lowering of enemy morale, particularly in industrial areas. This object can be conveniently furthered by allotting industrial areas and railway yards as alternative objectives to all aircraft detailed for the primary aim, and by making periodical heavy concentrations against industrial towns on nights which are unsuitable for the attack on oil targets.
- (c) The only diversions from (a) and (b) above should be:
 - (i) Invasion ports, when invasion is believed to be imminent;
 - (ii) Enemy naval forces, when favourable opportunities are presented for destroying or damaging important naval units or concentrations of submarines.¹

DUDLEY POUND
J. G. DILL
C. PORTAL

¹ *Authors' note:* For the resulting directive of 15th January 1941, see Appendix 8 (xiii).

APPENDIX 10

Memorandum by Lord Trenchard with comments by the Chiefs of Staff, May–June 1941

(i)

*Memorandum by Marshal of the Royal Air Force Lord Trenchard
on the Present War Situation Mainly in so far as it Relates to Air,
19th May 1941¹*

WHEN we have surveyed the whole area of the struggle and the factors involved, what is the outstanding fact? It is the ingrained morale of the British nation which is nowhere more strongly manifest than in its ability to stand up to losses and its power to bear the whole strain of war and its casualties.

History has proved that we have always been able to stand our Casualties better than other Nations

Strategically it must be sound to hammer the weak points of the enemy. When we talk of weak points we mean the spheres in which we are relatively stronger than he is. Where are those points to be found? Certainly not in land fighting.

The German army, with its eight to ten million trained and disciplined fighting men, well equipped and containing countless mechanised units, is a far more powerful weapon than we have to-day, or can have. At sea, though we have an infinite naval superiority, there is no point at which we can strike decisively with our navy, and the German submarine is a very powerful weapon.

It must be realised that to-day the Sea is a Source of Weakness to us as well as a Source of Strength

Germany has been able to turn the weapon of the blockade against us, and it is we, owing to our sea approaches, who are being increasingly blockaded, while Germany, owing to her land frontiers, is enabled to draw on the resources of the whole of Europe and the vast areas of Russia beyond. We cannot therefore find that weak point which we should attack either on the sea or by the blockade.

Germany, and Germany alone, is the Enemy that we have got to beat

It may be argued that Italy is the weak point, but this would be false, as nothing that we can do to Italy will win the war for us.

Where then is Germany's weak point? It is to be found in precisely the

¹ *Authors' note:* Circulated by the Prime Minister to the Chiefs of Staff.

sphere in which I began this paper by stating that we had a great strength. All the evidence of the last war and of this shows that the German nation is peculiarly susceptible to air bombing. While the A.R.P. services are probably organised with typical German efficiency, their total disregard to the well-being of the population leads to a dislocation of ordinary life which has its inevitable reaction on civilian morale. The ordinary people are neither allowed, nor offer, to play their part in rescue or restoration work; virtually imprisoned in their shelters or within the bombed area, they remain passive and easy prey to hysteria and panic without anything to mitigate the inevitable confusion and chaos. There is no joking in the German shelters as in ours, nor the bond which unites the public with A.R.P. and Military services here of all working together in a common cause to defeat the attacks of the enemy.

This, then, is their weak point compared with ourselves, and it is at this weak point that we should strike and strike again.

When we examine the technical factors governing our Air Force, and its use, we find striking confirmation that this policy is correct.

Taking all in all the percentage of Bombs which hit the Military Target at which they are aimed is not more than one per cent

This means that, if you are bombing a target at sea, then 99 per cent. of your bombs are wasted, but not only 99 per cent. of the bombs are wasted, but 99 per cent., too, of the pilots and of the training which went to produce them, and of all the machines and the labour and plant and raw material which went to their construction, and, further back, 99 per cent. of all the ships which have transported the raw materials and of the finance which purchased these raw materials are all equally wasted. So, too, if the bombs are dropped in Norway, Holland, Belgium or France, 99 per cent. do Germany no harm, but do kill our old allies, or damage their property or frighten them or dislocate their lives. It is more than wasted. If, however, our bombs are dropped in Germany, then 99 per cent. which miss the military target all help to kill, damage, frighten or interfere with Germans in Germany and the whole 100 per cent. of the bomber organisation is doing useful work, and not merely 1 per cent. of it.

So technical factors also point to the wisdom of striking at what in fact is Germany's weak point. We should therefore exploit to the uttermost this vulnerable spot in the German nation and we should bomb persistently military targets in every town in Germany and never let up on them.

The Germans have an advantage over us in that their geographical situation enables them to utilise every single type of bomber to drop bombs on England if they want to, and they do. While obviously their long-range bombers can attack any part of the British Isles, their short-range bombers, their reconnaissance machines, their fighters and even obsolete models all can hit Portsmouth, Southampton and Dover, whereas only our fairly long-range bombers can reach even the nearest target in Germany. Again, owing to the shortness of summer nights we can only bomb them for a relatively short time, whereas they can bomb England almost all the hours of darkness.

S.A.O.—IV—O

Our long-range bombers constitute only a comparatively small part of our total Air Force.

In the face, therefore, of these handicaps it is vital that none of our *long-range bombers* should be diverted from the single task of bombing military targets in Germany. By Germany, I do not mean only Western Germany, I mean Munich, Berlin, Stuttgart, and if possible in time even Vienna, where I understand Headquarters of the Army and other departments have been moved to from Germany. There is at present a far too large percentage of our bomber force which cannot be used to attack the military objectives in Central or Southern Germany either in winter or summer—a percentage which must be continually reduced. Meanwhile this percentage can be used, and only it should be used, for hitting at the oil in Rotterdam, the shipping on the coasts, the invasion ports, the empty barges, the ships in Brest and the other opportunities that exist for weakening the enemy outside Germany.

There should be established the same sort of clear priority for the use of bomber aeroplanes based on strategical reasons as exists in the economic sphere and is maintained by the Cabinet.

Absolute priority should be given to the long-range bombers for this work and this prior claim on the use of the long-range bombers must be backed up by a sufficient priority being accorded for the supply and training of pilots, air and ground staff, as also for the planes and the necessary materials of this branch of the Air Service. The training of these bomber crews must be given priority over the training of the crews for Coastal Command aircraft, Army Co-operation Squadrons, the Fleet Air Arm, Photography and Fighters, and this priority must be maintained despite the pressure on the Air Force by various departments, which I know must be great, with the Army wanting invasion ports bombed, the Navy wanting submarine bases and ships bombed, and the Ministry of Economic Warfare wanting the oil in Rotterdam and elsewhere bombed, a demand which becomes all the more acute owing to the small size of the bomber force, due not merely to the lack of belief in the efficacy of hitting with the bomber, but to its appalling neglect in the years before the war and at the beginning of the war.

What do I mean by persistent bombing? I mean that on every single night, and most days, some bombing of military targets in Germany must take place, even if sometimes only one machine can be sent. When all the conditions are favourable a great force can go to destroy some military objective of first-class importance. At other times perhaps military objectives in twenty towns should be selected for an attack by ten machines each. On another night perhaps one machine should be sent to towns in Germany with over 5,000 inhabitants to attack some military objective in that town. The plan must be flexible, but must result in unremitting nightly and daily bombing of military targets in Germany, sometimes here, sometimes there, sometimes with a large concentrated force and at others with widely dispersed small forces or single machines. Day bombing must necessarily be less than night bombing as it can only be done in bad weather and in very fast machines, but more day bombing must be done. The object of this night and day bombing of military targets in Germany

is to make the civil population realise what war means, and make them realise that if there is a military objective in their town it is going to be bombed.

Hitherto, we have not done this. There have been months or weeks without a machine going into Germany. Not a single day or night should pass without a visit from our machines.

Such a policy may necessarily involve fairly heavy casualties, but the counting of our losses has nothing to do with the soundness of the plan once you accept the view that the nation can stand their casualties. The pilots in the last war stood it, and the pilots of this war are even better, and, I feel, would welcome a policy of this description. It will need the very best and most up-to-date type of long-range bombers from America and this country, and it will also mean that great reserves are essential. It is quite possible to lose as many as 70 per cent. of your machines in a month, though these will not be all completely written off, as some can be repaired to fly again after crashes and accidents in England. Reserves will be needed of 400 to 500 per cent., not the mere 100 per cent. mentioned by the late Minister of Aircraft Production, a statement at which every airman must have said to himself: 'What—only 100 per cent. reserves!'

In the last war casualties of pilots were sometimes 30 per cent. per month or more, but now, owing to the universal use of parachutes, the percentage of those killed and wounded will be greatly reduced.

I am convinced that when this policy has been adopted, and then only if it has been pursued unrelentingly and persistently, will it be possible, when the morale of the German nation has begun to crumble, to utilise with success in victory over the German military forces the necessarily smaller British Army which is slowly but surely being equipped 100 per cent. with the necessary mechanical instruments of modern warfare, such as tanks, guns, munitions and aircraft.

It is because it is the only effective way in which we can hit at our enemy—Germany—now, and it is the only way that we can make effective for victory our eventually assembled forces of weapons and men that I so strongly advocate the dropping on military targets in Germany of every possible bomb where a 100 per cent. of every load dropped will have its value.

Provided nothing is allowed to interfere with the fullest possible production of bomber aircraft, I do not underestimate the importance of reinforcing strongly, with machines, tanks, munitions and men, Africa, Iraq and Singapore—the three areas vital to the Empire—and of constructing the largest possible fleet of fast surface craft to keep open the American artery which is so essential during the eighteen months or two years while the policy I urge is exploited persistently and unflinchingly.

(Sgd.) TRENCHARD
Marshal of the Royal Air Force.

(ii)

Notes by Sir Dudley Pound, Chief of Naval Staff, on Lord Trenchard's memorandum, 2nd June 1941

I am in agreement with the general thesis of this paper, that is to say that, so far as we can plan ahead the way the war is to be won (apart from the blockade) the most likely way of doing this is by achieving complete air superiority.

Not having any footing on the Continent today, an army can clearly only be employed when we can regain such a footing, and I am quite clear myself that we can only do this if we can approach the enemy coasts under cover of overwhelming air superiority (this of course means that the only place we can re-enter Europe in force is across the narrow strip of water, the English Channel).

While agreeing, therefore, with the general thesis, the paper is a complete over-statement and it suffers from the dangers of all over-statement. Read literally, it would seem very unlikely that we should get adequate air forces for the Battle of the Atlantic or that the Army would get any co-operation aircraft, in which they are so sadly lacking and the need of which is felt in every operation.

I suggest, therefore, that the line to be taken should be that while agreeing with the general thesis, we must not go to extremes. The danger of hard and fast priorities unintelligently interpreted has often been exemplified. The priority of all requirements must be discussed as they arise, and as long as the matter is approached in the spirit of the last sentence of paragraph 8 of C.A.S.'s paper, I do not think any difficulty should arise.

My conclusion, therefore, is that we might agree with the principle subject to its intelligent interpretation.

(Intld.) D. P.

(iii)

Comments by Sir John Dill, Chief of the Imperial General Staff, on Lord Trenchard's memorandum, 2nd June 1941

1. Lord Trenchard makes two main points:

- (a) That our primary bombing target should be German morale.
- (b) That the building up of a strong bomber force should be given the highest priority.

The primary Bombing Target

2. There is, I think, general agreement that the Battle of the Atlantic must at present remain our chief preoccupation: after that our effort

should be employed against the most profitable targets in Germany. The possibilities are:

- (a) Morale.
- (b) Oil.
- (c) Transportation.

The arguments in favour of attack on morale are set out in Lord Trenchard's paper. It is, however, essential to take into account the huge bomber effort needed to attack towns with sufficient intensity to produce a general breakdown in German morale: in order to get real effect attacks must be severe and frequently repeated. With our existing strength, and allowing for inevitable diversions of effort on to other targets, it is unlikely that we could achieve results on a large enough scale to justify selecting morale as our primary aim *at present*. At the same time it will almost certainly be the most profitable target when our bomber force expands, and in the meantime every opportunity should be taken of combining attacks on other targets with attacks on morale: our propaganda for home consumption should make the most of such attacks.

3. *Oil* has for some time been considered as the ideal economic target in Germany, and in their latest report Lord Hankey's Committee have asked for heavy bombing attacks during the next few months on German oil resources. Experience has however shown that, confined as we are to night bombing, our chance of doing real damage to stocks and production are small.

4. *Transportation* is probably the most profitable target in the near future. The Joint Intelligence Sub-Committee recently reported that continuous and co-ordinated bombing of carefully selected and related key points might produce a critical position: Lord Hankey's report referred to above suggests attacks on the road transport system at key points. The best railway targets lie within effective range of all our bombers throughout the year and, moreover, lie generally among workers' houses and congested industrial areas, where the morale effect would be most marked.

5. To sum up, I suggest:

The Battle of the Atlantic should have overriding priority. Subject to this consideration:

As a *short-term* policy, transportation should be our primary target, with morale the secondary one.

As a *long-term* policy, we should attack morale as a primary target as soon as our bomber force is large enough to have decisive effect.

Priority to be assigned to the Bomber Force

6. I agree with the principle laid down in para. 9 of C.A.S.'s memorandum, that before the Army can operate on the Continent the R.A.F. as a whole must have established decisive air superiority.

But we must be clear that, before any overriding priority is given to the building of a bomber force to achieve this end, adequate provision must first be made for the security of this country and of those areas overseas which are essential for the maintenance of our war effort.

(Signed) J. G. DILL.

C.I.G.S.

(iv)

*Note by Sir Charles Portal, Chief of the Air Staff,
on Lord Trenchard's memorandum, 2nd June 1941*

1. I agree with Lord Trenchard's main thesis that the most vulnerable point in the German nation at war is the morale of her civilian population under air attack, and that until this morale has been broken it will not be possible to launch an army on the mainland of Europe with any prospect of success.

2. I also agree that to exploit this weakness the main weight of our air attack should be directed against objectives in Germany, so situated that bombs which miss their target will directly affect the morale of the German civilian population. I share Lord Trenchard's view that absolute priority should be given to the building up of a bomber force of decisive strength equipped with aircraft capable of reaching all parts of Germany. I would add, however, that this should be done after the minimum force of aircraft (e.g. fighter, general reconnaissance, Fleet Air Arm, etc.) essential for our security has been provided.

3. The morale effect of bombing depends largely on the enemy's knowledge of our ability to inflict very severe material damage. Small scale raids will therefore be of little value unless there are also many heavy raids. Furthermore morale is apt to recover quickly and the maximum effect can only be achieved by repeated attacks on the same place.

4. In view of our present relatively small bomber force and the shortage of bomber aircraft suitable for daylight operations, we should concentrate our efforts against a limited number of objectives and aim at sustaining our attack on them. Even during the period of short summer nights, suitable objectives are to be found in the densely populated and industrially important Ruhr area.

5. If we are to have a bomber force which can maintain attacks on objectives throughout Germany it is essential that the efforts of our own and the American aircraft industry should be concentrated to this end and that other aircraft requirements should be reduced to a minimum.

6. I would add one important corollary to Lord Trenchard's argument that we can depend upon the superior staying power of our own people compared with the Germans. This is that our superiority in temperament should be fortified to the utmost practicable extent by material aids designed to alleviate the hardships that have to be endured. Clearly we should take no risks in this matter but should at once start to organise all possible measures of relief and protection on a nation-wide scale.

(Intld.) C. P.
Chief of the Air Staff.

APPENDIX 11

Minute from the Secretary to the Chiefs of Staff Committee to the Prime Minister, 11th June 1941

Prime Minister,

The Chiefs of Staff have considered your Personal Minute of the 8th June¹ and submit the following reply:

2. They are of the opinion that, in order to obtain the maximum offensive value from our Bomber Force, it is of the highest importance that its operations should not be conducted in a hand-to-mouth manner, but in accordance with a definite strategic aim.

3. The enemy's failure in this respect has been to our immense advantage, since we have ample experience to judge what would have been the effect had he maintained a consistent policy, such as a concentration on our ports or on the aero-engine industry.

4. That it is practicable to maintain a definite aim is shown by the attached record² of our attacks during the last three months against Battle of Atlantic targets.

5. There is also the psychological factor. There is no doubt that the morale and keenness of the bomber crews will be sustained at a far higher pitch if they know that their operations are part of a comprehensive plan.

6. The selection of a short-term policy aiming to disrupt the transportation system of Western Germany and the lowering of the morale of the industrial workers of that area was based on the following main factors:

- (a) The dependence of the German economic and military effort on the Ruhr-Rhineland area and the communications that traverse and radiate from it.
- (b) The extended character of German military operations has considerably added to the strain on communications, which are now the weakest link in the enemy's economic and military system. Moreover, any serious interference with communications would interfere with the enemy's military plan and, in particular, would delay a concentration in the West for invasion.
- (c) With the size of bomber force at present available this primary aim combines best with the secondary aim of morale. The targets lie amongst workers' dwellings in congested industrial areas, and their attack will have a direct effect on a considerable section of the German people. The interruption of supplies will influence to some extent the morale of the whole of Germany.

7. The Chiefs of Staff submit therefore that the policy they recommend

¹ *Authors' note:* Not printed. In this minute the Prime Minister had questioned the value of a long-term bombing policy and had suggested that it might be better to have a programme on a month-to-month basis.

² Not printed.

is not 'restricted.' The targets to be attacked cover a wide area of Germany and allow for all weather conditions.

In addition, the necessary diversions imposed by the Battle of the Atlantic would, as far as possible, have as a secondary objective the German civilian morale.

8. In conclusion, the Chiefs of Staff emphasise that the kind of attack on railway centres which they now contemplate bears no relation to the series of harassing attacks which were delivered against marshalling yards, such as Hamm, earlier in the war, when our Bomber Force was insignificant and our primary objective was German oil.

(Signed) L. C. HOLLIS

APPENDIX 12

Memorandum by Lord Hankey for the Chiefs of Staff on German Oil Targets, 15th July 1941

I SUBMIT a final appeal for air attacks on German oil targets.

2. Our Military Mission to Moscow has pressed for attacks on Roumanian oil targets. Mr Berthoud, one of our best experts, has been sent to Moscow to give advice. The Russians have responded well. Official Communiqués for many days have reported night and even day attacks on Ploesti, Constanza and Sulina. Reports of the first attacks were not encouraging, but according to the official Weekly Résumé for 10th July:

'Reports have been received about Russian bombing attacks on Roumanian targets, and it seems certain that the raids on Constanza did considerable damage. The railway station is said to have been destroyed and two empty tankers in the port are believed to have been sunk or severely damaged'.

In addition, shipments of Roumanian oil to the Adriatic by the Mediterranean route have ceased.

As good comrades in arms we ought to support this contribution to the common cause, especially as it has been undertaken at our request.

3. These attacks, if persisted in, should cause the Germans grave anxiety and loss. They are already drawing on reserves of oil for operations. The Russian supply (700,000 tons to 1,000,000 tons a year) has ceased. The Roumanian supply is not only threatened, but a large part is mortgaged to the Eastern Front. Part of the third great source of supply, the synthetic production, is already within range of our aircraft and prospects will improve with each successive phase of the new moon. We should take advantage of this situation. It was stated by the C.O.S. Committee last January:

'Of all types of targets in the German war machine the oil supply is the most vulnerable and practical for air attack. The synthetic oil plants are comparatively large targets, few in number, to some extent self-destructive and mostly in areas which are at present less heavily defended than others. The main targets are only nine in number, namely, the major synthetic plants. The complete destruction of these nine plants alone would reduce Germany's internal production of oil by 83 per cent.¹ The remainder of the synthetic production is at present derived from a further eight plants.'

4. Since January the Chiefs of Staff have changed their view. In the intervening months there have been very few attacks on oil targets, and

¹ This figure is an exaggeration.

the more important have been directed against Gelsenkirchen, which is now reported to be hard to find and to hit owing to persistent haze and for other technical reasons. It is admitted that we ought to do better against Leuna, and there are other synthetic oil targets.

5. In fact, however, no really heavy and sustained attack has ever been made on oil targets, as repeatedly advocated by the Committee on Preventing Oil from reaching Enemy Powers. Attacks have for the most part been small or at best medium and at intervals, giving time between them for repairs and the re-establishment of morale among the workers. If attacks on oil targets are to succeed, the same methods must be adopted as against our other main targets, such as battle cruisers at Brest, shipyards at Kiel and Bremen, and factories and railway communications in the Ruhr. That is to say the attack must be heavy and persistent. If this view is correct there is no reason to be depressed by past failures.

6. The argument, in favour of striking at the morale of the population is impressive, but in their Report of 7th January the Chiefs of Staff stated that:

‘The attack on oil targets would not be incompatible with the attack on morale since certain of these targets are situated in industrial areas.’

It is, however, just as important to strike at the morale of the High Command as at that of the people. We did not like it when in a single air raid at Pembroke we lost 70,000 tons of Admiralty oil. We should like it less if we lost, say, a month’s imports or one-tenth of our tanker tonnage or of our storage plants. We should strike a heavy blow at the morale of the German High Command if, on top of the loss of Russian supplies and of some Roumanian supplies, and of the closing of the Mediterranean route, were to come progressive attacks on synthetic supplies—at a time when they are already drawing on reserves of oil.

7. It has been suggested that attacks on oil targets will not give immediate help to Russia. If the above remarks on morale are correct, however, this would not seem to be the right view. Leuna, which was attacked last week, is reported to be heavily defended. This is a measure of the importance the Germans attach to synthetic oil plants. It seems unlikely that they would allow them to be destroyed in detail without withdrawing fighter forces to protect them, as in the case of other decisive air targets.

8. The Committee on Preventing Oil from reaching Enemy Powers does not ask for a relaxation of attacks on other decisive targets, but that synthetic oil should come into the programme of decisive targets.

(Intd.) H.

APPENDIX 13

Report by Mr. Butt to Bomber Command on his Examination of Night Photographs, 18th August 1941

SUMMARY

Statistical Conclusions

An examination of night photographs taken during night bombing in June and July points to the following conclusions:

1. Of those aircraft recorded as attacking their target, only one in three got within five miles.
2. Over the French ports, the proportion was two in three; over Germany as a whole, the proportion was one in four; over the Ruhr, it was only one in ten.
3. In the Full Moon, the proportion was two in five; in the new moon it was only one in fifteen.
4. In the absence of haze, the proportion is over one half, whereas over thick haze it is only one in fifteen.
5. An increase in the intensity of A.A. fire reduces the number of aircraft getting within 5 miles of their target in the ratio three to two.
6. All these figures relate only to aircraft recorded as *attacking* the target; the proportion of the *total sorties* which reached within five miles is less by one third.

Thus, for example, of the total sorties only one in five get within five miles of the target, i.e. with[in] the 75 square miles surrounding the target.

Recommendations

1. These results though fairly reliable should be checked by a thorough expert study of the day photographs, and by a comparative study of photographs of German and British towns.
2. In order to keep these figures up to date, and to obtain continuous records of the success of our navigation, staff should be set up to maintain statistical records of night photographs and any other evidence that may be available.
3. This staff should consist of at least one trained statistician, with a sufficient clerical staff. He should have authority to modify forms and questionnaires in order to make sample enquiries, e.g. to replace some existing questions for a certain period by others designed to elucidate some particular point.

I. NIGHT PHOTOGRAPHS IN JUNE-JULY 1941

A Statistical Analysis

1. Particulars sufficient for some rough statistical analysis have been collected for about 650 photographs taken during night bombing operations between 2nd June and 25th July. They relate to 28 targets, 48 nights, and 100 separate raids. All show enough ground detail for the position photographed to be plotted if previous photographs of the area exist.

Nearly half of these photographs were taken independently of bombing, but as in all these cases the position believed photographed was named, they are equally useful for measuring the accuracy of navigation and have been included.¹

The technique of taking night photographs is such that the area photographed is not necessarily the same as the area intended to be photographed. Changes of speed, height and direction, and any tilting of the aircraft will affect the result, as will delay in launching the flash. But the displacement is most unlikely to be more than a mile or two miles on a photograph which normally shows an area of over a square mile. As for the purposes of this enquiry the 'target area' is taken as the area within five miles of the aiming point, the possibility of error in the results from this source is allowed for. There is no reason to suppose that more photographs intended for points in the target area actually show points outside than vice versa.

2. *Success of attacks over period as whole*

The total number of photographs purporting to represent the target, target area, or believed target area for which details were obtained was 633. Of these 326 or 51 per cent. have not been plotted; 113 or 18 per cent. have been pinpointed outside the target area, and 194 or 31 per cent. within the target area.

The Photographic Interpretation Section are confident that all un-plotted photographs must be outside the target area. There seems no doubt that, in view of the specialised skill they have developed in examining some 750,000 prints, this claim is perfectly correct.

There is no reason to suppose that aircraft equipped with cameras are particularly unsuccessful. These 650 photographs were taken on over 500 different sorties; a sample of more than 1 in 10 of the sorties recorded as attacking during the raids covered.

The conclusion seems to follow that only about $\frac{1}{3}$ of aircraft claiming to reach the target area actually reach it.

Prolonged consideration has revealed only one real possibility of error in this result. It may be that violent evasive action by aircraft will give rise to complete photographic failures and it may be that such action has to be taken particularly often within the target area. If so the results would be biased. It is difficult to say whether these conditions are fulfilled, but from the records of Command Photographic Officer, it appears that some

¹ The separate figures are available and yield almost exactly similar results.

75 intended photographs either failed to be taken or, if taken, to come out in the period concerned by reason of evasive action, searchlights and flak. It is most unlikely that these failures wholly occurred over the target area. Supposing, however, that they did, and that had they been taken all would have been successfully developed, about 700 photographs with about 275 in the target area would have been available, i.e. the percentage of 31 reached above would be raised to 39.

This figure represents the maximum possible consistent with the data. The rough ratio of $\frac{1}{3}$ given above is more probable. Two qualifications to this average result should be made clear:

- (a) This figure of one third (and all other percentages given in paragraphs (4) to (7) below) relate to the aircraft recorded as having attacked the primary target, not to the total aircraft despatched. In the raids considered in this analysis 6,103 aircraft were despatched but 4,065 attacked, i.e. 66 per cent. Thus of the total despatched not one-third but one-fifth reached the target area.
- (b) It must be observed also that by defining the target area for the purpose of this enquiry as having a radius of five miles, an area of over 75 square miles is taken. This must at least for any town but Berlin consist very largely of open country. The proportion of aircraft actually dropping their bombs on built-up areas must be very much less, but what this proportion is, however, cannot be indicated by the study of night photographs.

3. Factors affecting the success of attacks

The data collected enable some analysis to be made to indicate the importance of some of the main factors affecting this general percentage of success. In the following paragraphs, ground features, moon, haze, cloud and A.A. are considered. Attempts to measure the effects of wind changes and searchlights which are said to be very important factors broke down through lack of data.

4. Ground features

Too few raids have been considered to allow any attempt to discover how easily any individual target can be found, but the following figures for groups of towns may be of interest.

TABLE I: *Effect of Ground Features*

	No. of Raids	Photographs		
		Total	In Target	% in Target
French ports (Brest, Lorient, La Pallice)	9	94	60	64
German ports (Bremen, Emden, Hamburg, Kiel)	21	91	16	18
Ruhr (Dortmund, Duisburg, Dusseldorf, Essen, Hamm, Koln, Schwerte etc.)	38	225	21	9
All Germany	91	539	134	25
All targets	100	633	194	31

This table brings out very clearly the relative success with which the French Ports (principally Brest) are reached, and it will be seen that had this group been excluded from the figures considered in section (2), it would have been necessary to reduce the figure of $\frac{1}{3}$ for the success of attacking aircraft in reaching the target to $\frac{1}{4}$.

These results are however considerably affected by the phase of the moon, e.g. only 1 of the 9 raids on French Ports were in the moonless period against 11 of the 21 on German ports. Making rough allowance for this factor the following ratios are obtained:

Germany (all targets)	.	.	.	100
French Ports	.	.	.	215
German Ports	.	.	.	125
Ruhr	.	.	.	25

The low figure for the Ruhr is presumably due to the prevalence of haze and smoke in the period covered and the absence of land marks.

5. Moonlight

Defining the full moon period as the night of full moon and three nights before and after; and the new moon and half moon periods similarly, we obtain the following figures:

TABLE 2
Effect of Moon

(1) All Areas

Moon	Sorties		Photographs		
	Despatched	Attacked	In Target	Total	In Target as Percentage of Total
Full	1,860	1,317	105	233	45
Half	2,837	1,766	80	260	31
New	1,406	982	9	140	6
TOTAL	6,103	4,065	194	633	31

(2) Germany

Full	1,500	990	74	190	39
Half	2,585	1,551	52	213	24
New	1,377	957	8	136	6
TOTAL	5,462	3,498	134	539	25

It will be noticed that in the full moon period over all targets 45 per cent. of the successful photographs are of the target area, in the mid-moon

31 per cent., and in the new moon 6 per cent.: percentages in the ratio of 15 : 10 : 2. When the figures for France are excluded all the percentages are of course reduced, but their ratios remain about the same.

6. Haze

Ground haze and industrial smoke obviously have a very considerable effect on the success of attacks. To test this each of the forms rendered with photographs has been examined, and all references to haze have been classified into 3 groups:

- (1) 'Nil' or 'slight' or 'clear', etc.,
- (2) 'Some haze', 'hazy', etc., and
- (3) 'thick haze', 'very hazy', etc.¹

The moon phase has also been noted. The following results were obtained:

TABLE 3
Effect of Haze

Moon	Haze	Photographs ²		
		In Target Area	Total	In Target Area as Percentage of Total
Full	Thick	5	35	14
	Medium	18	73	25
	Nil	89	142	63
Half	Thick	3	70	4
	Medium	18	88	20
	Nil	64	101	64
New	Thick	1	51	2
	Medium	1	40	2½
	Nil	8	49	16
All Phases	Thick	9	156	6
	Medium	37	201	18
	Nil	161	292	55
TOTAL		207	649	32

² 649 Photographs are reckoned in this table against 633 in Table 2. The extra prints were from photographs taken of alternative targets.

¹ In view of the rather vague nature of the references to haze on the forms used, a separate calculation was made from the summaries on weather included in the Interceptions Reports of the Intelligence Branch, H.Q.B.C., which are provided by the Meteorological Branch. These reports apply of course only to the weather of the whole raid and take no account of temporary changes at different times of the night, and in this respect, perhaps, give less precise information than the form accompanying the individual photographs. On the other hand they are prepared by experts. The results are not reproduced here, but they agreed very well.

If we take the degree of success (say 60–70 per cent.) attained in full moon conditions with no haze as 100, the results for the 9 'states of visibility' may be summarised as follows:

TABLE 4

Proportion of photographs representing target area in different moon and haze conditions represented as per cent. of success in full moon—no haze conditions

Moon	Haze		
	Nil, Slight	Some Haze, Hazy, etc.	Thick
Full	100	40	23
$\frac{1}{2}$	100	32	7
New	40	(4)	(3)

7. Cloud

A similar calculation was made with respect to the cloud amount stated on the forms sent in with the night photographs. It will be seen that this was based on a smaller number of reports, and is therefore still less reliable. They are perhaps worth giving as they are consistent. The categories are (1) Nil, Slight, $\frac{1}{10}$ – $\frac{3}{10}$, clear etc. (2) Medium, Cloudy, $\frac{4}{10}$ – $\frac{6}{10}$ etc., and (3) Dense, Heavy, $\frac{7}{10}$ – $\frac{10}{10}$ etc.

TABLE 5 : *Effect of Cloud*

Moon	Cloud Amount	Successful Photographs taken		
		In Target Area	Total	No. in Target as Percentage of Total ¹
Full	Heavy	1	19	(5)
	Medium	7	15	(46)
	Little	64	116	55
Half	Heavy	2	16	(12)
	Medium	3	13	(23)
	Little	43	91	47
New	Heavy	—	17	(0)
	Medium	1	19	(5)
	Little	4	47	8
All Phases	Heavy	3	52	6
	Medium	11	47	23
	Little	111	254	44
TOTAL		125	353	35

¹ Figures in brackets based on numbers too small to be significant.

These figures may be expressed, in the same way as those for haze, in a manner which shows the degree of success attained as a percentage of the degree found on cloudless full moon nights.

TABLE 6

Proportion of photographs representing target area in different moon and cloud conditions represented as percentage of success in cloudless-full moon conditions

Moon	Cloud		
	Little	Medium	Heavy
Full	100	(83)	(10)
Half	85	(42)	(22)
New	15	(10)	(0)

No attempt has been made to split the results up still further to show the effects of haze with and without cloud at the different phases of the moon, since each category would contain too few instances for the results to be of much interest.

8. A.A.

An attempt has been made to estimate the effect of flak. The data available, taken from the Interception reports already referred to, are extremely sketchy. They distinguish between light and heavy A.A. but only in the case of heavy is an indication of amount given in more than very few cases, and even here it is only possible to make a distinction between intense and not intense. The result of the calculation may be summed up as follows.

TABLE 7

Moon	A.A. Intense				A.A. Not Intense			
	No. of Raids	Photographs			No. of Raids	Photographs		
		Total	In Target	%		Total	In Target	%
Full	6	63	25	40	10	77	35	45
Half	13	36	7	19	18	185	73	39
New	5	24	1	(4)	16	97	2	(2)

Averaging these percentages, and allowing for two half moon weeks to one full and one new moon week, we reach a percentage success of 20 for intense A.A. and 31 for less intense fire, i.e. an increase in the intensity of A.A. fire reduces the number reaching the target area in the ratio 3 : 2.

This conclusion is based on the experience of so few raids that it should be treated with the greatest caution.

S.A.O.—IV—P

II. RECOMMENDATIONS FOR FURTHER STUDY

Figures are given in Part I which roughly measure the degree of success obtained by our night bombing and of the relative size of several of the main factors affecting it. Obviously it is vital to have such figures and that they should be accurate.

The data for this enquiry were collected from a number of sources—summaries of operations; plotting reports; interception reports; Forms 9; P.I.S. interpretation reports; the records of the Command Photographic Officer; the photographs themselves etc. Many of these reports were in literary rather than in statistical form. Many were inadequately filled up and the multiplicity of these sources no doubt gave scope for mistakes in judgement and transcription.

While, therefore, these figures cannot be rejected without enquiry, it is very desirable that they should be checked in every possible way.

The main independent check is the examination of day photographs. It should be possible for officers with expert knowledge of bomb damage and of photography to estimate from these, within a wide margin of error, the number of aircraft which attacked in various particular raids or series of raids. It is strongly recommended that such an enquiry should be carried out.

2. Valuable results could also probably be obtained by an expert comparative study of your photographs of British and German towns.

3. The enquiries referred to above could give the best possible estimate of actual damage done and they could indicate the limits of error in this and future studies of night photographs.

The night photographs are, however, chiefly of value in measuring the success of navigation, which seems from the results already obtained to be a matter of equal if not greater importance. For this purpose it seems absolutely essential that they should be subjected to every possible form of analysis. Practically speaking they are the only data about navigation brought back from Germany in which the human factor is slight.¹ A camera cannot make mistakes and cannot like a human being under conditions of extreme strain be misled by appearances. Conclusions drawn from photographs should be completely reliable.

It is therefore suggested that a statistical branch under a fully trained statistician should be formed and provided with sufficient clerical staff to maintain the necessary records and to carry out the laborious computations involved.

This statistician would have to rely upon the existing Photographic Interpretation Section for the plotting of the photographs and it is very desirable that this section should have time and staff enough to plot every photograph possible however remote from the target area.

The increasing flow of photographs which will follow from the increasing supply of night cameras will provide ample material for far more thorough statistical analyses than have been attempted above.

The proposed statistician could also arrange for a number of minor

¹ And will become slighter when fully automatic cameras are used.

improvements in the existing returns which would make them of much greater value for statistical purposes. As an example the plotting form which now accompanies the photograph when it arrives at Bomber Command has a heading 'Position Photographed'. In making the enquiry now submitted difficulty was frequently caused by it being doubtful whether the place named under this heading was the position the crew thought they had photographed at the time, the position they afterwards decided that it must have been or the position the station after developing the negative thought it was—three possibly very different things.

This officer could also arrange without great difficulty special enquiries on particular points. For example, he could ask one group for, say, a month not to bother about reporting weather conditions in detail, but instead to report on the features which caused the crews to consider that they had recognised the target area, or to report, say, especially on the number of searchlights seen in particular areas. He could then make a reliable study of these particular points without adding to the number of questions put to crews.

It is emphatically not suggested that to obtain good statistical material crews should be subjected to still further volleys of questions. It is not necessary to know the answers to every possible question in all possible cases. It is only necessary to have reliable answers in a selection of the cases, and for this selection to be made and the answers analysed by an expert statistician.

Doubtless a statistical branch such as is proposed could also assist in making ad hoc investigations of any of the other quantitative points that must turn up at frequent intervals in the work of the Command.

APPENDIX 14

Memorandum by O. L. Lawrence, Ministry of Economic Warfare, for Lord Selborne, Minister of Economic Warfare, on Night Bombing as an Instrument of Economic Warfare, 4th February 1942

I. Who settles bombing policy?

1. The general aims of bombing are laid down by the Defence Committee with the advice of the Chiefs of Staff. These aims are embodied in a directive which is sent to Bomber Command together with the recommendations of the Air Staff regarding the particular objectives which should be attacked in order to achieve the aims. The plans for attacking these objectives are made by Bomber Command, which asks for further advice from the Air Staff if this is required. Thus Bomber Command decides how and when the particular objective shall be attacked and on what scale the attack shall be, having regard to the needs of the target and the forces available and to its other tasks and operational limitations. The amount of latitude which Bomber Command enjoys in practice varies with the scope and precision of its directive as compared with the capabilities of the force at its disposal.

2. This set-up is very much like that of the other Services. The C-in-C Mediterranean Fleet, rather than the Admiralty, decides what ships, if any, can be spared to intercept blockade runners, how many ships shall be allotted for the task and how it shall be carried out. Unlike the Navy, however, the Air Force is still learning the possibilities and limitations of its weapons.

3. M.E.W. expresses its views on the importance of economic targets and on the bombing policy which ought to be pursued both at the Bomb Targets Information Committee (a Committee formed of representatives of Air Ministry Intelligence, M.E.W., Bomber, Coastal and Fighter Commands, Admiralty, W.O. and S.O.E. to advise and exchange views with the Director of Bombing Operations) and in continuous and informal contact with the Air Staff. The liaison between M.E.W. and the Air Staff has not always been free from difficulty but is now satisfactory in this respect, both in theory and in practice, and is continually growing better. It may be taken that if any matter of policy is referred by A.C.A.S.(I) or D.B.Ops. to their respective staffs, it will invariably be discussed and agreed with M.E.W. before recommendations are sent back.

4. There has for a long time been no direct contact between M.E.W. and Bomber Command except on the Bomb Targets Information Committee. There has, however, been a shake-up in the staff there recently and last week a spontaneous approach was made by them to improve this

state of affairs, an officer of their Intelligence Staff having been detailed to special duties which appear to include liaison direct with M.E.W.

5. The machinery for co-operation between the Air Staff and M.E.W. in the formulation of bombing plans at the lower levels seems satisfactory and there has been a noticeable improvement in the relations at this level with the intelligence and planning staffs at Bomber Command which may be expected to develop further. It must be recognised, however, that M.E.W. loses touch with questions of bombing policy when they reach a level higher than the Director of Bombing Operations, and that we are dependent upon him to resist, in the higher levels, any unsound tendencies to dilute, by-pass or emasculate policies which have been agreed between ourselves and the Air Staff as being sound in the respects which are within our respective provinces.

II. Limitations of Night Bombing

6. Some of the limitations of night bombing are obvious. As compared with day bombing it involves different, and in some respects higher, standards of skill in the crews, especially as regards navigation. It is less effective because of the greater difficulty of finding the target area and of hitting it when found. It is far more susceptible to interference by bad weather and involves a higher percentage of casualties from causes other than enemy action. Its sole merit is that it enables large, slow and unescorted bombers to take the offensive in spite of fighter opposition and ground defences which would decimate them in daylight. The greatest and least easily remediable limitation is the difficulty of recognising the target when the attacking force has reached it. Imperfect weather coupled with effective measures of passive defence may make it impossible to recognise objects on the ground and may consequently prevent accurate aiming. This limitation will continue to restrict the efficacy of night attacks so long as night bombing relies on visual identification of its targets.

7. It is obvious that the only targets which can be attacked effectively by night bombing are areas, however great or small, and whatever they contain, into which it is possible to drop enough bombs to do effective damage. It is much less obvious what these targets may be. In fact they vary from time to time in accordance with weather and moon conditions, the season of the year and the average skill of the crews in relation to the efficacy of the current aids on the one hand, and the enemy's defensive measures on the other. How many pilots are sufficiently skilled, given current techniques, to find objectives of varying degrees of difficulty? What size of target and aids to identification are adequate to ensure that an economical proportion of the bomb-load falls in the target area? What scale of attack is needed to do effective damage to different kinds of target? What form of attack (H.E., incendiary, mixed or otherwise) is most effective? What degree of concentration or continuity is required? What allowances must be made for the effect of ground defences? These and other similar questions are operational problems which have to be answered before Bomber Command and the Air Staff can form a view whether a particular target is vulnerable to night bombing or not. Those

outside Bomber Command and the Air Staffs cannot form an authoritative view on such questions, but they can appreciate that there must at any time be many targets of first importance which cannot be attacked effectively by night bombers, being too big to hurt, too small to hit, too hard to find, too well protected, too remote, or otherwise insufficiently vulnerable. But the better the working knowledge which M.E.W. can obtain of the current capabilities and limitations of the night bomber force, the less likely it is to waste time on examining impracticable projects or to exasperate the Air Staff and Bomber Command by proposing them.

8. The other Fighting Services are also, of course, subject to limitations which put certain types of target out of their reach. But whereas the limitations of other weapons are comparatively well known, the limitations of night bombing were not known, and could not be known, before the war, though this was unquestionably not sufficiently appreciated even in the Air Force. The first reliable information on the subject was to be derived (a) from our own experiences in this country between August 1940 and May 1941; (b) from day and night photography which was not developed on an adequate scale until the Spring of 1941; (c) from the experience of veteran pilots who went through and survived the bombing offensive of 1940-41 and have the mental equipment to profit by their experience. These lessons are only now being digested, disseminated and applied in evolving improved techniques and equipment. In taking effect, they have had to overcome—certainly outside the Air Force and perhaps to some extent within it—two influences which had already taken root in people's minds:

- (a) an exaggerated idea of the effect of night bombing based upon untested pre-war conceptions, and an insufficiently critical reading of pilots' reports and other unverifiable data collected during the initial period, including many real successes which had been disproportionately publicised;
- (b) a partly unconscious desire to make the most of night bombing as an effective weapon at a time when other kinds of offensive action seemed remote from possibility.

Within certain sections of the Air Force, including much of the rank and file, the disillusionment of early hopes would now appear to have swung the pendulum too far in the direction of assuming that night bombing is always, and of necessity, ineffective. In these circumstances, the inevitable strain on their morale is bound to be intensified.

III. What has night bombing done?

9. The results of night bombing against economic objectives have not been negligible, though they have been patchy, and less than the exaggerated hopes which have been centred on them. Night bombing has undoubtedly had a material effect on delaying the submarine-building programme, both by direct damage to building yards and (much more) by causing casualties and dislocation in the labour and organisation employed on the work. Night bombing has also had conspicuous success,

under clear weather conditions, against certain relatively small towns. The elements of this success have been:

- (a) the town has not been too large for the weight of attack directed against it;
- (b) the weather has been such as to enable a high proportion of the bomb-load to be aimed at the target;
- (c) the scale of attack has been so heavy in relation to the local Civil Defence organisation as to overwhelm the A.R.P. services and to allow fire and confusion to multiply the damage done by bombardment.

Other bombing attacks have not been negligible in result if judged by the standard of what should have been expected from attacks of such weight on the basis of operational data now accumulated rather than by the standard of what was sometimes expected at the time. In sum, however, they have not so far made an important contribution to the economic war.

10. It is important to remember that the situation is and will remain fluid. On the one hand new devices are being continually developed to assist the night bomber force and provided that they are not used prematurely (of which there appears to be a considerable danger)—that is to say, until they can be put into action with the maximum punch so as to exploit their possibilities to the full before the inevitable counter-measures are developed—the effectiveness of any given bomber force may be expected to increase. Presumably also the total weight of attack available will increase, subject to the demands of other theatres. On the other hand, defensive science is also developing. Protective smokes, camouflage, dummy objectives, physical protection, improved detection and ranging, devices for anti-aircraft fire, and the use of night fighters, have all developed in recent months and will probably develop further. The possibilities and limitations of the night bomber force vary constantly with the tug-of-war between these factors.

IV. Current developments

11. The technical and operational possibilities and limitations of night bombing are being carefully studied by the Air Staff and Bomber Command. M.E.W. is making such contribution as it is qualified to make under these heads in collaborating on the assessment of bomb damage and in laying on technical advice through our industrial contacts when required. The lessons to be learned from the German bombing of this country and from R.A.F. bombing of objectives in Syria and elsewhere which could be inspected after capture are not being ignored and no further action by M.E.W. is either necessary or possible to emphasize their importance or to draw them to the attention of the Service concerned. In fact, in view of their disillusionment regarding the results obtained by their earlier methods, the attention of the Air Staff and of Bomber Command has been practically monopolized in recent months by tactical and operational research with a view to improving methods and weapons and in getting the improvements into use in operational units, and this has to

some extent distracted attention from consideration of the objectives against which the improved weapons are to be used.

12. It may be that Bomber Command is still paying more attention to technical and operational problems than to economic strategy, though there are signs that this phase is now passing. There is no doubt, however, that the importance of economic targets is appreciated by the Air Ministry and the appropriate sections (Intelligence and Bombing Operations) are fully alive to the importance of applying tactical and operational lessons when learnt in accordance with a coherent and effective economic plan. I do not wish to suggest by this that Bomber Command has not hitherto had a plan in its night attacks on economic objectives. Bomber Command throughout last year followed certain directives. In the early part of 1941 the so-called oil plan was prepared but was never put into operation owing to the rapid substitution of the Battle of the Atlantic directive, necessitated by the strategic situation at that time. This plan was consistently followed for some months with attacks on shipbuilding centres and inland manufacturing areas which served them, with results which time has proved to have been by no means unsuccessful. With the change in the strategic situation in June a new directive was substituted, based on the attack of enemy transport. The plan was worked out in great detail in conjunction with transport experts but in the light of subsequent experience it can be said that it suffered from the following faults:

- (a) the precise objectives involved in the plan proved in the main too difficult for the standard of operational skill prevailing, having regard to the worse-than-average weather conditions which were almost continuous from the end of June onwards;
- (b) the plan was too wide in scope, having regard to the weight of effort available, and too lavish in alternative objectives which had only a somewhat tenuous connection with the main aim—there are very many objectives in any country which, by a suitable extension of the definition can be classed as 'transport objectives'. This appears to have been due not so much to the shortcomings of the original plan drafted by the experts as to extensions grafted on to it afterwards at higher levels.

The results of this plan were certainly not commensurate with the effort involved. The fact that attacks on the principal objectives involved in the plan were not heavier and more concentrated and that they have been interspersed with attacks on other objectives may be attributed in part to the difficulties already referred to in learning the possibilities and limitations of a new weapon, in part to the excessive latitude allowed in the directive, and in part to unavoidable factors such as persistent bad weather over bases or targets, a great strengthening of the enemy's defences in certain areas and the competition of other objectives of a largely non-economic kind. The competition of the latter has become so formidable in the last three months, in relation to the weight of attack available, that the transport directive may be reckoned as virtually in abeyance.

13. The plans for a resumption of the bombing offensive in the Spring are now being examined with a view to the preparation of a new directive.

These plans will naturally embody the experience gained in the past year and will make allowance for progress which current technical developments should permit. The Director of Bombing Operations has instructed his staff to get out a preliminary draft of the type of operations proposed, for discussion with the D.C.A.S.

The close contact between Bombing Operations, Intelligence and M.E.W. will ensure that these proposals will be worked out and put forward in an agreed form, and in fact discussions on this subject have already begun.

14. M.E.W. has already contributed by preparing at the request of the Air Ministry, and in collaboration with them, a paper on economic objectives.¹ This paper dealt in detail with priorities among industrial targets for precise bombing attack and is now being studied from this aspect by the Air Staff and Bomber Command. It will be followed by recommendations on priorities among towns and cities for area attack.

V. Is M.E.W. making the fullest contribution which can be expected from it?

15. It is thought by some that Bomber Command tend to underestimate the importance of economic targets and the scale of attack needed to have an important effect upon them. The latter defect is likely to be remedied by the examination now proceeding, which is referred to above, if it has not already been remedied. The former, if it exists, should be remediable by the efforts of the appropriate sections of the Air Ministry, who are fully alive to the importance of economic objectives. If these prove inadequate, an approach on Cabinet level might be useful but I would deprecate this until it could be invoked in favour of a plan which had been worked out and which was known to be practicable. The danger is not so much that proper co-operation will not be achieved between M.E.W., the Air Staff and Bomber Command in drawing up an effective and practicable plan for attacking economic objectives, as that a practicable plan when achieved at this level, will be rendered impracticable and ineffective by subsequent amendments at a higher Service or political level.

16. There is a danger that certain most valuable technical innovations of war-winning significance will be put into operation before they are fully ripe and therefore a risk that an opportunity of achieving full tactical surprise will be lost, as with the introduction of the tank in 1914-18. This seems to be a matter of such great strategic importance for the whole course of the war as to merit taking up immediately.²

¹ See Vol. I, pp. 460-461.

² *Authors' note:* No doubt the origin of the letter Selborne to Sinclair, 4th February 1942, quoted in Vol. I, p. 460.

APPENDIX 15

Correspondence between Lord Selborne, Minister of
Economic Warfare, Sir Charles Portal,
Chief of the Air Staff, Sir Arthur Harris and the
Prime Minister on the Augsburg Raid,
April–May 1942

(i)

Letter from Lord Selborne to the Prime Minister, 27th April 1942

Dear Prime Minister,

AUGSBURG RAID

As it is part of my function to advise on economic objectives for air attack, I think that you should know the following facts about the Augsburg raid, which disturb me.

Only a few months ago this Ministry, at the request of the Air Ministry and in consultation with them, made a detailed comparison of economic targets in Germany and identified six classes which were given the highest priority on grounds of their vulnerability, accessibility, concentration of output and economic value.

Submarine diesel engine manufacturers were examined and given lower priority on the grounds that the plant is not of vulnerable type and that the total capacity in Germany and occupied territories is so large that it could meet all the requirements of the submarine building programme, even if the M.A.N. factory at Augsburg were completely destroyed.

The most that an attack on that factory could be expected to do, therefore, so far as submarine building is concerned, is to hold up work on the twenty-odd sets of engines which may have been in an advance stage of construction at the time of the raid, thereby delaying for two or three months the construction of, say, ten submarines or two weeks' planned submarine production.

Whether this result, if achieved, would be worth the loss involved, I do not know. What disturbs me is that such a target should have been given priority over all the targets which have been so often recommended by this Ministry and which I believe are accepted by the Air Staff as being of the highest priority.

Some of these are not far from Augsburg—for instance, the Bosch injection pump and electrical accessory factory at Stuttgart Feuerbach, and the group of ball-bearing factories at Schweinfurt. Damage to either of these would be far more disastrous to a far wider range of war production,

and either would be more vulnerable to an equal weight of attack. (See attached note.¹)

I have not seen the current directive on bombing policy which was issued by the Air Ministry after the study of our paper on priorities referred to above; but I have no reason to think that it rejected any of the conclusions of that paper.² I should add that the proposal to attack Augsburg was not discussed with this Ministry, or on the inter-Service Bomb Targets Information Committee, though a fortnight ago this Ministry was asked by Bomber Command through the Air Staff to supply a list of the principal German manufacturers of submarine diesel engines.

This Ministry is in constant touch with the Air Staff on bomb target intelligence and liaison is very good. On the operational side the raid seems to have been brilliantly conceived and carried out. But the planning which directed it seems to bear no relation to the intelligence on which it should have been based. Unless our bombing of economic objectives is planned with the greatest care and the plan strictly adhered to, even the highest skill and courage in directing and carrying out operations will not achieve any commensurate success. The facts set out above leave me with the gravest doubts whether this attack was planned, in the light of the best intelligence available, to hit the enemy where it would hurt most. That is why I am reporting them to you.

(ii)

*Minute from Sir Charles Portal to the Prime Minister,
29th April 1942*

Prime Minister

In reply to your note on the attached minute of the Minister of Economic Warfare I would first endorse the Minister's statement that liaison between his department and the Air Staff is very good. They not only sit together on the Targets Information Committee but we also have a section of the Air Intelligence Department permanently bedded out with the M.E.W.

2. You will realise that on this occasion the value of the target to the Germans was by no means the only thing to be considered in its selection. The A.O.C.-in-C. had certain important tactical conditions to fulfil in planning what was largely an experiment.

First, he wanted to penetrate as far South as possible, both to minimise opposition and to cause demands for Flak from the widest possible area.

Secondly, since the raid was to be flown at ground level, he had to select a target with good landmarks leading to it. Augsburg is excellent in this respect, but neither of the two alternatives suggested by the Minister fulfils this condition nearly so well.

¹ Not printed.

² For the directive in question, see Appendix 8 (xxii).

Thirdly, with the small number of aircraft used, and the need for a quick getaway, the target itself had to be compact and unmistakable. Again, neither of the suggested alternative targets fulfils this condition.

3. There is no doubt that the A.O.C.-in-C. was guided, in his search for the best target for this experiment, by a desire to assist as much as possible in the Battle of the Atlantic. His examination of the list of U-boat Diesel factories (supplied at his request) showed him a target which not only ideally met tactical requirements, but also appeared from his Intelligence information to be one of the most important targets in this category. He might of course have informed us of his intentions and asked for a check on the value of the factory. I think he was entirely justified, on grounds of security, in not doing so. It was vitally important to maintain complete secrecy; reference to the Air Ministry and M.E.W. would probably have resulted in a great deal of discussion and debate about rival alternatives and this could not have been very profitable in the absence of the tactical knowledge possessed only by the A.O.C.-in-C., but might well have compromised secrecy.

4. I suggest, therefore, that what emerges from the Minister's letter is the need to ensure that the A.O.C.-in-C. asks for a confidential check of the economic importance of any target against which he decided to carry out a special operation of this kind in future. He is being so informed.

5. There is one final point that I might mention. The Minister states that the plant in the M.A.N. factory is not of a vulnerable type. I submit that this is a matter which the A.O.C.-in-C. and the Air Staff must judge in the light of experience. Our attack on the Renault plant had shown that even the heaviest industrial equipment could be damaged by our newer bombs, if we could get them well into the target. The reports we have had so far of the results of the attack show that we may have achieved important damage to the M.A.N. plant.

(Intld.) C. P.
C. A. S.

Minister of Economic Warfare.

Please let me have any further comments you may wish to make.

(Intld.) W. S. C.

30.4

(iii)

*Minute from Lord Selborne to the Prime Minister,
2nd May 1942*

Prime Minister

AUGSBURG RAID

I have read with great interest the Minute from the Chief of Air Staff dated 29th April.

I appreciate the important part which tactical conditions play in planning an attack, especially one of an experimental type. I am very glad to have had the opportunity which has been afforded to me by the Minute from C.A.S. of appreciating these more fully in the present case.

With regard to paragraph 3, I do not question that the target was one of the most important in its category. My comment was directed only to the choice of a target in a low category according to the study of target priorities prepared here at the request of the Air Ministry which had, I understand, been accepted by the Air Ministry and forwarded to Bomber Command, and which was no doubt part of the intelligence information which the A.O.C.-in-C. consulted.

I am surprised to learn that it is within the discretion of A.O.C.-in-C. Bomber Command in selecting targets to weigh matters such as the desirability of assisting in the Battle of the Atlantic. I have always supposed that such general strategic considerations are taken into account by the Defence Committee or the Air Staff, as the case may be, when settling the directive by which I understand A.O.C.-in-C. Bomber Command is governed.

I am glad to note from paragraph 4 that the A.O.C.-in-C. has been directed to obtain a confidential check of the economic importance of any target against which he may in future decide to carry out a special operation of this kind. I appreciate the extreme importance of secrecy. The arrangements made in this Ministry for canalising enquiries of an operational character through a single carefully guarded channel should, I think, suffice to ensure security insofar as this Ministry is concerned.

As regard vulnerability, it is my understanding that a knowledge of the relative effect, in terms of production, of bombing different targets is more easily derived from experience in this country than from the much less exact information obtained from the other side. Since the representatives of this Ministry are in continuous contact with the Air Staff on the assessment of bomb damage, and have direct access to persons of practical industrial experience both inside this Ministry and elsewhere, I feel that they are entitled to express an opinion on this question.

While there can be no question of the authority of Bomber Command and the Air Staff to measure the tactical results of their weapons, I feel that in estimating the probable effects of damage on production, this Ministry has something useful to say.

It is extremely satisfactory to know of the indications which have been received that important damage has been done to the M.A.N. plant. No one could be more aware than I of the addition which a new technique like this, if successful, might make to the power of the R.A.F. to strike effectively at Germany's war potential.

(iv)

*Minute from the Prime Minister to Lord Selborne,
3rd May 1942*

Reference: Lord Selborne's minute of 2.5.42, about Augsburg Raid.

'I see these officers at least every week. We often talk these things over together; and the President has particularly asked for efforts to cut off the U-Boat supply. All this was known to the Air Staff and the Defence Committee and is confirmed in the general Directive.

Minister of Economic Warfare

See also my other note of this date.

(Intld.) W. S. C.'

(v)

*Minute from the Prime Minister to Lord Selborne,
3rd May 1942*

Minister of Economic Warfare

Please see this excellent reply by Air Marshal Harris to your paper.

I would suggest that you ask him to luncheon one day, and have a talk with him. This would knit up afresh the close relations between the two Departments.

(Intld.) W. S. C.

(vi)

*Minute from Air Marshal Sir Arthur Harris to the Prime Minister,
2nd May 1942*

Prime Minister

You spoke to me about the value of the AUGSBURG raid, apropos the comments of the Minister of Economic Warfare.

2. I have now seen the correspondence, as you directed.

3. I am not at variance with the facts as stated in the Minister's note. But these facts are necessarily reviewed by him solely in the light of Ministry of Economic Warfare factors. Naturally the Minister allows no weight to the other, and over-weening, factors which strategy, tactics and technicalities bring to bear on such an operation. They are necessarily unknown to him.

4. The initial intention of the Augsburg operation, in pursuance of the common directive to C.-in-C. Fighter Command and myself, was to

subscribe to the intention of enforcing the enemy to retain and exercise in Northern France a major portion of his Fighter Force, to the relief of the Russian and other fronts. That necessitated an attack deep into France to disabuse him of the idea that a mere defensive crust on the coast is enough.

5. The second factor therefore arose from my intention, which I consistently pursue, to force the Boche to spread his air and anti-aircraft defences all over the Continent, to the extreme north and the extreme south, into France and all over the interior of Germany, in order partially to relieve us of the enormous concentrations with which we are now confronted over our main targets in the Ruhr in particular, and in north-west Germany in general; and to embarrass him to the utmost.

6. The third factor was to find entry for the Bombers in daylight at some point where the operations of Fighter Command could protect the Bombers while they broke through the crust, in the foreknowledge that, further inland, they were unlikely to meet serious fighter opposition. On this I sought, of course, the advice of C.-in-C. Fighter Command.

7. The fourth factor was to find a worth-while target in the southern interior of Germany which was within range of aircraft proceeding thus through France which would permit them to achieve their object in daylight while finding themselves covered shortly thereafter by darkness before entering *any* heavily defended area of Germany on their return journey. That was vital.

8. The fifth factor was to find a worth-while objective the approaches to which were unmistakably marked by first-class landmarks, and which also allowed of deceiving the enemy up to the last moment of the outward flight as to the precise target. The landmarks for Augsburg were the Lake of Geneva and the Ammer See. A course between these two points was calculated to deceive the enemy into thinking that our objective was Munich, (a little further east on that direct line), rather than Augsburg, which meant a last moment turn off of over 90 degrees from the course flown, and reported, between Lake Geneva and the Ammer See. I reasoned that the enemy would undoubtedly think us committed to Munich, which was straight ahead, a likely objective and a sore point with him.

9. The appreciation of all these factors lead inevitably to Munich, Nurnberg or Augsburg as the final selection. These were the only worth-while objectives in the area ordained by the above considerations.

10. Schweinfurt was first considered. But by the route in question—a route decided upon for the many reasons I have given above—Schweinfurt was out of range unless the aircraft returned thence due west across the Rhine. This, however, would have brought them, while still in too much daylight, right across some of the heaviest defences in Germany. They would have to cross these at high altitude, and the higher you go the longer daylight persists. Alternatively, they would have had to dawdle round marking time until dark in a dangerous area. To return by the south-about route from Schweinfurt put it right out of range, 200 miles further than Augsburg. Moreover Schweinfurt, having no such leading landmarks as Augsburg, was extremely difficult if not impossible to find in a hedge-hopping operation such as that envisaged.

11. The answer to the last paragraph of the Minister's letter is, therefore, that the attack was based and the objective selected on the consideration of a large number of strategical, tactical and technical factors of so over-whelming import that the purely economic factor necessarily fell into minor focus.

12. The Minister rightly describes the M.A.N. Factory at Augsburg as not vital to the enemy war effort in itself: but he is possibly as yet unaware that we were concurrently, and have been for some time, making a dead set at the whole of the submarine diesel engine capacity in Germany. In this we have been in the closest liaison with his Department. In each of the many attacks we make on COLOGNE, a special force is always told off to bomb the DEUTZ suburb wherein is the second important submarine diesel engine and accumulator factory—HUMBOLT DEUTZ, & HAGEN. Similarly, whenever we attack KIEL, special efforts are made to plaster the GERMANIA WORKS wherein is the third important submarine diesel factory. All these objectives are therefore *complementary*. All have been hard hit. Of the three only Augsburg is suitable for daylight attack and almost impossible to find at night. We cannot tackle Kiel or Cologne in daylight.

13. I am fully au fait with the importance of Schweinfurt and the Bosche Factories at Stuttgart. But for the reasons I have mentioned above Schweinfurt was not even on the cards. Even if it had been, my information is that a ball-bearing factory is not susceptible to serious damage from a light scale of attack. Indeed, I went to the trouble to send a specially selected Engineer-Intelligence Officer of mine round the ball-bearing factories in this country to examine them with that end in view, i.e., the probable effect of a light-scale attack. His report to me was that the ball-bearing manufacturing processes involve the use of multiple batteries of similar machines and does not, therefore, present vital key points for destruction by a light-scale attack; i.e. one might knock out a battery or two of the multiple machines, but that could only proportionately and but slightly reduce production. Schweinfurt, therefore, requires a very heavy scale of attack. I hope it may get it. But this means a night attack, and Schweinfurt is unfortunately just about as difficult a place to find, either at night or in daylight, as any in Germany. To peck at it would merely stiffen the defence against the time when a worth-while attack can be delivered.

14. In regard to the Minister's other proposal that we should have attacked the Bosche Factory in Stuttgart. A daylight attack into the heart of a heavily defended area like Stuttgart is of course completely out of court. Plain suicide. Moreover, an attack of the Augsburg weight would be just silly. Nevertheless, as you are personally aware, I have long had Stuttgart as number one on my list the moment that suitable weather in the locality, and the pressure of other ad hoc commitments, makes it possible for us to get at it. In the design of that attack, half of the total force to be employed is especially detailed to attack the Bosche Works which the Minister mentions, with the primary intention of knocking out what we all well know to be a vital factory specialising in injection pumps and other intricate, difficult and essential key products.

15. I hope, therefore, that it is now abundantly clear to you that while the Minister's complaint is perfectly justified on the one facet which presents itself to his Department, operations of this description have to be regarded from every angle, and that as often as not practical tactical and technical factors are the overweening considerations in the eventual decision—as in this case.

16. I hope also that you have been left with no impression that my Intelligence Staff are not in the closest possible contact, through the Air Staff, with M.E.W. That is certainly not the case. We were fully informed as to the precise importance of the Augsburg Factory, and the penultimate paragraph of the Minister's letter shows that his Department received those enquiries necessary to the operation during our investigation prior to this raid.

17. But I could not in any circumstances agree to discuss projected attacks outside my Headquarters with other Departments. I do not even tell my crews, to whom security is a matter of life and death, where they are going until the last moment before briefing. I am sure indeed that a continuation of that policy is the first essential of security. You and C.A.S. are the only people who ever know my intended precise targets prior to the day, except in special cases such as the Tirpitz operation wherein other Departments have to be consulted about such things as special weapons.

18. I am, however, most disturbed that the Minister should have been led into so many erroneous assumptions and conclusions by the unavoidable, but necessary, secrecy maintained as to the whys and wherefores of this operation. If you see fit, therefore, perhaps you will let him see this Minute. I must assure you and him that while M.E.W. appreciations are always the *first* factor in the considerations of any operation on economic targets, they can seldom, in the nature of things, be the overriding factor amongst so many that are so often opposed. Hence the *raison d'être* of the 'Directive'.

(Signed) A. T. HARRIS
Air Marshal.
Commanding-in-Chief
Bomber Command.

APPENDIX 16

Memorandum by Colonel Oliver Stanley for the Chiefs of Staff on Attack on Axis Oil Supplies, 16th April 1942

1. In accordance with the instructions of the Defence Committee I have examined the possible methods of attack on the Axis oil supplies.

2. To assess the value as well as the practicability of various methods of attack, it is necessary to form some picture of the Axis oil position both now and over the next few months. This is no easy task, for definite intelligence is limited and conjecture must play a large part in any estimate we make. The possible margin of error is—as has so often been demonstrated in the past—very considerable.

3. In making the most accurate picture possible, I have tried to give the benefit of any doubt to Germany, so that the German oil position is unlikely to be any better than is shown here, and may, in fact, be appreciably worse.

Oil Position of the Axis over the next six months

4. Broadly speaking, Germany is at present able to maintain the minimum stocks necessary for efficient local distribution (estimated at something round $1\frac{1}{2}$ million tons) by drastic cuts in civilian consumption throughout Axis Europe.

5. This estimate is based on a figure for Axis service consumption well below the peak of active fighting last summer and autumn. The present balance will be upset by any renewal of a major German offensive and it is estimated that during the period of intense fighting on the Eastern Front, the Germans will have to withdraw from stocks at the rate of 200,000 tons a month.

6. Although these heavy withdrawals will have immediate and growing effects on industry and civilian life, it will be some time before they necessarily affect military operations. It is estimated that even at this rate of withdrawal the Germans might be able to maintain their Russian campaign at peak intensity for a maximum of six months.

7. If by the end of that time Germany has failed to secure the Caucasus oil, she will be incapable not only of continuing the offensive but also of resisting a Russian counter-offensive. She might save herself by a withdrawal to pre-June 1941 frontiers, thus making a substantial economy in her service oil consumption.

8. Assuming that the German offensive starts on 1st May and continues through the summer with the expected intensity, Germany would reach this position by about 1st November. The effect of the destruction before then of any of her anticipated intake of oil would be to advance proportionately the date of her military impotence.

9. Germany will start her Russian campaign with certain accumulations of railhead stocks behind the front. As the destruction of these stocks is impracticable, nothing we can do is likely to prevent her maintaining her offensive at maximum intensity for 3 months. If, therefore, the Russians are incapable of resistance for that length of time, no action by us will be effective.

10. If, by the time Germany reaches a state of impotence, Russia is too exhausted to force the continuance of active fighting by a counter offensive, the economy in oil, which a cessation of intensive warfare would give to Germany, would save her from collapse and a winter of stalemate might enable her to repair some of the damage done to her general economy.

The effect of destroying anticipated oil intake

11. Any estimate is complicated by the fact that we are dealing not only with the destruction of stocks, the result of which accrues immediately, but also with the destruction of output capacity (wells, refineries, synthetic plants, etc.), the full results of which only accrue over a period. The effect, therefore, of any particular destruction depends upon:

- (a) the date of the destruction;
- (b) the extent of the destruction;
- (c) the rapidity with which its effects accumulate.

12. For instance, if it were possible on 1st May to take action which resulted in a loss to the Axis of 500,000 tons of oil between 1st May and 1st August, the probable result would be to advance the date of German 'impotence' by something like two months.

13. Taking that estimate as a standard against which to measure the results of any proposed action, then if the date of the action is earlier, the total loss greater, or the time, over which the loss is spread, reduced, that period of two months can be proportionately increased. In so far as conditions are reversed, then the period must be proportionately reduced.

Methods of Attack

14. I have examined the vulnerable points in the Axis oil supply, the possible means of attacking them, and the results which might be expected. This examination is set out in some detail in the Annex.¹

15. The examination shows that the only action which offers any possibility at all of reaching the standard of damage set out in para. 12 is the air bombardment of the oil refineries at Ploesti. Even there, to be certain of achieving the standard, it would be necessary to put out of action for three months all the six grouped refineries.

16. The target can only be reached by certain types of heavy bombers, operating from Fuka or from Cyprus; under present arrangements the maximum forces available will be two squadrons of Liberators in the late summer. It is clear that with a force of this size it will not be possible to

¹ Not printed.

develop either by day or night a scale of attack which offers any reasonable prospect of causing the requisite amount of damage.

17. Before any final decision is possible, more information than is at present available will be necessary. The required information (some of which will have to be supplied by the Middle East) will be on the following points:

- (a) The weight of bombs in the target area necessary to put out of action the 6 refineries, in the light of the latest available intelligence as to the protective measures adopted at Ploesti and the vulnerability of oil refineries in general.
- (b) The number and type of aircraft required to deliver this scale of attack either by day or by night.
- (c) The practicability of providing this number of aircraft in the Middle East and, in particular, the date by which such provision might be possible.
- (d) The results of this diversion upon our commitments elsewhere.

18. With this information the Chiefs of Staff would be able not only to decide the practicability of the operation but also to assess the probable result and the commitment involved, and so to strike the balance. If it was decided to make the attack, Russia should be urged to take whatever action they could against the same target.

Recommendations

19. I recommend, therefore, that the Air Ministry, in conjunction with the Middle East, press this enquiry as a matter of urgency.

20. The following points emerge from the consideration of other methods of attack:

- (a) In the event of a successful attack on the refineries at Ploesti, we should be prepared immediately to intensify all other methods of attack, particularly the bombing of German synthetic plants and the attack by sea or air on the refineries at Bari and Leghorn.
- (b) Where practicable, S.O. should give first priority to the attack on the oil targets set out in the Annex.
- (c) Plans for possible action in the event of Germany reaching the Caucasus should be prepared now.
- (d) The wholesale destruction of Roumanian oil wells and refineries by sabotage is impossible except as part of a major revolutionary movement. I do not know what are the chances of such a movement occurring, but it is unnecessary to emphasise how decisive it might be and how essential it is that we should encourage it. Even a movement which ultimately proved unsuccessful, might yet give the time and opportunity for the damage to be done.

(Sgd.) O. STANLEY

APPENDIX 17

Report by Mr. Justice Singleton for the Defence Committee on the Bombing of Germany, 20th May 1942

*To the Right Honourable Winston Churchill, C.H., M.P.,
Prime Minister and First Lord of the Treasury*

Sir,

By a letter dated the 16th April, 1942, I was informed of your desire that I should undertake an Inquiry into the effect which our bombing policy is likely to have on Germany with terms of reference:

'In the light of our experience of the German bombing of this country, and of such information as is available of the results of our bombing of Germany, what results are we likely to achieve from continuing our air attacks on Germany at the greatest possible strength during the next six, twelve and eighteen months respectively.'

I have since seen a large number of people able to help, and I have read a great many reports so as to make myself acquainted with various questions arising on the matter.

The fact that Germany ceased bombing this country for a long period gives rise to much thought. I feel that it may be taken that the reason was shortage of aircraft. When raids were recommenced a few weeks ago they were on a much less scale than of old. On the night of the 25th/26th April (Bath) aircraft of Reserve Training Units took an appreciable part in the operations over this country, and quite a number of aircraft made two sorties. On each of the two following nights (Bath and Norwich) aircraft from four Reserve Training Units took a considerable part. This is unusual, to say the least, though it may be that Reserve Training Units are disappearing and are becoming ordinary operational units.

Another feature to which reference should be made is the recent German propaganda, which appears to show the anxiety felt in Germany on our air raids on that country.

It is estimated that the tonnage of bombs which can be dropped on Germany within the six months April to September 1942 is around 47,000 tons: I do not think that this is an unduly high figure, having regard to the aircraft available and expected to be available. Still, a considerable part of that will surely be required for attacks on shipping and on ports, and circumstances arise which call for attacks on work in occupied countries rather than on Germany. Assuming that the whole of it is dropped on Germany, only a portion of it is effective. Location of target presents great difficulties, and these are increased by camouflage and decoys, while

improved defences and searchlights negative to some extent better methods employed to find the target area.

During the ten months from August 1940-June 1941 the German Air Force dropped some 50,000 tons on this country. Great discomfort was brought about in a number of places, some 40,000 deaths were caused, and the war effort was impeded to some extent. The highest at which this has been put to me is that it caused three months' delay in our effort generally: on the other hand, the researches of the Ministry of Home Security appear to show much less interference. One thing is clear, and that is that if it had continued on the same scale its effect would have been very seriously felt.

The German bombing policy was not well directed, nor is it considered that ours was any better. Latterly there has been a change in policy.

If an industrial area, which has in its centre important factories engaged on war work, is taken and dealt with thoroughly by concentration of bombing better results are likely to be achieved. The possibilities are shown by what was done recently by the Royal Air Force at Lübeck, at Rostock and on the Renault works, as well as by what was done by the German attack on Coventry in November 1940. And shortage of materials makes repair work more difficult than it was.

But whatever target is chosen there are always difficulties in finding it, and many of the bombs carried are wasted or are ineffective.

The navigation aid (T.R.1335)¹ now in use should prove of great help to crews to get to the neighbourhood of the target, but it is limited in range and, to some degree, in accuracy. A new target-finding device (H2S), from which there are great expectations, is in course of production, but I am told that it is not likely to be in use before the autumn, and perhaps not this year.

There are a number of ways in which the war effort of Germany may be hindered or hampered by bombing:

1. By damage to factories, &c., engaged on war work, and damage to public utility services and to communications.
2. By the hold-up of a number of fighter aircraft on defence work.
3. By keeping occupied a large number of men and guns on anti-aircraft work and on searchlights and a very large number on Air Raid Precautions.
4. By the lowering of morale.

1. *By Damage to Factories, etc.*

The amount of damage which can be inflicted on the war effort of Germany must depend on the degree of accuracy which can be attained. Results in the past have been disappointing, but there now appears to be among senior officers of the Royal Air Force a feeling of optimism as to the prospects: indeed, they appear to be satisfied that they are getting much greater accuracy than they were a short time ago. The results of the attacks on Lübeck, on Rostock and on the Renault works were, indeed, highly satisfactory. At the same time, it is well to bear in mind

¹ *Authors' note: i.e. Gee.*

that the conditions on each night were all that could be desired, the targets were easy to find and the defences were less than would be encountered in many places. Rostock—a town of some 120,000 inhabitants—was attacked on four consecutive nights, with the Heinkel works nearby as a subsidiary target. The aircraft detailed for the four attacks carried 843 tons of bombs: the first night's attack was not very successful, but on the other nights both the Heinkel works and the town appear to have been dealt with thoroughly.

I am not sure that there is any very noticeable improvement on other occasions when conditions as to light, &c., have not been so good. When I asked for evidence on which it could be said that our bombing generally was more accurate since the adoption of T.R.1335 it was suggested to me that it would be found in the analysis reports of photographs taken at the time of bombing. I have studied these with care: some show better results than others: taken as a whole, I do not think that they can be regarded as satisfactory when it is remembered that the target area is a circle with a five mile radius, i.e., an area of 78 square miles. I take the instance of Essen. The first operation carried out with the use of T.R.1335 was on the night of the 8th/9th March, 1942. Since then there have been eight attacks on Essen: on three of those occasions the bombing photographs fail to show that the bombers were within five miles of the target: on other occasions the results were better, though I do not think that it can be said that they were as good as had been expected. The weather was not always against the crews. It may be that T.R.1335 has not been sufficiently long in use to enable a true view to be formed—and there were difficulties in connexion with the change over—but, at the same time, it is to be remembered that the enemy may find an answer to it at any time.

I do not overlook the fact that some of the bombs which fell in other built-up areas were not wasted (and herein lies the wisdom of bombing a large industrial area), but that is far from showing that greater accuracy has been achieved, and, moreover, the effect of concentration may be lacking.

The navigation aid ought to take the crews reasonably near the target, but thereafter the human element comes in and, however well trained the men are, they may fail to identify the target: they are dependent on conditions of weather and on the nature and position of the target, they may be led astray by decoys or by a fire accidentally caused, and they are hampered by the enemy's defences. It has been suggested to me that in the bombing of a large industrial area better results might be obtained if the crews relied solely on T.R.1335 and dropped their bombs when the appliance told them they were at the target, i.e., without looking for the target at all. I find that this was tried in an experimental attack on Cologne on the night of the 22nd/23rd April, but there were not enough photographs to give a complete picture.

There is no doubt that it is possible to wipe out, or at least to disorganise completely, a particular area, given sufficient concentration of bombing. I take the Ruhr area merely as an illustration. The heart of the industrial area consists of a belt 10 to 15 miles deep from north to south and 40 miles long from west to east. If an area such as this can be treated with a heavy

concentration of bombs directed sometimes to one part of it and sometimes to another part, and if the process is repeated from time to time, much damage will be done to the war effort of the enemy, the amount of that damage depending on the degree of accuracy and the amount of concentration brought to bear. How far this can be done successfully depends on a number of considerations. It is within the range of T.R.1335, and the results from that may well improve. On the other hand, the defences of the Ruhr are such that the Commander-in-Chief, Bomber Command, has thought it wise recently to confine attacks to dark nights, and that means difficulty in identifying the target area so long as that is necessary. The need for this identification will be avoided when H2S is in use, or rather when the crews are accustomed to it. In the meantime it would be interesting to see what would be the result in accuracy and in concentration of a number of aircraft bombing a large industrial area by the use of T.R.1335 only, that is without looking for the target.

Before I concluded the Inquiry I had the advantage of seeing two officers who had recently been using T.R.1335 in night bombing attacks on Germany. They are officers of great experience. They are both completely satisfied with the accuracy of T.R.1335 provided that it is used by a specially trained crew. In such conditions they say it will take you within 4 miles of the target longitudinally with a possible error of 2 miles laterally. They regard it as of tremendous help. It is in the last few miles that the real difficulties arise, and they can only be overcome by determination and will power. The crews are not by any means all of the same calibre, and the officers to whom I refer are firmly convinced of the desirability of a specially trained Target Finding Force, which, they believe, would lead to greatly increased efficiency in bombing. This has been considered by the Commander-in-Chief, Bomber Command, and it is not for me to express any opinion upon it. The advantage of this meeting from my point of view was that it satisfied me of the real value and of the accuracy of T.R.1335 in capable hands, and it may be hoped that results to come will be much better than they have been so far. Only a portion of bomber aircraft are fitted with T.R.1335 as yet, and it may be that some of the troubles in the raids I have mentioned came from aircraft which were not so fitted. I should add that the officers did not look with favour on the idea of blind bombing with the help of T.R.1335 alone: they think that in anything like reasonable conditions the target ought to be found and that results ought to be much better than they appear to have been.

Unless and until a greater measure of accuracy in target finding can be reached it will probably prove to be good policy to keep chiefly to targets which can be found fairly easily. This course limits the number of targets considerably, but it is much better to treat a second-rate target thoroughly than to fail in an attack on one of a higher class.

It is recognised that a small attack does not serve much purpose, and that it is concentrated bombing that is needed, and systematic bombing.

The selection of targets is of great importance, be it a first choice or an alternative target. The final choice of the target for the night must always rest with the Commander-in-Chief, Bomber Command. It is

worthy of consideration whether the Targets Committee, meeting once a fortnight and having its recommendations passed through the various channels to the C.A.S., is in sufficiently close liaison with Bomber Command. There are intermingled questions of economic policy as well as weather conditions and probabilities of reaching the target. To assess the probable effect on Germany's war effort of different degrees of damage to different parts of her economy is difficult, but it is essential in the framing of an effective bombing policy.¹

Another question which must often arise, and which calls for careful consideration, is the proportion of High Explosive and of Incendiary bombs which shall be used on a particular target.

It has been pointed out to me that our bombs have not proved so effective as those used by the German Air Force, but I understand from the Commander-in-Chief, Bomber Command, that there is now no cause for complaint.

The difficulties facing the Royal Air Force are, of course, enormous. The crews have to fly greater distance than have those of German bombers and the targets are spread over a wider area: they have all the trials of anti-aircraft fire, searchlights, camouflage and decoys which the Germans have, in addition to which they may expect attention from fighter aircraft over a greater distance. There is a feeling in some quarters that it has not yet been shown how effective an instrument a bomber force can be, and that great improvement in results ought to be sought. This is far from saying that there is any loss of morale among crews: I have heard no suggestion of that. At the same time it will not be thought out of place for me to mention this. Nothing is more disheartening for crews than to find after long nights spent on operations that they have not been near the target area at the time they dropped their bombs and after they have made efforts to find it and believe that they have found it. This, I believe, is recognised by the Commander-in-Chief, Bomber Command, as is the desirability of limiting bomber operations as far as possible to occasions when there is a reasonable chance of the target being found—at least until the new device is in operation. And it must not be forgotten that the bombing photographs may not always show the complete picture of the raid as has been found on occasion from daylight photographs taken later. I am told that the successful attacks—and that on Lübeck particularly—had a most cheering effect on the crews, and that is all to the good.

The bomber strength of the Royal Air Force is increasing rapidly, and I have no doubt that, if the best use is made of it, the effect on Germany's war production and effort will be very heavy over a period of twelve or eighteen months, and such as to have a real effect on the war position.

So far I have dealt with the position from the point of view of night bombing. I do not overlook the fact that there are some targets—perhaps vital ones—which can only be found and bombed in daylight, and that this may be done with increasing frequency as our strength increases, especially so if the enemy fighter strength on the Western front falls.

¹ *Authors' note:* For the origin of this sentence, see Vol. I, p. 465.

2. *By the hold-up of a number of fighter aircraft on defence work*

The figures of the German Air Force supplied to me are surprisingly small, and present a striking change from what they were a year ago. On these figures it is obvious that Germany must be hard pressed in the air on the Russian front, and it is equally obvious that she will need every aircraft which can be spared from the Western front. So long as our raids persist she must keep a number of fighters spread over a large area to help to repel the raiders, and this includes both day and night fighters. The estimate of Air Staff (Intelligence) is that Germany retains something over 600 fighter aircraft on the Western front. A falling off in our bombing policy might well result in some of those fighters being withdrawn from the Western front and sent to Russia. Conversely, intensified bombing by the Royal Air Force might call for an increase of fighter aircraft on the Western front. Furthermore, Germany keeps on the Western front (according to the estimate) some 279 long-range bombers, apart from bomber reconnaissance aircraft. Until recently there had been a long spell without any bombing attacks on this country. Those which have taken place in the last few weeks on Exeter, Bath, Norwich, York, &c., are believed to be by way of reprisal or because it is felt that some reply must be made to our bombing attacks in order to satisfy the German people. The result is that both fighter and bomber aircraft are kept on the Western front (and some of them are destroyed), a fact which may turn out to be of incalculable value to Russia, as well as of great help to our forces in Libya and in Malta.

3. *By keeping occupied a large number of men and guns on anti-aircraft work and on searchlights and a very large number on Air Raid Precautions*

Much of that which I have said under Head 2 applies in this case. It is impossible to say how many men and guns are kept on anti-aircraft work in Germany and in the occupied countries, and it is equally impossible to say how many men are employed in Germany on Fire Prevention and the like. It is not likely that they would be greatly increased by an acceleration of our bombing effort. It is important that they should be kept where they are rather than that they should be free to add to German strength elsewhere. On A.R.P. services in Great Britain there are employed about 340,000 men and women on full time, and over a million on part-time work. It is thought that the German numbers so employed are greater.

4. *By the lowering of morale*

The question of morale is a much more difficult one with which to deal. There has been no break of morale in this country, though some people think that there was a danger of it locally on one or two occasions when bombing suddenly ceased. Now we expect to be able to deliver to Germany in the future a much greater weight of bombs than we received. If we can combine with this a greater measure of accuracy and intensified concentration, I feel that it will have a very considerable effect, growing as the intensity of the bombing increases, and the more so if there does not appear to the German people any likelihood of their Air Force being

able to deal with the forces of those opposed to them. At the same time it is noticeable that the effect of bombing on morale is local, and is usually of a temporary nature. Its effect on the German people will be much greater if the projected attack on Russia fails. But, again, Germany is a very large country, and there is strict censorship. Instances of what has happened in other countries (or places) do not help greatly to enable one to form a view, nor does consideration of what happened in Germany in 1918 take one much further than consideration of the happenings in Prussia 180 years ago, having regard to the dictatorship and control of Germany today. I have had before me calculations showing the probable effect on the population of the dropping of a large number of bombs in closely populated areas. It is right to say that among the things which are important from the point of view of morale of the people are housing, warmth, sleep and food. The view seems to be held that the people in Saxony and Thuringia are more likely to suffer in morale from a long course of bombing than those in, say, East Prussia and Schleswig-Holstein. I doubt whether our bombing ability is, or in the near future can be, sufficient to bring about a break of morale in this way alone. Herein again arises the importance of increased accuracy. I prefer to think of the effect on morale combined with the other factors and to envisage the bombing of an industrial area with important factories in the centre rather than the bombing of houses, and I think better results will be achieved thereby.

The first sign of the effect may well appear in the German troops if they realise that those they have left at home cannot be protected from air attack, as was promised to them.

Generally

When the four heads with which I have dealt are considered together I think there is every reason to hope for good results from a sustained bombing policy. I do not think it ought to be regarded as of itself sufficient to win the war or to produce decisive results; the area is too vast for the effort we can put forth: on the other hand, if Germany does not achieve great success on land before the winter it may well turn out to have a decisive effect, and in the meantime, if carried out on the lines suggested, it must impede Germany and help Russia. If Germany succeeds in her attack on Russia there will be little apparent gain from our bombing policy in six months' time, but the drain on Germany will be present all the time: and if Russia stands it will remain a powerful weapon in our hands. It is impossible to say what its effect will be in twelve or eighteen months without considering the position of Russia. If Russia can hold Germany on land I doubt whether Germany will stand twelve or eighteen months' continuous, intensified and increasing bombing, affecting, as it must, her war production, her power of resistance, her industries and her will to resist (by which I mean morale).

The terms of reference to me ask me to assume 'air attacks on Germany at the greatest possible strength.' There must always be demands on the bomber force for work outside Germany, indeed in the twelve months ending 28th February, 1942, 49 per cent. of the effort was directed on

invasion ports (including Brest) and shipping. Even if all this could be eliminated I do not think a great difference would be felt within the first six months' period. The total amount which can be put over within that period is, as I have said, under 47,000 tons, and that is not enough to have anything in the nature of a decisive effect. As the months go on the increasing size of the bomber force will enable a great deal more bombs to be put on Germany. But the important matter is to reach a greater degree of accuracy. If H2S comes up to expectations the load of bombs then carried will have a much greater effect than a like load carried to-day. Until that device, or something similar, is in use the success of the operation is dependent on the identification of the target area. Recent results are not encouraging except in almost ideal weather conditions, and there are few nights in the month on which such conditions can be expected, and few targets on which a night bombing attack can be really successful. At the same time, reports appear to show that the effect of our bombing is being more seriously felt in Germany than it was a little time ago.

I appreciate that bombs falling on a built-up area do damage and may affect morale, even though they are a long way from the target area, but the concentrated effect is lost, and, again, it is clear that a very large proportion have fallen on open ground. The improved training of crews is off-set by casualties and by improved defences.

To sum up, I do not think that great results can be hoped for within six months from 'air attacks on Germany at the greatest possible strength.' I cannot help feeling that the six-months period ought to be looked upon as leading up to, and forming part of, a longer and more sustained effort than as one expected to produce results within that limited time. Much depends on what happens in Russia. The effects of a reverse for Germany, or of lack of success, would be greatly increased by an intensified bombing programme in the autumn and winter. Effect on morale would normally be greater at that time than it would now. And if this was coupled with knowledge in Germany that the bombing would be on an increasing scale until the end, and with realisation of the fact that the German Air Force could not again achieve equality, I think it might well prove the turning-point—provided always that greater accuracy can be achieved.

Air Commodore Baker has been most useful in suggesting various persons who could help, and in arranging for them to see me.

Once again I have reason to be grateful to Mr. J. A. C. Robertson of His Majesty's Treasury for his work as Secretary of the Inquiry.

I have the honour to be,

Sir,

Your obedient Servant,

(Signed) JOHN E. SINGLETON

APPENDIX 18

Note by Air Marshal Sir Arthur Harris for the
Prime Minister and War Cabinet, and prepared
at the request of the Prime Minister,
on the Role and Work of Bomber Command,
28th June 1942

1. Those who advocate the breaking-up of Bomber Command for the purpose of adding strength to Coastal and Army Co-operation Commands and overseas requirements are like the amateur politician who imagines that the millennium will arrive through the simple process of dividing available cash equally between all. Ignorance of what is available for distribution is such that he does not realise that the outcome would be to give every individual £50 once at the cost of wrecking the entire industrial organisation and income of the country. Similarly, if the Medium and Heavy Bomber Operational Squadrons of Bomber Command were distributed between the many claimants for favour on the one hand, none of these claimants would receive anything more than a mere morsel towards the satisfaction of their alleged requirements. On the other hand, our only offensive weapon against Germany would be destroyed. One cannot win wars by defending oneself. The defensive use of offensive weapons must therefore be reduced to the irreducible minimum necessary to survival.

2. There is surprising ignorance about the effective strength of Bomber Command. On an average, it is able to produce about 30 operational medium and heavy night bomber squadrons and six light bomber squadrons, the latter with no reserves of aircraft behind them. The first-line strength of the operational squadrons of Bomber Command represents no more than 11 per cent. of the total operational first-line strength of the Royal Air Force and Fleet Air Arm, and well over half of the effort of this 11 per cent. is directed against Naval and Military targets. (See Appendix 'A'.)¹

3. People often point to the vast training organisation behind Bomber Command. It is truly and necessarily great. What such people fail to realise, however, is that the Bomber Command training organisation provides the whole requirements for reinforcing all the bomber forces overseas and much else besides. At present, for instance, it provides 148 pilots per month for overseas bomber squadrons, including 95 complete crews. In the past this quota has at times been even higher. In addition to this monthly output for overseas requirements, Bomber Command has trained, equipped, and then given away or lent to Coastal and Overseas

¹ Not printed.

Commands and other claimants, 24 squadrons in the last year. It also provides the crews of 2 squadrons employed on special S.O.E. and S.I.S. duties, and crews to man a great number of experimental and special training Units, which work for all Commands, at home and overseas. Finally, it is required from time to time to find from 300 to 400 operational aircraft in order to make up the 1,000 or so required to carry out specially heavy attacks against objectives of major importance.

4. Another common error is to suppose that the effort of the Command is devoted to the bombing of targets in Germany remote from and chosen without reference to the general military and naval situation. Nothing could be further from the truth. Approximately 50 per cent. of the total operational effort of Bomber Command during the twelve months April 1941–March 1942 was directly employed against the enemy's sea power. (For details see Appendix 'B'.)¹ During the last three months the proportion has been well over 50 per cent. All the remaining efforts of Bomber Command have great direct effect on the Naval and Land war situations as a whole.

5. For all practical purposes the squadrons of Bomber Command have done almost all the air-sea mining throughout the War. They have laid some 2,000 odd mines from the beginning of the War to December 1941, which accounted for one known enemy ship per 26.2 mines (it can be reasonably assumed that at least one unknown ship was sunk or damaged for every known one). The Command has enormously increased its mining efforts since the beginning of March this year. It is now laying mines at the rate of over a thousand a month, and already the reports on sinkings are greatly increased over anything previously achieved. Amongst particular mining successes can be counted the closing of the Kiel Canal to heavy enemy ships for some four months and the damaging and sinking of several of the highly specialised Baltic train ferries and ice-breaker ferries on which the enemy is peculiarly dependent. Also, the sinking by mining and bombing, according to the evidence from German wreck charts, of something over 300 enemy-employed ships, and damage to a large number more. The mining of both *Scharnhorst* and *Gneisenau*, and also other enemy war vessels and troop transports, some of which are known to have resulted in great loss of life, must also be taken into account.

6. The story of the *Scharnhorst* and the *Gneisenau* is perhaps an outstanding incident of the vast effect of the small Bomber Command force on the Naval war. These two ships, on their one and only raid into the Atlantic, did appalling damage to our shipping, sinking no fewer than 19 vessels, totalling 150,000 tons. They returned to Brest to refuel and turn round prior to repeated forays, but since that date, over fifteen months ago, and almost entirely due to the efforts of Bomber Command, they have never been able to sink another British or Allied ship. They have only just been able to escape and stagger home, both of them striking air-laid mines on their return journey. Since their arrival in Kiel for repair, *Scharnhorst* is known to have been further hit and heavily damaged. *Gneisenau* has been so heavily hit and damaged by bombs that she has been taken away

¹ Not printed.

to Gdynia and largely dismantled. There are circumstantial reports that it has been decided to abandon repair on her. *Prinz Eugen* was also hit at Brest by Bomber Command. The direct result of the damage to these important ships is that *throughout the war the German Fleet has never been able to operate as an entity, with all that that implies*. It was directly due to the immobilisation of *Scharnhorst* and *Gneisenau* that *Bismarck* essayed her lone raid in the Atlantic and to that fact can be largely credited her subsequent destruction. To Bomber Command, therefore, can also largely be credited the fact that *Tirpitz* in her turn is now a lone wolf.

7. Additional and direct effects on the war efficiency of the German Fleet arising from the efforts of Bomber Command are as follows:

- (i) The main enemy Naval base at Kiel has been repeatedly and very heavily damaged by bomber attacks. A large number of workshops have been destroyed and the dockyard workers' quarters have received vast damage, with all that that implies in regard to delay in Naval supply and repair work.
- (ii) Amongst other instances the depot ship *Monte Olivia* was bombed and burnt out, with reported heavy loss of life to submarine ratings and some of *Gneisenau's* crew who were living on board.
- (iii) There is no doubt that the morale of enemy Naval personnel, who largely come from the German coastal ports, has been seriously affected by the heavy damage, and the raid-fear inflicted on these ports and their populace.

8. The six light bomber squadrons of Bomber Command are responsible for the close support of the Army in the event of invasion, or in the event of the Army proceeding overseas. They provide the bait for Fighter Command without which the fighter sweeps would be ineffective, because the enemy often refuses battle unless bombers are present. They also provided the detachments at Malta which so successfully attacked the enemy's lines of communication. They are known to have sunk some 51,000 tons of enemy shipping on that supply line. By direct bomber attack in European waters, these light bomber squadrons have sunk some 250,000 tons, seriously damaged 287,000 tons and damaged a further 380,000 tons.

9. The effects on the enemy's submarine activities have been equally important. It is known that repeated interference with submarine crew training resulted from our mine laying in the Baltic and the Bight. It is known that, from time to time, considerable damage has been done to submarine building yards at Hamburg, Kiel, Rostock, Emden and other ports. Heavy damage has been done to the three main submarine Diesel engine factories at Augsburg, Deutz, and the Germania yards at Kiel. Damage has also been done to one of the two main submarine accumulator factories. In addition, the widespread damage done to German industry by Bomber Command, perhaps especially in Cologne, must have profoundly affected the submarine campaign. It is known that, at the submarine building yard at Le Trait, three submarines under construction were reported destroyed and between 150 and 200 workmen employed on them were killed.

10. It can also be safely assumed that damage has been inflicted on submarines operating from the French West Coast ports. Although the actual cause of loss of a submarine which does not return can seldom be determined, the known losses inflicted on German shipping remove any shadow of doubt that some losses, possibly considerable losses, have been inflicted on the enemy submarine fleet by Bomber Command's mine-laying. (For details see Appendix 'C'.)¹

11. By smashing up the invasion ports and the invasion barges and shipping concentrations, there is little doubt that Bomber Command had impressed upon the enemy the difficulties, if not the impossibility, of invasion. Indeed, history may yet show that invasion was prevented by the Command. It certainly can be if it is attempted in future.

12. The known results of the bombing raids on Germany show that they cause vast destruction and vast embarrassment to the enemy. It would not be possible in a note to detail a tithe of the known immense damage occasioned in Germany. Whilst it takes approximately some 7,000 hours of flying to destroy one submarine at sea, that was approximately the amount of flying necessary to destroy one-third of Cologne, the third largest city in Germany, in one night, a town of vast industrial import. 250 of its factories were damaged or destroyed. This must have gravely embarrassed the enemy war effort in every direction. The towns of Rostock, Lübeck, Emden and Cologne have all been destroyed to or beyond the point where they can be counted as a liability rather than an asset to the enemy. The very heavy damage to the Heinkel Aircraft Factory at Rostock is known to have gravely affected the Heinkel output, and is reported to have had the most serious effect on the enemy's air war on all fronts, and also at sea. The Focke Wulf works at Bremen have also been very seriously damaged.

13. The destruction of the Renault Factory might be counted as an astounding achievement of Bomber Command. Achieved in a few hours with practically no loss it is clearly a major victory against the enemy's land forces such as no other of our forces has yet achieved. Through the loss of this factory and the Matford works at Poissy, the enemy is known, according to the Ministry of Economic Warfare, to have been permanently deprived of the armoured fighting vehicles and transport equipment sufficient for the formation and maintenance of 10/11 motorised divisions.² The important enemy aircraft factories at Gennevilliers and Salmsons have been destroyed. The Goodrich rubber factory, and the Thomson Houston and Ericsson Electrical gear factory have also been destroyed, and 16 neighbouring factories damaged, some 'on a tremendous scale'. (Interpretation Report.)

14. One of Germany's most pressing problems is to maintain her system of internal transport. The German Transport Minister recently stated that, unless the problem of improving the transport facilities inside Germany were solved, Germany's victory would be imperilled. He said that in the western and north-western regions of Germany, where frequent

¹ Not printed.

² More than our Libyan operations have destroyed in the whole course of the war, almost as much as we lost at Dunkirk.

bombing raids had taken place, the transport service was carried out under extremely difficult conditions. An additional strain is thrown upon the railways by the diversion of traffic caused by sea-mining, while the bombing of ports and industrial towns has been shown to do much incidental damage to the transport services. It is known that the internal transport system has recently been put under the control of the German Minister responsible for armaments production and that very high priorities, which must interfere with other production, have been given to locomotive and wagon construction, and repair. Concomitant with this declaration by the Reich Minister, Bomber Command virtually destroyed the important rolling-stock works at Cologne and severely damaged another such works at Bremen.

15. To the negative, but very worthwhile, credit of Bomber Command can be counted the strain upon the enemy of maintaining an enormous and ever-increasing mine-sweeping effort, and also the establishment and maintenance of the largest anti-aircraft and A.R.P. organisation in the world. Some three-quarters of a million personnel are employed on anti-aircraft duties in Germany. If one adds to that the A.R.P. services, the damage and repair organisation and the manufacture of guns and their anti-aircraft ammunition, and also the mine-sweeping and mined ship repairing organisation, there is little doubt that the very existence of Bomber Command costs the enemy the whole-time services of at least three million able-bodied personnel. In addition, Bomber Command forces the enemy to maintain a large and rapidly increasing force of night fighters, which now amounts to some 300 aircraft. Many of these are Ju.88's, a type which, if released, could be used effectively for the attack of our shipping. There is no doubt that, if the Bomber policy was to be abandoned, the release of this vast man-power for other essential work would be of the greatest value to Germany. The release of the twin-engine fighter bombers and the anti-aircraft guns for service on the eastern front and in the Mediterranean would have a powerful and perhaps even a decisive effect on those campaigns.

16. The purely defensive use of air power is grossly wasteful. The Naval employment of aircraft consists of picking at the fringes of enemy power, of waiting for opportunities that may never occur, and indeed probably never will occur, of looking for needles in a haystack. They attempt to sever each capillary vein, one by one, when they could, with much less effort, cut the artery. Bomber Command attacks the sources of all Naval power, rather than the fringes of the one type of enemy Naval operation which obviously menaces us—the submarine. An outstanding example of waste of air effort is the taking away from Bomber Command of all the Hampden aircraft for conversion to torpedo bombers for the defence of this country. These squadrons have, for more than two years, exercised continuous and direct pressure on Germany. Since allocation to Coastal Command they have done practically nothing. It is within the bounds of possibility that they will never get an opportunity to achieve anything. The enemy is not such a fool as to flaunt valuable ships within reach of shore-based aircraft otherwise than when compelled by circumstances to do so, and then only on his own terms as to weather and fighter cover.

17. To sum up, Bomber Command provides our only offensive action yet pressed home directly against Germany. All our other efforts are defensive in their nature, and are not intended to do more, and can never do more, than enable us to exist in the face of the enemy. Bomber Command provides the only means of bringing assistance to Russia in time. The only means of physically weakening and nervously exhausting Germany to an extent which will make subsequent invasion a possible proposition, and is therefore the only force which can, in fact, hurt our enemy in the present or in the future secure our victory. It is the only type of force which we shall ever be able to bring directly against Japan.

18. Finally, it is apparent that an extraordinary lack of sense of proportion affects outside appreciation of the meaning, extent and results of Bomber Command's operations. What shouts of victory would arise if a Commando wrecked the entire Renault factory in a night, with a loss of seven men! What credible assumptions of an early end to the war would follow upon the destruction of a third of Cologne in an hour and a half by some swift moving mechanised force which, with but 200 casualties, withdrew and was ready to repeat the operation 24 hours later! What acclaim would greet the virtual destruction of Rostock and the Heinkel main and subsidiary factories by a Naval bombardment! All this, and far more, has been achieved by Bomber Command; yet there are many who still avert their gaze, pass by on the other side, and question whether the 30 Squadrons of night bombers make any worth-while contribution to the war.

APPENDIX 19

Correspondence between the Air Staff and Sir Arthur Harris on ball-bearings, November 1942, between the Air Staff, Sir Arthur Harris and Mr. C. G. Vickers (Foreign Office and Ministry of Economic Warfare), July 1944

(i)

*Letter and enclosure from Air Vice-Marshal N. H. Bottomley,
Assistant Chief of the Air Staff (Operations), to
Air Marshal Sir Arthur Harris, 21st November 1942¹*

Sir,

I am directed to refer to the recent discussion between yourself and the Chief of the Air Staff on the attack of the ball-bearing industries at Schweinfurt and to say that the Ministry of Economic Warfare have now completed a re-examination of the European ball-bearing position and have issued a full report with special reference to the attack of German ball-bearing factories. A summary and the conclusions of the report is attached at Annexe 'A' to this letter.

2. A statistical estimate of the importance of the Schweinfurt factories can best be obtained from considering together the figures given in the first sentence of para. 3 in the summary with the last sentences in paras. 8 and 9.

52% of the present ball-bearing supplies available to Germany are concentrated in the factories at Schweinfurt (para. 3).

The real load of armaments demand upon the ball-bearing industry (in Germany) is probably in the region of 66% (para. 8).

The qualitative importance of the leading German factories is likely to be even greater than their obvious quantitative importance (para. 9).

3. From these figures and statements it is fair to deduce that the destruction of the Schweinfurt Factories would result in a loss to the Germans of considerably more than half their requirements in ball-bearings for their production of armaments.

4. The M.E.W. summary gives also a very good indication in the underlined sentences of paras. 6 and 7 of the additional difficulties which the Germans would have to face in re-establishing these highly specialised

¹ *Authors' note:* This letter is a directive, but since it refers only to the attack on ball-bearing production it is placed here and not in the directive section.

factories and of the additional shortages which would result from the destruction of stock in the factories at the time of an attack.

5. In forwarding the report, the Ministry of Economic Warfare have stressed the greater results which could be hoped for if the Schweinfurt factories were destroyed while Germany is striving to refit her forces for the 1943 campaigns; they point out that steps are already being taken by pre-empting a substantial proportion of the Swedish ball-bearing capacity to enhance the effects of damage to the German industries.

6. In the circumstances, I am to request that you will now reconsider your plans for the attack of Schweinfurt and the associated ball-bearing factories on the principle that their destruction should be regarded as of critical and vital importance to our strategy, and that the object now to be attained is the complete devastation of the factories and town in one overwhelming operation.

7. To this end I am to convey to you the requisite authority to plan the attack, in conjunction with the Air Officers Commanding-in-Chief, Fighter and Coastal Commands and the Commanding General Eighth Air Force, on the heaviest scale and in the most effective manner which our total resources in the United Kingdom will permit. At Annexe 'B' ¹ is a brief appreciation and suggested method for the operation as an indication of the scale and type of attack envisaged.

8. While the German armed forces are still fully extended and are being redispersed to counter our latest moves in North Africa, conditions are eminently favourable for staging this operation and exploiting surprise. If by waiting a month or six weeks, however, the resources available could be strengthened and brought to a higher pitch of efficiency thus making more certain the achievement of the aim, the delay would be acceptable.

9. In the report by the Ministry of Economic Warfare certain other sections of the ball-bearing industry are suggested for attack, particularly the Stuttgart-Bad Canstatt factories, but if it is felt that the Schweinfurt industries are of such key importance as to justify all resources being concentrated initially to their decisive destruction without regard to these related targets.

10. I am accordingly to request that you will prepare a plan on the lines indicated and submit it to the Air Ministry at the earliest possible date with such views as you may wish to express including an estimate of the likely cost in general of such an operation.

ANNEXE A

THE EUROPEAN BALL-BEARING POSITION

(With particular reference to the attack of German
Ball-Bearing Factories)

SUMMARY AND CONCLUSIONS

The ball-bearing supplies at present available to Germany (387,000 bearings per day) are some 75% greater than the supply available to

¹ Not printed.

Germany from her own factories at the outbreak of war (220,000 bearings per day).

2. While there is some evidence that at the outbreak of war, German capacity was having difficulties in keeping pace with demand, this increase in supplies, although accompanied by an extension of the territories which Germany has to supply, appears to have resulted in a situation in which the present supply position is fairly comfortable. There is no suggestion that any branch of the German war effort is now being held up by difficulties in obtaining an adequate supply of ball-bearings. On the other hand it is not believed that the position has so far improved as to allow users to build up any substantial stocks. This would in any case be contrary to the usual practice of the industry which is based on good economic reasons.

3. It is estimated that 42% of the present Continental ball-bearing capacity, 46% of the present Continental output, and 52% of the present ball-bearing supplies available to Germany are concentrated in the three factories of the V.K.F. combine, and the one factory of the Fischer group at *Schweinfurt*. The next most important contribution comes from the V.K.F. factory at *Stuttgart-Bad Canstatt* which is estimated to account for 12½% of the Continental capacity, 14% of the present output and 15½% of the supplies at present available to Germany.

4. *Immobilization of the Schweinfurt factories would therefore deprive Germany of more than half her present ball-bearing supplies. The immobilization of the Canstatt factory in addition would deprive Germany of over two-thirds of her present ball-bearing supplies.*

5. The prospects of making good such losses by increased reliance on the factories in Italy and the Occupied Territories and by increased imports from factories in Sweden and Switzerland are not good. It is estimated that these sources account for 30% of the present Continental capacity. At the present time, they are believed to be working at an overall average of 70% of their capacity, due principally to lack of raw materials. Of their present output however, it is estimated that over 60% is already going to Germany and 17% to Italy. Even if these factories were put on to full production and the whole of their output sent to Germany, the additional supply which would be available would be equivalent to only 24% of the present supplies available to Germany—that is to say less than one-half the supplies at present obtained from *Schweinfurt* and little more than one-third of the supplies at present obtained from *Schweinfurt* and *Canstatt*. In the event, it would be most unlikely that even these additional supplies would materialise fully. Both Italy and Sweden have their own requirements to satisfy. In addition, part of the capacity of the Swedish industry is already engaged on British orders which are being increased.

6. In these circumstances, the restoration of supplies following on the immobilization of the principal German factories would depend chiefly upon the speed with which these factories could be rebuilt and re-equipped. Here again the prospects are not good. *The manufacture of ball-bearings requires such special tools for certain grinding processes that these are made only in the ball-bearing factories themselves. British experience has shown that if such tools have to be made by ordinary machine-tool manufacturers, a delay of fully*

9 months is involved before they can be built and 'run in'. Destruction of the principal German factories could therefore be expected to destroy simultaneously the German industry's ability to re-equip itself. Some assistance might be obtained from the ball-bearing factories in Italy and Sweden which (and particularly the latter) are experienced makers of grinding tools. The ability (apart from the willingness) of the Swedish firm to help could however depend on the extent to which their machine-making capacity had already been occupied by British orders.

7. Apart from the loss of future productive capacity, the destruction of ball-bearing factories would also certainly involve the loss of an immense quantity of material in course of manufacture. The 'production period' in a ball-bearing factory from raw material to finished product is considerable and there may be as much as six months' output present in the factory in various stages of manufacture at any time. *Apart from the difficulty of collecting together literally millions of balls and rings from the ruins of a damaged factory, contamination by fire and water would certainly render much of the stock valueless since the balls and rings are made within such fine limits of size that the process of cleaning would destroy their accuracy.* In view of this factor and the probable absence of stocks in the hands of users, the effect on the supply to users would probably be immediate and could only be offset by such difficult expedients as the recall of spares from maintenance depots.

8. None of the uses of ball-bearings are 'non-essential'. They are used in all types of machinery where high performance is required by the maximum elimination of friction losses. Since they are more expensive than solid bearings, they are only introduced where overwhelming technical advantages are presented by their use. Since the ball-bearing supplies available to Germany are fully three times as large as those available to Great Britain the proportion entering directly into the production of armaments and equipment is certainly lower than in Great Britain. The proportion of British ball-bearing supplies which will be allotted to such uses in 1943 is 75%. All the necessary data for the calculation of the division of consumption in Germany is not at present available, but it is thought that the comparable figure for Germany, in terms of the number of ball-bearings would be 40% to 45%. This, however, under-estimates the real load of armaments demand upon the industry since this demand is largely for large sizes and special types which require a disproportionate amount of man-hours and machine capacity for manufacture. Taking this factor into consideration, the real load of armaments demand upon the ball-bearing industry is probably more in the region of 66%.

9. The manufacture of special types for armament requirements is certain to be concentrated in the largest and most experienced factories—that is to say the factories at *Schweinfurt* and *Canstatt* with the possible addition of the small factories at *Leipzig* and *Erkner*. The factories in the Occupied Territories are being relied upon mainly to produce standard types for motor vehicles and aircraft—and in fact they are not capable of doing anything else since they are for the most part not equipped to produce 'specials'. The qualitative importance of the leading German factories is therefore likely to be even greater than their obvious quantitative importance.

10. Having regard to the vital nature of the product, to the peculiarly vulnerable features of the production process and to the paucity, both in quality and quantity of the alternative sources of supply, the concentration of over half the German ball-bearing supplies in the one town of *Schweinfurt* therefore presents an opportunity to strike a blow at German war industry which is not shared, or even approached by any other town or industrial target in Axis Europe. The destruction of this town, and of its factories and the killing or wounding of the greatest possible number of its inhabitants promise to produce such far-reaching effects on the German war effort as to take the project right outside the field of routine bombing operations.

11. If the destruction of Schweinfurt could be accompanied or followed by the destruction of the V.K.F. factory at *Canstatt* the effects of the Schweinfurt operation would be greatly reinforced. Pre-emption measures are already in hand to limit the assistance which Germany could obtain from Sweden and some confidence is justifiable in the co-operation of the S.K.F. company, and probably of the Swedish Government, in resisting pressure.

It can also be stated with confidence that the remaining factories in Germany, Italy and the Occupied Territories would be quite incapable of coping with the situation created by fulfilment of the above projects. But if it should be desired to make certain, this could be ensured beyond any shadow of doubt by the destruction in addition of the R.I.V. factory at *Villar Perosa* and the two C.A.M. factories in *Paris*.

Ministry of Economic Warfare

20th November 1942

(ii)

*Letter from Air Marshal Sir Arthur Harris to the Air Ministry
(Assistant Chief of the Air Staff (Operations)) 23rd November 1942*

Sir,

I have the honour to refer to your letter dated November 21st, 1942, and to say that, after a preliminary study of your letter and its annexures, I have the following comments to make.

2. The town of SCHWEINFURT, although not large, is vulnerable to incendiary attack and should be satisfactorily dealt with by night attack. On the other hand, the factories, although not small as factories go, could be dealt with only by means of a low altitude night attack in good weather conditions, (e.g. the Renault Works) or by means of a daylight attack. In both cases precise bombing is required which, either by day or night in the face of the defences known to exist there, could only be carried out successfully by fully trained and experienced crews. The inclusion, therefore, in the plan of O.T.U's and Conversion Units would be unlikely to add much, if anything, to the number of bombs hitting the target, and would undoubtedly result in a largely increased number of casualties. In

this connection, it should be noted that the full output of the O.T.U's and Conversion Units, if left undisturbed, will not suffice to build up the number of crews required to fill the establishments of the 50 medium and heavy operational bomber squadrons which we are endeavouring to have available by the end of the year. The use of these Units, as proposed in your letter, would therefore be certain to have a very serious effect on my expansion programme and there is little doubt that, at best, it would destroy all chances of completing the programme within the date laid down.

3. The situation of the target, more than 300 miles from the continental shore and remote from any obvious landmarks, provides an added reason for confining the attack to fully trained crews. It is most unlikely that crews from O.T.U's or scratch crews from Conversion Units would succeed in finding the target even in good conditions. It is in fact, far beyond the radius of action into enemy territory which I regard as practicable for such crews.

4. The scheme of starting a conflagration by means of a daylight attack on a scale sufficient to ensure its persistence as a beacon for the whole of the night bombing effort cannot be relied upon. Experience has shown that suitable weather for such an operation occurs very seldom. Good weather at home bases, over the target and en route would be required for at least 16 hours. It is worth noting that the only unsuccessful attack on an Italian target during the last month was a night attack carried out on Milan in an attempt to take advantage of the beacon produced by a daylight attack during the preceding afternoon. The weather conditions deteriorated, but it was hoped that the fires lit during the daylight attack would compensate for this. They did not, however, do so in practice and the night attack was not a success.

5. Enquiries have been made from Fighter and Coastal Commands in order to find out the maximum number of aircraft which they could provide respectively for daylight and night attacks. The tentative replies are as follows:

Coastal Command

By day—Nil.

By Night—20 (Bomber Command) Halifaxes. 30 (Torpedo-Bomber) Hampdens, 55 Liberators, Fortresses and Wellingtons, and 10 (Torpedo-Bomber) and 20 (Ordinary) Beaufighters.

Fighter Command

No aircraft available which can carry a bomb for the distance required either by day or night.

6. With regard to the proposal to employ long range fighters as cover for the daylight operations, it is not considered that Beaufighters or Mosquitos would be able to provide any appreciable protection against the enemy's short range day fighters. It is understood that both Fighter Command and Coastal Command concur in this view.

7. The best method, therefore, of causing the maximum interference with the production of these factories is, in my view, as follows:

(i) To carry out a moonlight attack in good weather conditions with

the maximum available numbers of fully trained crews, which, by the December moon, should be approximately 225 heavies and 125 mediums. In addition, if it is considered desirable, the 20 (Bomber Command) Halifaxes and 85 other bomber type aircraft of Coastal Command could be employed, making a total of 455 aircraft. The attack should be carried out from a low level and pressed home with determination, the best crews being selected for the attack of the actual factories. If necessary, the attack should be repeated on every suitable occasion until the required damage has been done.

- (ii) Should the weather on the day preceding the operation be suitable a precise daylight attack on the factories should be carried out by the maximum force of the U.S. VIIIth Bomber Command, whose personnel are trained and units equipped for this type of operation. This should not be regarded as an essential part of the plan, and if, for weather or other reasons, it cannot be undertaken, the night attack should nevertheless be carried out as proposed above. It is not yet known if the U.S. VIIIth Bomber Command will agree to co-operate.

8. It is seen from para. 3 of Annexe 'A' to your above quoted letter that it is estimated that 52% of the ball-bearing supplies available to Germany are produced by the 4 factories at SCHWEINFURT. It is also stated in para. 8 of the same paper that it is estimated that the real load of armaments demand upon the ball-bearing industry is approximately 66%. Assuming, therefore, that these estimates are accurate, the complete destruction of the SCHWEINFURT group of factories would not necessarily do more than reduce the production available for the armaments industry by more than a small percentage. If the remaining factories in German occupied Europe could be made to increase their outputs or if substantial stocks have in fact been built up, the effects of this operation might be very far from those envisaged in the paper. In addition, the confidence felt in the Swedish Government to resist German pressure to relieve a possible Axis shortage of ball-bearings appears to under-estimate German capacity for coercion. It is surely expecting too much to suppose that Germany will allow her war industries to be crippled without taking steps to remove from Sweden every ball-bearing in that country.

9. The conclusion, therefore, in Annexe 'B' ¹ that this operation should be carried out 'at whatever cost' appears very dangerous. Further, the implication in para. 7 of Annexe 'B' that losses up to 200 aircraft and crews per month can in any way be compared to the same number lost in a single operation is entirely fallacious. Crews lost over a period of a month are replaced gradually and provided the daily rate of loss does not exceed a small percentage, the effects are not serious. On the other hand, the sudden loss of a large number of crews in a single operation has a crippling material and moral effect on the squadrons taking part. Squadrons would remain at low strength for a considerable time and new crews could only be fed into them as and when they become available

¹ Not printed.

from O.T.U's and Conversion Units. The moral effect of the concentrated losses and the inability to replace them at once would be very marked. I must emphasise that this Command, which is not and never has been up to full strength and which, owing to its continuous employment at maximum sustained operational effort, has always been short of experienced crews, is in no position to accept and recover from the effects of incurring a very large number of casualties in one operation. I can accept up to 10% of losses in the course of a night operation specifically undertaken against valuable objectives, and I do not estimate that in the type of attack described in para. 7 above, casualties in excess of this need be incurred. It is however quite probable that, in an attack such as that suggested in Annexe 'B' to your letter, carried out by a total of 850 sorties (including 400 pupil crews), 20% or more losses might be incurred, making a total of between 150 and 200 crews.

10. I submit that a detailed appreciation, signed by responsible persons, of the whole ball-bearing industry of Germany, Czechoslovakia, France, Holland, Belgium, Switzerland, Italy, Poland and Sweden should be demanded and closely studied before any implicit reliance is placed on the facile assumptions in the M.E.W. paper of November 20th.

11. It will be recalled, for instance, how insistent the authorities were on the desperate shortage of oil fuel, and particularly lubricants, in Germany. Thereupon Germany opened and conducted with great success in Russia the most vast military campaign in history. A campaign which could not have lasted a month had the German fuel situation even approximated to that which had been so confidently asserted.

12. In these circumstances we should I feel be justly arraigned for levity if we were to accept the casualties suggested in implementing a plan based on a paper such as the M.E.W. paper of November 20th. In the circumstances, I am of the opinion that the existing plan of attack, which I had hoped to make with my normal force shortly, is adequate and will achieve probably as much as the wholesale plan at a tithe of the cost.

(Sgd.) A. T. HARRIS

(iii)

*Letter from Air Chief Marshal Sir Arthur Harris to the Air Ministry,
8th July 1944¹*

Sir,

I have the honour to refer to the series of attacks on the German Ball Bearing Industry and to draw attention to the final statement on this subject on page 3 of M.E.W. Weekly Intelligence Report.

2. From this, it appears that as a result of the attacks on these targets,

¹ *Authors' note:* For directives to Sir Arthur Harris of 14th January, 28th January, and 17th February 1944, which laid special emphasis upon ball bearings, see Appendix 8 (xxxiv), (xxxv) and (xxxvi).

the production of ball bearings within Germany has been reduced by 54.5%.

3. If, in fact, this item had been as vital to the German war effort as repeatedly asserted by the Ministry of Economic Warfare, a reduction of 54.5% could not have been otherwise than a fatal blow to the German war effort.

4. Yet it will be noted that the final assumption by M.E.W in the last paragraph of their report, is that if attacks are now renewed on German ball bearing production, and if there is increased military effort in the field in addition to the cut of about 64% on Swedish exports (in the face of clandestine possibilities of delivery), then in sum all these efforts 'may well eventually have an effect on German military capabilities.'

5. Further comment on this matter, in the light of that statement, would appear to be superfluous, beyond making it necessary to express a hope that the enthusiastic assertions of the past on this subject may in future be tempered with more discretion whenever further targets of a like panacea nature are urged upon us by the Ministry of Economic Warfare.

6. On page 5 of the same report, the statement with regard to Molybdenum at Knaben is deserving of the same comment; while on page 7 there is evidence in the paragraphs headed 'shortages of Particular Products' and 'The effect on Strategy and Morale' that the fickle enthusiasms of these authorities are now being almost entirely retransferred to German oil production.

7. I trust that the M.E.W. will be called upon to account for their overweening enthusiasm over the enemy's ball bearing position, in view of their calculations as to the effects already achieved at so heavy a cost in life and effort.

(Sgd.) A. T. HARRIS

(iv)

Letter from C. G. Vickers (Enemy Branch, Foreign Office and Ministry of Economic Warfare) to Air Vice-Marshal F. F. Inglis (Assistant Chief of the Air Staff (Intelligence)), 26th July 1944

You have shown me a letter from C-in-C Bomber Command dated 8th July. I will deal in order with its comments and implications.

Ball Bearings

The fragment of a sentence quoted in para. 4 from an article in M.E.W. Intelligence Weekly Report is, of course, an understatement, as appears from the earlier part of the same sentence. We plead guilty to an excess of editorial caution. I think it no very serious offence that predictions made in publications which have as wide a circulation as this should err on the side of caution, but I agree that the words do not express a correct appreciation of the situation.

This mistake, however, is not the subject of C-in-C Bomber Command's complaint. Instead, he makes two more serious suggestions which, as it seems to me, are disproved by facts; namely, that the results of the attack on ball-bearings have not been in accordance with our forecasts; and that our forecasts were indiscreet.

I refer first to what our forecast actually was. The case for attacking this industry is set out in the Anglo-American report of January 10, 1944, entitled 'Target Potentialities of the Axis Anti-Friction Bearing Industry.' I would draw your attention to two passages in particular.

Introduction: Para. 8. 'This industry is put forward as the point at which success today will most affect the enemy's power of a continued resistance. It is thus recommended, not as a "panacea", but as the best practical objective for impairing the enemy's ability to fight.'

Summary and Conclusions: Para. 21. 'Re-examination of the Axis bearing position in the light of recent intelligence available to us, and in the light of recent attacks, has in fact served, at every turn, to confirm our earlier conclusions regarding the paramount importance of this industry to the enemy's war potential and particularly to his aircraft production programme. Recent intelligence shows most clearly that the injury already inflicted has penetrated to the field of Service uses. In the light of this intelligence we have no doubt that if this very favourable opportunity is successfully exploited there will be a progressive reduction in weapon production, including aircraft production, within a matter of weeks, which will directly impair the enemy's ability to fight.'

Let us now consider what the position was at the date of that report and what subsequent attacks achieved. This is estimated in our report dated 5th June, 1944 and entitled 'Current Status of the Axis Ball-Bearing Industry' a copy of which was no doubt sent by the Air Ministry to Bomber Command. This report estimates the decline in ball-bearing production since July 1943 as follows:

Production in July 1943 = 100

1943 August	.	.	.	92.0
September	.	.	.	90.5
October	.	.	.	84.0
November	.	.	.	77.0
December	.	.	.	73.0
1944 January	.	.	.	71.5
February	.	.	.	72.5
March	.	.	.	61.0
April	.	.	.	45.5
May	.	.	.	45.5

It will be seen that the position as at the date of the first report (January, 1944) was not substantially worsened until March, when for the first time production fell below 70% of the level of July 1943; and that in April and May it reached its lowest point of 45.5%. On these facts, the paper of 5th June drew the conclusion that up to March 'the use of pipeline stocks, some substitution in uses of lower priority and the relief afforded by diminished aircraft production may have averted for the time being

a serious deterioration in the situation', but that a more serious situation had developed since that date.

Let us next consider what effect might be expected since March from a reduction of this order of magnitude. The C-in-C states that it ought to have been 'a fatal blow to the German War effort.' I prefer to be more precise and to say that it ought to have eliminated a significant though minor part of the enemy's capacity for weapon and equipment production during the period for which it was maintained. In other words, the flow of finished weapons including aircraft, tanks and vehicles, moving from the factories and repair depots to the front ought to have diminished, not of course by 54.5% but by a substantial though much smaller proportion. This reduction might be expected, in the words of our appreciation, 'directly to impair the enemy's ability to fight'—whether fatally or not, would of course depend on the military situation, whilst the speed with which it would be felt at the front would depend on the rate of wastage.

If the C-in-C will refer to the paper on German Weaknesses which has just been issued by the J.I.C., he will find these expectations fully realised. That paper contains abundant evidence from the Service Intelligence Directorates, apart from ourselves, of desperate shortages which have developed in all kinds of enemy weapons and equipment, especially aircraft, tanks and M.T. Some specific evidence links restriction of tank production with ball-bearing shortage and attests the value which the Germans set on getting further supplies of ball-bearings even to the point of offering the Swedes Me.109 and F.W.190 aircraft in exchange. So many other causes, including attacks on other industrial objectives by the strategic air forces, have combined with the attacks on ball-bearing plants to produce the enemy's present disastrous position that it is impossible to say from the evidence available how much of the credit should be given to the attacks on ball-bearing plants; but there is certainly sufficient evidence of the effects, both in kind and in degree, which were to be anticipated on the basis of our appreciation of January 10, from the weight and continuity of the attack delivered, despite the fact that this has fallen something short of the weight of effort which we hoped and anticipated would be devoted to a primary objective.

We would not now, even after the event, alter a word in our original appreciation, and in this case it would be surprising if this should be necessary. Few target systems have received such careful analysis. American as well as British, and Service as well as civilian, intelligence staffs contributed to this, but we readily accept the primary responsibility. The case was eventually made with such cogency that it convinced the Air Staff, up to and including the C.A.S., as well as the Combined Chiefs; overcame, as I supposed, the scepticism of the C-in-C; was adopted as an operational policy, and carried into effect by both Air Forces in a series of attacks. This would hardly have occurred if it had been no more than an 'enthusiastic assertion'.

I am driven to the conclusion that the C-in-C expects some result from industrial bombing other than that which we forecast. If so, he must not blame us if his expectations are disappointed. The advice which we give is based on industrial analysis and current intelligence. These sources

have never yet indicated any target which was calculated to win the war alone. We have therefore never been in the position to advocate any target the attack on which was calculated to do more than make it possible for the Services in combination to defeat the enemy and win the war. This is what we forecast in the present instance and this is what is being achieved.

Molybdenum

I do not understand the implications of the comments on molybdenum contained in para. 6. This paragraph states that the effect of an American attack on the Knaben mine in November had been overcome by May. I am sure that the C-in-C Bomber Command does not share the delusion which exists in some quarters that industries, unlike armies, navies and air fleets, do not recover from attack. If C-in-C Bomber Command was disappointed with the extent of the damage inflicted in this or the previous raid, or the speed with which it was repaired, his expectations were certainly not based on anything said or written by Enemy Branch. If, on the other hand, he concludes from this paragraph that the ferro-alloy system is not a worth-while target for attack, his conclusion seems ill-founded and I can only refer him to the exhaustive analyses of this target system which have so often been made.

Oil

So far from being a 'fickle enthusiasm', our emphasis on the importance of oil has been monotonous in its regularity for more than four years. What is new is the capacity of the strategic air forces to deal with the target effectively. Their success in doing so has evoked enthusiasm, I believe, not only in us but in all the Chiefs of Staff; and I thought that it had also evoked the enthusiasm of the C-in-C Bomber Command, judging by the manner in which his bombers have lately been knocking about the synthetic oil plants in the Ruhr.

The reason why oil has in our view become of particular importance at this juncture (and of greater importance now even than ball-bearings) is that, given the present capacity to attack it and the present greatly increased enemy need for ample supplies, our estimates show, and the most reliable of Service intelligence confirms, that its direct effect on the enemy's fighting forces is likely to be felt more quickly than attacks on other industrial objectives; and at the present stage of the war targets which show quick returns are obviously of particular importance.

Incidentally, appreciation of the enemy's oil situation is another field which has been explored as thoroughly and, as the evidence now shows, as successfully as any other target system. We cannot claim the whole credit, because as you know all the three Service intelligence directorates, as well as other technical help, have always been associated in the study; and parts of the picture, in particular the assessment of oil consumption by the enemy armed forces which has become the most important variable, are the sole responsibility of the Services. But we are glad to claim a share of the credit commensurate with our responsibilities.

Our function, in so far as it affects Bomber Command, is (i) to advise

on the relative importance of different industrial target systems and on the effect on the German war effort which may be expected from different degrees of interruption; and (ii) to supply detailed intelligence for the planning of operations against such targets. In doing this, we have as you know developed close working relationships with your staff and with the staff of D.B.Ops. Over the past year these staffs have been supplemented by their American opposite numbers, Service and civilian. The whole of this organisation now works as a closely associated team; and I believe that it is shown by the facts to serve Bomber Command both carefully and well; but its usefulness is diminished by these persistent misunderstandings both about the kind of result to be expected and about the degree of effort needed to attain it. If the foregoing observations serve to dispel these misunderstandings and therewith any hindrance which still exists to Bomber Command making full use of the contribution which we can make to their operations, it will fulfil the only purpose with which I am concerned. For I believe that these operations are now paying in generous measure the only return which on economic grounds can be expected, namely such a weakening of the enemy's fighting power as will lead to his capitulation or his final defeat in the field or both.

I enclose a copy of this letter so that you may send it to C-in-C Bomber Command.

(Sgd.) C. G. VICKERS

APPENDIX 20

Note by the Chief of the Air Staff for the Chiefs of Staff on an Estimate of the Effects of an Anglo-American Bomber Offensive Against Germany, 3rd November 1942

At the 137th Meeting of the Committee, held on the 5th October, I was invited to circulate a Note setting out the facts and arguments which support the Air Staff view that a heavy bomber force rising to a peak of between 4,000 and 6,000 heavy bombers in 1944 could shatter the industrial and economic structure of Germany to a point where an Anglo-American force of reasonable strength could enter the Continent from the West.

2. The only difficulty in complying with this request is that of dealing with this very wide subject in a Paper of reasonable length. I have accordingly been obliged to restrict this note to an outline of the salient points. Some of the factors involved are treated more fully in Appendices.

Choice of a Yardstick

3. As the starting point for an appreciation of this kind it is necessary to decide upon a reasonable estimate of the results likely to be achieved by a given weight of bombs. From photographs and intelligence reports we have a very good idea of the damage being inflicted on Germany by the current operations of the Bomber Command. Nevertheless, this information is far from complete and would not serve as a satisfactory basis for the study.

4. The only comprehensive analysis of the results of bombing is that derived from the German bombing raids on this country during the twelve months ended the 30th June, 1941. Estimates derived from the results of these attacks are accordingly employed to forecast the effect of the very much heavier scale of bombing contemplated under the plan in question.

The German Attacks

5. During the twelve months ended the 30th June, 1941, the Luftwaffe dropped 55,000 tons of bombs on this country, of which 36,000¹ tons were directed at industrial areas. These attacks caused 41,000 deaths and serious injury to 45,000 persons. Nearly 350,000 houses were rendered uninhabitable for the duration of the war and one million people were displaced from their homes. In addition there were some 2½ million 'incidents' of housing damage, many of which caused the temporary displacement of the occupants and all of which required repairs. Beyond these results, the destruction caused to factories, power plants, shipping and harbour

¹ Probably one-quarter of this total fell in built-up areas.

facilities and public utilities had a direct reaction on the war effort, but is not susceptible of exact numerical assessment.

6. Judging by contemporary standards, the German attacks were an inferior example of bombing technique. The attacks were not well planned; the Luftwaffe was only partly prepared for night operations; the effort was widespread over the country and the methods of reaching and marking targets were, on the whole, unreliable. Above all, the small raids of those days effected only a fraction of the damage per ton of bombs achieved with the large-scale concentrated attacks of to-day employing the latest incendiary technique.

7. It follows that the estimates of damage made later in this paper and based on the achievements of the German Air Force over this period are likely to be far short of reality.

Why the German Attacks were not Decisive against Great Britain

8. It is worth turning aside from the main argument for a moment to deal with the not uncommon suggestion that the German attacks against this country proved that large-scale bombing is not a decisive weapon.

9. The first comment which must be made on this suggestion is that the large-scale raids were brought to an end, not because Germany believed they were paying an unsatisfactory dividend, but because it was necessary for the Luftwaffe to move East for the invasion of Russia.

10. Nevertheless, it is a fact that the German raids of 1940/41 produced no major interruption of the British war effort. The reasons for this lie partly in the small scale of the German attacks and partly in the degree of resilience which characterised the British war economy at that stage.

11. The scale of the German attacks was far below that necessary to produce a decisive effect. The total tonnage of bombs dropped by the Luftwaffe throughout the year amounted to less than two-thirds of the peak monthly scale of attack contemplated in this paper.

12. Again, the German attacks came at a time when the British war effort was running far below its potential maximum. With certain important exceptions, alternative manufacturing capacity was available or could be adapted to replace damaged factories. Nearly a million building trade operatives were available for repair work and could be supplemented by military personnel. Our own efforts were backed up by access to the resources of the United States of America located far beyond the reach of enemy bombing and undisturbed by the effects of war. Our resources in man-power were free from any vast operational commitment of the character imposed on Germany by the Russian campaign. From the moral standpoint, the attack came at a time when the British people were comparatively fresh, well-fed and well-clothed. They were braced by the ordeal of Dunkirk and sustained by the triumph of the Battle of Britain. They had been warned to expect heavy air raids and they were convinced that the attack was a temporary hardship to which an answer would soon be found and which would undoubtedly be repaid with interest.

13. Thus the British industries and the British people possessed a degree of resilience and recuperative power adequate to sustain a greater shock than was in fact inflicted.

14. For all these reasons the German attacks fell short of their aim. Nevertheless, their importance must not be underestimated. Nearly 18 months have passed since the last major air attack on this country, and it is easy to forget how gravely the German bombing offensive was regarded by responsible authorities at the time. Many who were in close touch with the events would support the view, that, had even this small scale of attack been more concentrated and persistent, the effect on our war effort and on civilian morale might have assumed a most serious character.

Scale of Attack Contemplated for the Anglo-American Bomber Offensive

15. For the purpose of this paper I have assumed that the Anglo-American Bomber Force based in the United Kingdom would expand to a first-line strength of 5,000 by June 1944 rising to a peak of 6,000 by the end of the year.

16. During the period of development of this force the scale of attack would amount to 25,000 tons a month by June 1943, to 50,000 tons per month by December 1943, to 65,000 tons a month by June 1944, and to a peak of 90,000 tons a month by December 1944. Under such a plan 1½ million tons of bombs would be dropped on Germany during 1943 and 1944.

17. A simple calculation based on the results of the German bombing raids referred to in paragraph 5 would suggest that apart from the direct destruction of industries and public utilities, an attack on this scale would lead to the destruction of eight million German houses. But regard must be paid to the fact that the proportion of undamaged houses would be a steadily decreasing quantity. Allowing for this, the estimate of houses rendered permanently uninhabitable falls to six million. In addition there would be some sixty million 'incidents' of bomb damage to houses. Civilian casualties are estimated at about 900,000 killed and about 1,000,000 seriously injured. These estimates make no allowance for the fact that the number of persons per house would tend to increase as the destruction of dwellings progressed. Altogether the calculations suggest that some 25 million Germans would be rendered homeless and many additional millions would have to be temporarily evacuated elsewhere.

Effect on German Industry

18. It is now necessary to consider the effect of destruction of this order on the German war machine.

19. Assuming that the attacks were concentrated on urban areas, the scale of devastation described in paragraph 17 would be adequate to render homeless three-quarters of the inhabitants of all German towns with a population of over 50,000. Superimposed upon the destruction of dwellings there would be a proportionate destruction of industrial plant, sources of power, means of transportation and public utilities.

20. It is possible to paint an even clearer picture of the degree of destruction involved by describing it in terms of attacks of a specified intensity.

21. On the night of the 30th/31st May, 1942, a major attack was car-

ried out on Cologne. In the space of 90 minutes, 770 tons of bombs fell in the city. As a result, nearly one-third of the inner zone of the town was completely destroyed and the areas of total devastation aggregated nearly a square mile. 20,000 houses were completely destroyed and many others damaged. 200,000 persons had to be evacuated. 250 factories were destroyed or suffered varying degrees of damage.

22. Taking this attack as a unit of measurement the probable results of the attacks can be described in rather more definite terms, as follows: During 1943 and 1944 every industrial town in Germany with a population exceeding 50,000 could receive *in proportion to its size*, ten attacks of 'Cologne' intensity.

23. In practice, the attacks would be more concentrated. Assuming, for example, they were directed against such a selection of towns as those listed in Appendix I,¹ each of these towns would receive, *in proportion to its size*, some 17 attacks of 'Cologne' intensity during the period.

24. The towns listed in Appendix I comprise between one-quarter and one-third of the total urban population of Germany and it is safe to conclude that they contain more than one-third of total German industry. The method of selection employed ensures that they are the most important third of the German economy.

25. It is not, I think, unreasonable to suppose that under a policy of concentrated attack the contribution to the German war effort of these 58 towns would be eliminated and that they would become instead a serious liability to the German war machine.

26. Germany is in no condition to withstand an onslaught of this character. Her strength has passed its peak and is diminishing. The heavy drain of the Russian war, the campaign in Libya, the existing air offensive and the blockade are all contributing to a progressive attrition. Damaged resources, plant and stock of materials cannot now be adequately replaced; structural damage can no longer be adequately repaired; replenishments obtainable from the stocks of occupied countries are a waning asset. The output of German labour is falling through war weariness, food difficulties and other domestic problems, while that of foreign labour—whether in Germany or in the occupied territories—falls with Germany's diminishing prospects.

27. It should not be supposed, moreover, that the effect of destroying one-third of German industry as contemplated in paragraphs 23-25 would be limited to a corresponding drop in the German war potential. In practice the effect would be very much greater. A certain minimum proportion of the industrial effort of any country must always be devoted to maintaining a minimum standard of subsistence throughout the country as a whole. In Germany it is believed that this minimum has already been reached. It follows that any large-scale damage inflicted on industry as a whole cannot be absorbed evenly but must be borne to an ever-increasing degree by that part of industry which is maintaining the armed forces. The only alternative is to face a collapse of the Home Front.

28. This point can be illustrated numerically. It is believed that the

¹ Not printed.

urban working population of Germany is divided as two-thirds in industries engaged in maintaining the national economy and one-third in the munitions industries. It is also believed that the former proportion is now at its minimum. In these circumstances any general loss to German industry as a whole must be borne almost exclusively by the munitions element. This important point is treated at greater length in Appendix III.¹

29. The proportions quoted above may not be entirely accurate. But that the loss of one-third of German industry would be attended by a far greater proportionate loss to her war potential as a whole can scarcely be disputed.

30. In considering the estimates included in the foregoing paragraphs it is instructive to note the results achieved in certain recent heavy-scale attacks on Germany. Details of the damage inflicted during attacks on Cologne, Dusseldorf and Karlsruhe are accordingly included in Appendix II.¹

31. I have purposely said nothing about the moral factor as this is a subject on which opinions differ widely. It is, in fact, difficult to estimate the moral consequences of a scale of bombardment which would far transcend anything within human experience. But I have no doubt whatever that against a background of growing casualties, increasing privations and dying hopes it would be profound indeed.

The Improved Standard aimed at

32. The foregoing discussion is based entirely on the assumption that the results of our future bombing will be proportionate to those attained by Germany during the attacks of 1940/41. This has the merit of providing a cautious estimate. It is, however, very far from corresponding to our reasonable expectations. The technique of bombing is improving rapidly. Better training, the Pathfinder Force, incendiary technique, better bombs and radio aids have all to play their part. The ability to concentrate a large-scale attack into the shortest possible time has already proved itself as a means both of reducing casualties and of increasing the damage caused per ton of bombs. There is every chance that together these various factors will make possible a substantial improvement over the results achieved by Germany against this country.

33. There is also the possibility that the United States will prove successful in their daylight technique, in which case a high proportion of the total effort contemplated in this paper will take the form of precision bombing by daylight.

34. The higher standards of efficiency we hope to attain from these improvements in air tactics and technique are dealt with in greater detail in Appendix IV.¹ If these expectations are realised the forecast decline of German war potential will, of course, be greatly accelerated.

The German Defences

35. The development of our offensive would certainly result in a desperate expansion of the air defences of Germany. I have carefully con-

¹ Not printed.

sidered this possibility and I am convinced that the German defences would be incapable of dealing effectively with attacks on the scale proposed. A summary of the factors on which this conclusion is based is set out in Appendix V.¹

36. In fact, I think there is a distinct possibility that the implementation of the plan would result in a progressive deterioration of the air defence system of Germany. The rapid development of the offensive would force upon the German defences a scale of effort and a scale of wastage far greater than anything they have yet encountered. The pressure would be applied at a time of acute and increasing industrial difficulties. To the extent that they failed to meet the threat, the difficulties would intensify. Thus the task might grow increasingly beyond their ability to control.

37. I believe that the operations of an Anglo-American force of the size contemplated in this paper might well create a situation of this kind which would lead to the whole of Germany being laid open to deliberate bombing by day and night.

Meanwhile, the ever-increasing demands made upon a waning aircraft industry for the support of the Home Front could not but inflict a most serious handicap on Axis operations by land, sea and air in all other theatres.

Conclusion

38. For the reasons described above, I am convinced that an Anglo-American bomber force based in the United Kingdom and building up to a peak of 4,000-6,000 heavy bombers by 1944 would be capable of reducing the German war potential well below the level at which an Anglo-American invasion of the Continent would become practicable. Indeed, I see every reason to hope that this result would be achieved well before the combined force had built up to peak strength.

Summary

(i) The paper assumes that an Anglo-American Heavy Bomber Force would be based in the United Kingdom and built up to a first-line strength of 4,000 to 6,000 by 1944.

(ii) Such a force could deliver a monthly scale of attack amounting to 50,000 tons of bombs by the end of 1943, and to a peak of 90,000 tons by December 1944.

(iii) Under this plan 1½ million tons of bombs would be dropped on Germany between January 1943 and December 1944.

(iv) Assuming that the results attained per ton of bombs equal those realised during the German attacks of 1940-41, the results would include:

- (a) the destruction of 6 million German dwellings, with a proportionate destruction of industrial buildings, sources of power, means of transportation and public utilities;
- (b) 25 million Germans rendered homeless;

¹ Not printed.

- (c) an additional 60 million 'incidents' of bomb damage to houses;
- (d) civilian casualties estimated at about 900,000 killed and 1,000,000 seriously injured.
- (v) If the attacks were spread over the main urban areas the result would be to render homeless three-quarters of the inhabitants of all German towns with a population of over 50,000.
- (vi) Expressed in other terms, this scale of attack would enable every industrial town in Germany with a population exceeding 50,000 to receive, in proportion to its size, ten attacks of 'Cologne' intensity.
- (vii) If the attacks were concentrated on the 58 towns specified in Appendix I,¹ each would receive, in proportion to its size, some 17 attacks of 'Cologne' intensity.
- (viii) A concentrated attack of this character would destroy at least one-third of the total German industry.
- (ix) A substantial proportion of the total industry of Germany is necessary to maintain minimum standard of subsistence among the German people. As the German economic structure is now stretched to the limit this proportion cannot be further reduced. Consequently, the loss of one-third of German industry would involve either the sacrifice of almost the entire war potential of Germany in an effort to maintain the internal economy of the country, or else the collapse of the latter.
- (x) It is hoped that our bombing efficiency will prove to be substantially better than that achieved in the German attacks of 1940-41. In that case the process of attrition will be much accelerated.
- (xi) It is considered that the German defences will be incapable of stopping these attacks.
- (xii) It is certain that the diversion of more and more of a waning aircraft production to the defence of Germany will heavily handicap all German operations by land, sea and air in other theatres.
- (xiii) It is concluded that an Anglo-American bomber force of the size proposed could reduce the German economic and military strength to a point well below that at which an Anglo-American invasion of the Continent would become possible. This result might well be achieved before the combined force had built up to peak strength.

C. P.

¹ Not printed.

APPENDIX 21

Extract relating to the Bomber Offensive from a report by the Chiefs of Staff on American-British Strategy in 1943, 31st December 1942

THE BOMBER OFFENSIVE

18. The aim of the bomber offensive is the progressive destruction and dislocation of the enemy's war industrial and economic system, and the undermining of his morale to a point where his capacity for armed resistance is fatally weakened.

19. In estimating the prospective results of the air offensive, it is important not to be misled by the limited results attained in the past two and a half years. Bombing methods and technique have been passing through a phase of rapid development; new navigational aids and other ancillary equipment which should bring about a great advance in bombing accuracy are being introduced; the training of air crews has been improved, and better tactical methods, showing great promise, have been devised.

20. As a result, the British bomber force will attain far higher standards of efficiency and accuracy in night bombing in the future than have been possible in the past. We have gained a lead in quality over the German defences, and we do not believe that they will be able to develop counter-measures sufficient to offset our advantage.

21. In spite of the progress made during recent months by the United States Bomber Command in the bombing of targets in Occupied Territory, it is still an open question whether regular penetration of the defences of Germany by daylight will be practicable without prohibitive losses.

While every effort should continue to be made to achieve success by day, it is important to arrange that, if the daylight bombing of Germany proves impracticable, it will be possible to convert the United States Bomber Command from a primarily day to a primarily night force with the least possible delay and loss of efficiency.

22. The result attained with a given bombing effort does not vary directly with the scale of that effort, but tends to become progressively more fruitful as the effort increases. Moreover, experience shows that, as the bombing effort mounts above a certain level, the defences become saturated and the aircraft casualty rate is reduced.

23. While the enemy's attention is focussed on Russia, the Allies have the initiative in strategic bombing, which is the chief method by which they can at present inflict direct damage on Germany and Germans. We must, therefore, exploit it to the full.

24. British heavy bombers are in steadily increasing production. In parallel, the build-up of American heavy bombers in the United Kingdom

will increase our combined strengths at little cost to shipping space, once the transfer of American ground personnel has been completed.

25. *It is not claimed that the bomber offensive will at once shatter the enemy's morale. It is claimed that it already has an appreciable, and will have an increasing effect, on the enemy's distributive system and industrial potential—an effect which the German High Command and German people will fear more and more.*

26. We recommend that we should aim at operating a force of 3,000 British and American heavy and medium bombers from the United Kingdom by the end of 1943. Without drawing on reserve stocks, this increase in the Allied Bomber Force in the United Kingdom will only involve an increase in petrol import requirements of about 350,000 tons in 1943—a very small proportion of total requirements.

APPENDIX 22

Letter and enclosure from C. G. Vickers
(Ministry of Economic Warfare) to
Air Chief Marshal Sir Charles Portal,
commenting on the Report of Committee
of Operations Analysts, 3rd April 1943

1. I have been asked by D.B.Ops to provide you with the M.E.W. views on the document entitled 'Report of Committee of Operations Analysts: March 8th 1943'.¹

2. We have not been able in the few hours available to examine all the detailed facts and arguments in this document, which covers nearly 500 targets, but further examination is not likely to alter our views regarding their conclusions on these subjects, which are as follows:

3. We are in substantial or close agreement with the Committee in the opinions which they express in their covering letter, in so far as these are within our province; and with their conclusion the following classes of targets:

- Aircraft
- Ball Bearings
- Petroleum
- Non-Ferrous Metals
- Synthetic Rubber and Tyres
- Transportation
- Submarines.

4. Several of their other surveys appear to have been based on what we regard as a somewhat superficial examination of the enemy's position and show a certain divergence of opinion between us on questions of fact, which we are already in process of trying to reconcile by discussion here and in Washington.

5. These divergences do not in practice seem to matter because they relate to industries which we and, it would appear, the Committee, do not consider to be in the forefront of the candidates for adoption as primary targets.

6. Whatever they may say on the inadvisability of making a written priority list, the Committee's report makes it clear that they favour the following industrial groups for prior consideration:

- Fighter Aircraft and Aero-Engines
- Ball-Bearings
- Petroleum Products

¹ *Authors' note:* This was the Committee appointed by General Arnold to report on targets for the air offensive.

Grinding Wheels and Abrasives
 Non-Ferrous Metals
 Synthetic Rubber and Tyres.

These views concur very closely with our own, as appears from the conclusions of the enclosed memorandum (Annexe I pages 1 and 2) which we prepared for you two months ago and to which we still adhere.

7. The only significant points of difference are that

- (a) we would take a less optimistic view than the Committee of the damage which it may be possible to inflict on Axis industry by attacking grinding wheel factories;
- (b) we consider that the possibilities of attacking motor transport and aircraft via selected internal combustion engine components and accessories should receive consideration;
- (c) we believe that the possibilities of affecting aircraft production through the attack of propellers factories is worthy of further investigation.

8. We agree with the Committee in concluding that the effect on the Axis war effort of attacks on submarine yards and transportation objectives is subject to a very substantial time-lag.

9. The enclosed commentary (Annexe I) states in more detail the points of disagreements mentioned above. In the time available it has not been possible to make this more specific. If you would like us to elaborate any of the arguments you have only to let me know.

(Sgd.) C. G. VICKERS

DETAILED COMMENTARY ON
 'REPORT OF COMMITTEE OF OPERATIONS ANALYSTS,
 MARCH 8TH 1943'

Aircraft & Aero-Engines

We agree with the main line of the argument and with the selection of targets.

In the last paragraph but one, the fact that the destruction of certain aero-engine factories would affect the production of other aircraft, such as bombers, in addition to the production of single-engine fighters is adduced as an argument for preferring engine factories to assembly factories as targets in a programme designed to reduce the enemy's S.E. fighter strength. This argument should however lead to precisely the opposite conclusion. If a considerable proportion of the present output of any type of aero-engine used in fighters (e.g. the D.B.601/605) is also used in bombers, the allocation of engine production for bombers in fact constitutes a reserve from which, in an emergency, the production of fighters might be sustained, and there is therefore the possibility that the achievement of the main aim of reducing fighter production will be delayed by the operation of this factor.

Ball-Bearings

We are in full agreement with the general argument but believe that it would be over-optimistic to look for a significant effect in the production of finished equipment in less than three months. We think, however, that the difficulty in obtaining replacement equipments and the vulnerability of ball-bearing plants generally has been understated.

Of the targets recommended Nos. 4 and 9 might be discarded without greatly affecting the coverage of production obtained. The two D.K.F. plants at Leipzig should however be added as it is believed that they are important producers of special bearings for aircraft.

The preoccupation of the Swedish industry with Swedish requirements is over-stated; in fact there is an appreciable export to Germany. It is nevertheless true that the spare capacity available in Sweden (and elsewhere in neutral Europe) would not in practice be sufficient to offset more than a small proportion of the prospective decline in German production.

Oil

We have recently reported on this subject to the Air Staff. Our conclusion was that the loss of 250,000 tons of production in the period April/June 1943 would have or contribute to a number of critical effects on the German war effort. Thereafter, the target figure might have to be increased in view of a potential increase in synthetic capacity by $1\frac{1}{2}$ million tons per annum in the course of 1943. There is however no question that the destruction of *either* the 13 Bergius plants *or* the leading Roumanian refineries at any time in the next twelve months would have a critical, and perhaps decisive, effect on the enemy's war effort.

The relative importance of the various synthetic plants as stated in the table would appear to require revision in one or two instances.

Grinding Wheels and Crude Abrasives

We consider that the prospects of achieving decisive results through the attack of this type of target has been over-estimated. Owing to the large number of sources of production and the probable existence of considerable stocks, plants manufacturing crude abrasives do not appear to us to offer favourable targets. In the light of data collected from grinding wheel manufacturers in this country, it is possible that the vulnerability of grinding wheel factories has been over-stated.

There is, however, no doubt about the fundamental importance of this industry.

Non-Ferrous Metals

We are in agreement with the analysis of the position and attach a high priority to the attack of alumina plants (including those in Southern France, which are not listed) as well as the two copper producers specified. The Mansfeld mine does not however appear to possess many features which would be particularly vulnerable to air attack.

The additional results which could be expected from the attack of

high-grade zinc plants would probably not justify the additional expenditure of effort.

No. 13 is largely inactive at the present time.

Synthetic Rubber and Rubber Tyres

We are in agreement with the analysis of the present position. The priority to be accorded to attacks on synthetic rubber plants depends in part upon the institution of measures which will impose such a heavy cost on blockade running as to deter the enemy from further attempts.

We would strongly endorse the belief in the susceptibility of tyre factories to incendiary attack which might make their destruction possible with a comparatively small expenditure of effort. This makes the tyre industry a very attractive target. An additional attraction is the extent to which a successful attack would affect the efficiency of equipment in service, as well as new output, owing to the large proportion of tyre production which is required for maintenance purposes.

We can confirm the existence of a third Continental plant in Hanover and can produce strong evidence to suggest that the percentage of total Axis tyre production produced by these factories is of the order of the figure stated in the footnote. In these circumstances, it should be possible at any rate initially to discard some of the targets listed (e.g. Nos. 1, 2, 7 and 9).

Submarines

We are in complete agreement with the views expressed. We would only add that there appears to be no effective means of interfering substantially with submarine construction by attacks on inland factories producing components and accessories owing to the great dispersion of production and the large reserves of manufacturing capacity.

Motor Transport

The estimate of total holdings agrees with our own. We consider Axis production, however, to be at least twice the rate of 8500/9000 per month stated here. We do not accordingly believe that the seven plants named account for anything like 85 per cent. to 90 per cent. of total Axis truck production. Owing to part conversion of factories to other purposes, the relative importance of the various leading motor factories at the present time is a subject of considerable obscurity. The whole matter is under discussion with Washington in an attempt to reconcile the present wide divergence of British and American estimates.

Any list of major motor assembly plants in Axis Europe should include the Opel works at Russelsheim and the Peugeot works at Sochaux. The list given would have to be very greatly extended in order to cover even three-quarters of total Axis truck output.

We do not consider that the attack of motor assembly plants is a satisfactory object for *primary* target policy. We believe that the output of motor vehicles can be more effectively disturbed through the attack of factories manufacturing specialized components and accessories. Such a policy has the additional advantage that it is also calculated to affect the

serviceability of equipment already in use, via maintenance requirements. The most promising target groups in this category are tyres (see above) and fuel injection and ignition equipment.

Transportation

We are in complete agreement with this analysis.

Coking Plants

The analysis is unexceptionable; the total number of targets involved effectively debars further consideration of coke-ovens as primary targets.

Ferro-Alloy and Carbide Plants

We agree with the implicit conclusion that this industry does not offer a suitable focus for primary target policy, though not with the arguments on which the conclusion is reached. The fact is that owing to the German deficiencies in alloying materials which is likely to become more and more of a limiting factor, the available furnace capacity in Axis Europe is by no means fully employed.

The list of suggested targets would appear to require extensive overhaul in order to provide the most important targets in this category.

Machine Tools

The first two paragraphs are unquestionably true in theory, though difficult to follow up in practice. The further analysis is based on a paper which we have criticized severely. We do not consider that the subject justifies a quantitative assessment of the type undertaken here and doubt the validity of the conclusion.

The list of targets, however, is an accurate statement of the most important German machine-tool makers.

Electric Power

We are in agreement with the general argument though we do not believe that the possibilities can be given as definite a quantitative expression as is done in Paras. 3 and 4.

In both areas, a severe degree of dislocation would be produced by the destruction of a much smaller number of carefully selected targets than the 32 and 23 indicated.

Electrical Equipment

We cannot endorse any of the statements in this section without detailed examination. It seems, to say the least, to be a somewhat superficial examination of a large subject.

The importance of Siemensstadt, though considerable, is greatly over-estimated by the statement that it is responsible for 30 per cent. of the entire German output of electrical equipment.

Optical Precision Instruments

The importance of the two selected plants in the total output is probably somewhat over-estimated. We agree that in estimating the effects of damage to this class of production, the time factor is very problematical.

It is thought that reserves of optical glass blanks are so large that instrument makers would not in practice be inconvenienced by the destruction of the optical glass works unless it could be kept out of production for at least 12-18 months.

Chemical Industry

Although some of the larger mixed chemical works represent worthwhile targets for night attack, we agree that the chemical industry does not provide any suitable focus for primary target policy.

While we agree that the artificial fibre industry does not qualify as a primary target, we base our conclusion on the fact that the industry is such a long way behind the front line of the German war effort, rather than upon the possibilities of developing alternative capacity. If there really are 154 rayon plants in Axis Europe, which we doubt, it is certain that at least 100 of them must be of quite negligible importance.

Food

We agree that there are no promising targets in this field.

Nitrogen

The statement that 42 per cent. of the total Axis nitrogen production (? capacity) is devoted to synthetic petroleum products does not fit the facts and appears to be based upon a misunderstanding of the functions of certain nitrogen plants with which synthetic oil plants are now associated. In fact, up to 20 per cent. of the nitrogen capacity of Axis Europe has recently been idle, and the proportion occupied in fertilizer production undoubtedly exceeds 50 per cent. of the total. The list of individual plants appears to have been based on inaccurate information; for instance there is no question that Oppau (No. 11) is a much larger plant than Scholven (No. 15) to which 12 per cent. of Axis nitrogen capacity is attributed.

The conclusion that shortage of nitrogen would be felt 'to a disastrous degree' in food production within fifteen months is, in our opinion, a gross overstatement of the possibilities.

Anti-Aircraft and Anti-Tank Artillery

We are not in possession of adequate information regarding rates of production and wastage to be able to confirm or deny the statements made under this heading. The implicit conclusion that this is not a useful target, however, concurs with such views as we have been able to form.

APPENDIX 23

The Combined Bomber Offensive from the United Kingdom (*Pointblank*) as approved by the Combined Chiefs of Staff, 14th May 1943

1. THE MISSION

(a) The mission of the United States and British bomber forces, as prescribed by the Combined Chiefs of Staff at Casablanca, is as follows:

To conduct a joint United States-British air offensive to accomplish the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened. This is construed as meaning so weakened as to permit initiation of final combined operations on the Continent.

2. THE PRINCIPAL OBJECTIVES

(a) A thorough study of those elements of the German military, industrial and economic system, which appeared to be profitable as bombing objectives, was made by a group of Operations Analysts consisting of eminent United States experts. The report of the Operations Analysts concludes that:

The destruction and continued neutralization of some sixty (60) targets would gravely impair and might paralyze the western Axis war effort. There are several combinations of targets from among the industries studied which might achieve this result.

(b) Examination of this report shows complete agreement by United States and British experts. From the systems proposed by the Operations Analysts, six systems, comprising *seventy-six (76) precision targets*, have been selected. These targets are located within the tactical radius of action of the two air forces, and their destruction is directed against the three major elements of the German Military machine: its submarine fleet, its air force, and its ground forces, and certain industries vital to their support.

(c) The six systems are:

Submarine construction yards and bases.
German aircraft industry.
Ball bearings.
Oil.
Synthetic rubber and tires.
Military transport vehicles.

Concentration of effort against these systems will have the following

effect. The percent of destruction is as indicated by the Operations Analysts:

- (1) *Submarine construction yards and bases.* Destruction of the submarine building yards selected will reduce present submarine construction by eighty-nine percent (89%). Attack of submarine bases will affect the submarine effort at sea. If it is found that successful results can be achieved, these attacks should continue whenever conditions are favourable for as long and as often as is necessary.
 - (2) *German aircraft industry.* Depletion of the German air force will fatally weaken German capacity to resist our air and surface operations. Complete domination of the air is essential for our ultimate decisive effort. Destruction of forty-three percent (43%) of the German fighter capacity and sixty-five percent (65%) of the German bomber capacity is provided for in this plan, and will produce the effect required.
 - (3) *Ball bearings.* The critical condition of the ball-bearing industry in Germany is startling. The concentration of that industry renders it outstandingly vulnerable to air attack. Seventy-six percent (76%) of the ball bearing production can be eliminated by destruction of the targets selected. This will have immediate and critical repercussions on the production of tanks, airplanes, artillery, diesel engines—in fact, upon nearly all the special weapons of modern war.
 - (4) *Oil.* The quantities of petroleum and synthetic oil products now available to the German is barely adequate to supply the lifeblood which is vital to the German war machine. The oil situation is made more critical by failure of the Germans to secure and retain the Russian supplies. If the Ploesti refineries, which process thirty-five percent (35%) of current refined oil products available to the Axis, are destroyed, and the synthetic oil plants in Germany which process an additional thirteen percent (13%) are also destroyed, the resulting disruption will have a disastrous effect upon the supply of finished oil products available to the Axis.
 - (5) *Synthetic rubber and tires.* These products are vital to all phases of German Military strength on land and in the air. Provision is made for destruction of fifty percent (50%) of the synthetic rubber capacity and nearly all of the tire production. This destruction will have a crippling effect.
 - (6) *Military transport vehicles.* Seven (7) plants produce a large proportion of the military transport and armored vehicles. The precise proportion is unknown. Loss of these plants will strike directly at the German Military strength. *The cumulative effect of the destruction of the targets comprising the systems just listed will fatally weaken the capacity of the German people for armed resistance.*
- (d) The selection of these objectives is confirmed by the fact that the systems about which the Germans are most sensitive, and about which

they have concentrated their defenses, such as balloons, camouflage, anti-aircraft, searchlights, decoys and smoke, are:

Aircraft factories.
Submarine construction yards.
Ball-bearings.
Oil.

3. INTERMEDIATE OBJECTIVE

(a) The Germans, recognizing the vulnerability of their vital industries, are rapidly increasing the strength of their fighter defenses. The German fighter strength in western Europe is being augmented. *If the growth of the German fighter strength is not arrested quickly, it may become literally impossible to carry out the destruction planned and thus to create the conditions necessary for ultimate decisive action by our combined forces on the Continent.*

(b) Hence the successful prosecution of the air offensive against the principal objectives is dependent upon a prior (or simultaneous) offensive against the German fighter strength.

(c) To carry out the Eighth Air Force's part of this combined bomber offensive it will be necessary to attack precision targets deep in German territory in daylight. The principal obstacle to this is the growing strength of the German air force. The growth of this fighter force has become so pronounced as to warrant a brief review of this development (Chart A).¹

(d) The upper curve shows what has been happening to the German air force in the past nine months. The bomber strength has been sharply reduced from 1,760 bombers to 1,450 in operational units. The fighters, on the other hand, increased from 1,690 to 1,710. They suffered a reduction in strength, doubtless caused by the intense operations in Russia and the Mediterranean as well as on the Western Front, but those losses have been made good at the expense of the bombers. That same trend is reflected in the lower curve, which shows production was maintained fairly constantly for about five months and then increased, so that fighter production has risen from 720 to 810 per month. Over a longer period of time, from the entrance of the United States into the war until the present time, the trend has been even more pronounced. German fighter strength has increased by forty-four percent (44%) in that period in spite of the heavy losses. This chart shows the margin of production over average monthly wastage in German fighters. Of course, the monthly wastage has not been constant over the past seven months, as shown on the chart, but the average for that period has been fairly accurately determined at 655 fighters per month. The production rate as of last February showed 810 fighters per month. The average increase in production over the six-month period depicted indicates a monthly surplus of production over average wastage of 108 airplanes. If this trend simply continues in its present ratio, it is well within the capacity of the Germans to produce enough fighter airplanes over and above wastage to provide a strength of 3,000 fighters by this time next year. (See Chart B.)¹ This is, of course, a

¹ Not printed.

capability and not necessarily a German intention, although current German development points very strongly in that direction. The increase in fighter strength is not reflected in this curve covering the past eight months; however, during that period the Germans converted a great many fighter-type airplanes into fighter bombers and fighter reconnaissance airplanes. The wastage rate was very high in those units and that probably accounts for the temporary decline in German fighter strength; however, in the last three months it has shown a sharp uprise.

(e) The disposition of German fighters is also significant (see Chart C).¹ The top line shows the number of fighters on the Western Front. Since we entered the war that strength has nearly doubled. It has risen from 420 to 830. This, in spite of the heavy drains on the Russian and Mediterranean fronts. When we entered the war only thirty-six percent (36%) of German fighters were concentrated on the Western Front; to-day, fifty percent (50%) of all fighters available to the German air force are concentrated in opposition to our principal bombing effort from the United Kingdom. The German fighter force is taking a toll of our forces both by day and by night, not only in terms of combat losses, but more especially in terms of reduced tactical effectiveness. If the German fighters are materially increased in number it is quite conceivable that they could make our daylight bombing unprofitable, and perhaps our night bombing, too. On the other hand, if the German fighter force is partially neutralized our effectiveness will be vastly improved.

(f) For this reason German fighter strength must be considered as an *Intermediate* objective second to none in priority.

4. INTEGRATED R.A.F. - UNITED STATES ARMY AIR FORCES' OFFENSIVE

(a) The combined efforts of the entire United States and British bomber forces can produce the results required to achieve the mission prescribed for this theater. Fortunately the capabilities of the two forces are entirely complementary.

(b) The tremendous and ever-increasing striking power of the R.A.F. bombing is designed to so destroy German material facilities as to undermine the willingness and ability of the German worker to continue the war. Because of this, there is great flexibility in the ability of the R.A.F. to direct its material destruction against those objectives which are closely related to the United States bombing effort which is directed toward the destruction of specific essential industrial targets. It is considered that the most effective results from strategic bombing will be obtained by directing the combined day and night effort of the United States and British bomber forces to all-out attacks against targets which are mutually complementary in undermining a limited number of selected objective systems. All-out attacks imply precision bombing of related targets by day and night where tactical conditions permit, and area bombing by night against the cities associated with these targets. The timing of the related day and night attacks will be determined by tactical considerations.

¹ Not printed.

(c) This plan does not attempt to prescribe the major effort of the R.A.F. Bomber Command. It simply recognizes the fact that when precision targets are bombed by the Eighth Air Force in daylight, the effort should be complemented and completed by R.A.F. bombing attacks against the surrounding industrial area at night. Fortunately the industrial areas to be attacked are in most cases identical with the industrial areas which the British Bomber Command has selected for mass destruction anyway. They include Hamburg, Bremen, Hanover, Berlin, Leipzig, Wilhelmshaven, Bremerhaven, Cologne, Stuttgart, and many other principal cities. They also, of course, include smaller towns whose principal significance is coupled with the precision targets prescribed for the Eighth Air Force.

5. GENERAL PLAN OF OPERATIONS

(a) It would be highly desirable to initiate precision bombing attacks against German fighter assembly and engine factories immediately. However, our present force of day bombers is too small to make the deeper penetrations necessary to reach the majority of these factories. Considering the number of German fighters which can be concentrated laterally to meet our bombers on penetration, and again on withdrawal, it is felt that 300 heavy bombers is the minimum operating force necessary to make deep penetrations.

(b) The general tactical plan of operations with this minimum force involves the following general conception: a holding attack intended to attract German fighters to a particular area and prevent their massing against the main attacking force. For this purpose 50 heavy bombers with fighter escort are required. Second, a main striking force to penetrate through the fighter defenses and carry out the destruction of targets in Germany and return. Two hundred bombers is considered the minimum requirement to provide self-protection and at the same time carry out worthwhile destruction. Third, the covering force to attack still another area and attract fighters in order to divert them from the main force on withdrawal. Again, 50 bombers with fighter escort is the minimum force to carry out such a function.

(c) In order to establish a yardstick to be used in the determination of the number of bombers required to destroy the objectives desired, the following procedure was employed:

Twelve successful missions were conducted in January, February and March. Approximately 100 bombers were dispatched on each. It was found that sufficient bombs fell within a circle of 1,000-foot radius centered about the aiming point to cause the desired destruction. For each prospective target the number of 1,000-foot radius circles necessary to cover it has been calculated. The yardstick, as determined by experience, is, therefore, the number of 1,000-foot radius circles of destruction, each requiring 100 bombers.

(d) The plan of operations is divided into four phases (see Chart E).¹

¹ Not printed.

The depth of penetration, the number of targets available and the capacity of the bombing forces increases successively with each phase.

(e) Seventy-six precision targets have been selected for Eighth Air Force bombing operations. Having selected these 76 targets the questions arise: Can they be effectively destroyed, and, if so, how many bombers will be required? As to the first question, operational experience answers yes.

6. EFFECTIVENESS OF EIGHTH AIR FORCE

(a) The operations of the United States Army Air Force in daylight bombing of defended objectives in German-occupied Europe have been sufficient to establish a criterion of precision daylight bombing effectiveness; the operations of the R.A.F. Bomber Command leave no room for doubt of the ability of that force to devastate industrial areas.

(b) The daylight operations of the Eighth Air Force from the 3rd January, 1943, to the 6th April, 1943, definitely establish the fact that it is possible to conduct precision-pattern bombing operations against selected precision targets from altitudes of 20,000 to 30,000 feet in the face of anti-aircraft artillery and fighter defenses.

(c) Of 20 missions dispatched by the United States Eighth Air Force in that period, 12 have been highly effective. These 12 daylight missions have been directed against a variety of targets, including:

- Submarine bases
- Locomotive shops
- Power houses
- Marshalling yards
- Shipbuilding yards
- Motor vehicle and armament works
- Airplane engine factories

The average number of aircraft dispatched against these targets has been 86. The destructive effect has, in every case, been highly satisfactory. From this experience it may be definitely accepted that 100 bombers dispatched on each successful mission will provide entirely satisfactory destructive effect of that part of the target area within 1,000 feet of the aiming point; and that two-thirds of the missions dispatched each month will be successful to this extent.

7. FORCES REQUIRED

(a) *Heavy bombers*

(1) In computing the force required, a yardstick of 100 bombers dispatched per target area of 1,000 feet about each aiming point has been accepted as a reasonable product of actual experience to date. Each target has been evaluated in terms of these 'Target Units,' or the number of 1,000-foot radius circles in which this destructive effect must be produced.

(2) Experience in the European Theater to date indicates that at least 800 airplanes must be in the theater to dispatch 300 bombers on operations. Hence, until the level of United States bomber strength

in this theater reaches approximately 800, it will not be feasible to sustain a precision bombing offensive against the German fighter factories. It is estimated that we will be able to accommodate and train a force of this capacity by July of this year. In the interim every effort should be made to reduce the German fighter force by attack of those fighter factories which can be reached, and by combat under favourable conditions. The repair depots and airdromes are included for the purpose of giving commanders the necessary tactical latitude. Concurrently, operations can be conducted against submarine installations within reach and against other targets contributing directly to the principal objectives which are within covering range of our own fighters, or which do not require deep penetration. Some operations will have to be conducted to provide the necessary training for the incoming forces; such operations must be conducted against objectives within the listed categories.

- (3) During the next phase, from July to October, in which it is estimated that we will be able to penetrate to a limit of 400 miles, a determined effort must be made to break down the German fighter strength by every means at our disposal, concentrating primarily upon fighter aircraft factories. During this time interim an additional increment of 248 bombers are required, so that the strength in the theater by October should be approximately 1,192. This would provide a striking force of 450 bombers at the end of this period. The average striking force during this period would be 400.
- (4) During the third phase the German fighter force must be kept depleted, and the other sources of German strength must also be undermined. During this phase our bombing offensive forces must be adequate to perform all their major tasks.
- (5) From October to January an additional increment of 554 bombers are required, bringing the total to 1,746. This should provide an operational striking force of 655 bombers at the end of that time. The average striking force during this period will be 550 bombers.
- (6) During the last phase—early 1944—the entire force should be used to sustain the effect already produced and to pave the way for a combined operation on the Continent. This will require a force of 2,702 heavy bombers.
- (7) It will be observed that the charts of the actual location of the targets to be attacked in each phase show the joint bombing effort of each phase. It will be noted that, in the first phase (see Map 1),¹ operations are limited to relatively shallow penetration. They include submarine bases along the coast, submarine construction yards, and the Focke-Wulf airplane factory at Bremen. Actually, of course, these operations have all been undertaken with the small forces available and in the case of the submarine yards at Vegesack and the Focke-Wulf plant at Bremen, a long step has already been taken towards completion of the plan. There are two other

¹ Not printed.

systems of operations calling for deep penetrations shown in this phase. One of them calls for an attack against oil installations in the Ruhr. This operation is entirely contingent upon an earlier attack from the Mediterranean area against the oil refineries at Ploesti in Rumania. Such an attack is under consideration now, and if it is carried out we will be forced to operate against the Ruhr refineries in order to exploit the advantage achieved in Rumania. The other attack calls for a very deep penetration at Schweinfurt. This operation might be undertaken as a surprise attack in view of the tremendous advantages accrued from a successful destruction of these plants; however, it would be most unwise to attempt it until we are perfectly sure we have enough force to destroy the objective in a single operation. Any attempt to repeat such an attack will meet with very bitter opposition. In the second phase (see Map 2),³ the plan calls for a concentration of effort against the German fighter assembly and fighter aircraft factories as well as attacks against airdromes and repair facilities. It is anticipated that approximately 75% of the striking force will be applied to this end during this phase. The other 25% is directed against submarine construction yards. In the third phase (see Map 3)¹ an all-out attack against all the principal objectives is provided as well as repeat operations to continue neutralization of installations which have been destroyed and which can be repaired. During the fourth phase (see Map 4),¹ these operations are continued and allowances made for concentration of attacks against installations more directly associated with a cross-channel operation such as rail transportation, arsenals, Military installations, &c.

- (8) The determination of the number of aircraft required in each phase has been based strictly upon past experience. As to the rate of operations, the Eighth Air Force has averaged six per month over the past six months. In the past three months, it has actually carried out twelve highly successful operations out of a total of twenty. This plan is based on a total of twelve successful operations in each three-month phase and recognizes the probability that the other six will for one reason or another be less satisfactory. Experience has shown that about 3/8ths of the total number of airplanes in the theater can be dispatched on operational missions at any one time. This makes allowances for the airplanes in depot reserve, those in depot repair, and those being ferried and modified. There is every reason to believe that our forces will be more effective in the future than these figures indicate. In order to be as realistic as possible, however, the plan has been based in each case upon actual past experience.
- (9) Chart E¹ tabulates all the targets for contemplated destruction by the United States and British bomber forces to carry out the mission. The precision targets for attacks by the United States Bomber Command are shown as small symbols. The cities and

¹ Not printed.

towns in or near those precision targets and which constitute the complementary targets of the R.A.F. are shown as in circles. The German fighters are at present deployed in four main concentrations positioned well forward toward the coast. In general, the day fighters are in four lots of approximately 100 each in the general areas of north-west coastal Germany, Holland and Belgium, the channel coast of France and western France in the vicinity of the submarine pens. These fighters are capable of concentrating laterally from bases at least 200 miles away, so that forces of 300 fighters might be employed against our main efforts if we penetrated directly towards the Ruhr without distracting or diverting part of them.

- (10) Chart D¹ is illustrative of the effect of this plan of operations upon the intermediate objective, German fighter strength. This chart must be considered as pictorial rather than precise. The top line shows the increase in German fighter strength. That is a German capability if they choose to follow it. If German production is not interrupted and if German wastage is not increased, it is possible for Germany to have in operation 3,000 fighters by next April. The broken line shows the effect of our operations upon that German fighter strength. In the first phase we do not expect to accomplish a great deal because our forces will not have been built up to decisive proportions. In the second phase, our attacks against German fighter factory and engine factories and the increased attrition should cause the levelling off of the German fighter strength. In the third phase the full effect of the attacks against German fighter production should make themselves felt so that German fighter strength should fall off rapidly in this phase. In the fourth phase that German fighter strength should decline at a precipitant rate. This second line has been computed in the following manner: The decrease in German fighter strength is the result of two factors. One is the attacks against German fighter factories, the other the accelerated rate of combat wastage caused by our increased bomber forces. This wastage rate has been computed in an extremely conservative manner. It is realized that past claims of enemy aircraft shot down may seem high, although our evaluation of them is very careful; nevertheless, in order to avoid any charge of unwarranted optimism combat claims have been arbitrarily divided by four, the resulting decrease in German fighter strength dependent upon expected combat wastage is at a rate only one quarter as great as our present combat claims. Even under these very conservative assumptions it is apparent that the German fighter strength will have passed its limit by the end of the second phase, and its powers of resistance should decline very rapidly thereafter.

(b) *Medium bombers*

It will be noted that no United States medium bombardment aircraft

¹ Not printed.

have been specifically included in the computation of force required above. That does not mean that medium bombardment is not necessary to implement this plan. Supplementary attacks against all strategic targets within range of medium bombers are anticipated as necessary adjuncts to the heavy bomber attacks. In addition, medium bombardment is required in order to conduct repeated attacks against German fighter airdromes, to aid the passage of the heavy bombers until the attacks against the German aircraft industry make themselves felt. Medium bombardment will be necessary to support combined operations in early 1944. The crews must be operationally trained in this theater by that date.

(c) *Fighters*

At all times there is a need for an extensive United States fighter force both to protect the bombers and to assist in the reduction of the German fighter strength. Prior to the initiation of operations on the Continent, this fighter strength must be at a maximum, and must be fully trained for operations in this theater.

Note. This plan deals entirely with the requirements for the strategic bombing force, except for its use in the 4th Phase on missions which will render most effective support to surface operations on the Continent, which may begin in early 1944. In order to supplement this force in providing the close support required for the surface operations, steps must be taken early to create and train a tactical force in this theater. This force must include light bomber, reconnaissance, fighter, and troop carrier elements.

8. CONCLUSIONS

(a) *Recapitulation of United States bomber forces required:*

	<i>Heavy</i>	<i>Medium</i>
1st Phase . . .	944	200 Bombers required by June 30, 1943.
2nd Phase . . .	1,192	400 Bombers required by September 30, 1943.
3rd Phase . . .	1,746	600 Bombers required by December 31, 1943.
4th Phase . . .	2,702	800 Bombers required by March 31, 1944.

(b) If the forces required as set forth above are made available on the dates indicated, it will be possible to carry out the mission prescribed in the Casablanca Conference. If those forces are not made available, then that mission is not attainable by mid-1944.

(c) Depletion of the German fighter strength must be accomplished first. Failure to neutralize that force will jeopardize the prosecution of the war toward a favourable decision in this theater.

(d) The following bombing objectives should be destroyed under the provisions of the general directive issued at the Casablanca Conference:

(1) *Intermediate objectives:*

German fighter strength.

(2) *Primary objectives:*

German Submarine yards and bases.

The remainder of the German aircraft industry.

Ball bearings.¹

Oil.¹ (Contingent upon attacks against Ploesti from the Mediterranean.)

(3) *Secondary objectives in order of priority:*

Synthetic rubber and tires.

Military motor transport vehicles.

(e) The following statement of principle, expressed by the Operations Analysts, is concurred in:

In view of the ability of adequate and properly utilised air power to impair the industrial source of the enemy's Military strength, only the most vital considerations should be permitted to delay or divert the application of an adequate air striking force to this task.

¹ A successful initial attack on the key element of either of those systems would demand the immediate concentration of effort on the remaining elements of that system to exploit the initial success.

APPENDIX 24

Report by the Ministry of Home Security on the Effects of British Air Attacks in Force on German Targets During the Period 4th July to 30th September 1943, 19th October 1943

During the period under review there were 20 R.A.F. attacks in force on individual German towns. The analyses of the effects of 15 of the attacks are presented in this paper. Particulars of these attacks and of the material available for the assessment of their effects are given in Table I. Particulars of the 5 attacks for which insufficient material is available are given in Table Ia.

The omission of these 5 attacks will result in a slight under-estimate of the total effects of the raids, since the 15 attacks considered were made on 9 towns containing an aggregate of more than $2\frac{1}{2}$ million dwelling units, and the 5 attacks omitted from consideration were made on 4 towns containing an aggregate of approximately $\frac{1}{2}$ million dwelling units.

The results of the assessment are presented in Tables II to VI and Figure 1.

Table II gives the area and percentage of total building estimated to have been seriously damaged in the attacks; industrial and non-industrial damage are given separately. 42 million square feet of industrial building (1.5 sq. miles) and 156 million square feet of non-industrial building (5.6 sq. miles) are estimated to have been seriously damaged.

It is estimated that there are 53 sq. miles of non-industrial and 26 sq. miles of industrial building in the zoned areas; thus¹ 9.5 per cent. and 5 per cent. respectively of the areas of non-industrial and industrial buildings have been seriously damaged.

Table III gives the numbers and percentages of dwelling units estimated (a) to have been demolished (the figure includes dwelling units so seriously damaged as to require demolition), (b) rendered uninhabitable (which includes dwelling units demolished and requiring demolition) and (c) habitable but requiring first aid repairs. The aggregate details are summarized below:

Total dwelling units originally present	2,684,000 (100%)
Dwelling units demolished or requiring demolition	193,000 (7%)
Total dwelling units rendered uninhabitable for the duration	280,000 (10%)
Dwelling units requiring first aid repairs	351,000 (13%)
Total dwelling units affected	631,000 (23%)

¹ Excluding 15 million sq. ft. of non-industrial and 4.6 million sq. ft. of industrial building damage in the unzoned areas of Hamburg.

In interpreting these figures it should be borne in mind that approximately 25% of the dwelling units within these cities lie in Zone 3, and that the major part of the damage to dwelling units occurs in the more central zones.¹

Table IV summarizes the effects of damage to housing, and presents estimates of (a) the number of people whose houses are uninhabitable, (b) other people whose houses have been damaged, (c) labour required for house repairs, and (d) the cost of repairs to houses. The labour and cost figures include those involved in the demolition and in preparation and transport of materials for repair. The aggregate details of this table are summarized below:

People whose houses are uninhabitable	931,000
Other people whose houses have been damaged	1,150,000
Labour required for repairs	323,000 man months
Cost of repairs	£8,066,000
Labour force engaged in first six months	21,000

Attention is drawn to the footnote to Table IV which states that the estimate of the labour force required is based on British experience, involving completion of repair over a period of 18 to 24 months. Should completion of repairs be required within six months, it is estimated that the labour force would have to be tripled.

It should be noted that the figures in this paper refer to damage in urban areas only and contain no allowance for damage done by spill of attacks onto villages and small towns near the main target areas. In the United Kingdom, for every 100 houses demolished in urban areas 40 were demolished in rural areas, but this factor cannot be applied directly to Germany because of differences in the population distribution; the appropriate factor for Germany will be less than 0.40 but no definite figure can be given at present.

Table V gives estimates of production loss due to direct damage to factories and other industrial establishments, and to indirect factors, including absenteeism on the part of industrial workers and interruptions of electricity, gas and water supplies. Total loss of production in the target towns is estimated to be 1,780,000 man-months, which may be expected to be spread over a total of 9 months from the beginning of the period under review (i.e. 4th July 1943). Figure 1 has been constructed to show the probable distribution of production loss resulting from R.A.F. bombing operations during the July-September quarter, and the loss resulting from R.A.F. operations during the April-June quarter.² The peak rate of loss occurs in July 1943 when the mean rate is estimated to be approximately 700,000 man-months per month.

¹ *Authors' note:* the division into zones is described in Vol. I, p. 475, fn. 1.

² The estimates of production loss during the April-June quarter given in RE/H 28 have been revised and placed on the same basis as the estimates in this report.

On the basis of a rough estimate¹ of the number of industrial workers in the bombed towns, it appears that on the average all towns together lost some 3 weeks' production. The range of loss was wide, extending from 11 weeks in Hamburg and Remscheid to 2 days in Berlin.

Table VI summarizes the cost in man months of repairing and replacing the damage to industrial building, plant, equipment, stocks, and houses resulting from the July-September raids. An attempt has been made to eliminate from this estimate damage which the Germans will probably not repair during the war.

The total loss summarized in Tables V and VI amounts to approximately 4,100,000 man-months, and may be expressed as an average of 25 days for each worker in the bombed towns.² In interpreting this figure it should be noted that part of the burden of repair and replacement of damage will fall on other towns, and further that no allowance has been made for certain categories of loss, such as time lost by non-industrial workers, and indirect production losses due to the interruption of supplies from factories suffering raid damage.

TABLE I

Particulars of raids considered and of material available for the assessment of the raid effects

Town	Date of attack	No. of aircraft engaged	Weight of weapons claimed dropped		Material available for the assessment of raid effects
			H.E. Tons	I.B. Tons	
Aachen .	13/14 July	327	308	471	C.I.U. damage plot
Berlin .	23/24 Aug.	565	865	733	R.E.8 damage plot
	31/1 Aug./Sept.	469	748	592	
Cologne .	8/9 July	247	667	381	R.E.8 damage plot
Essen .	25/26 July	599	1,030	898	C.I.U. damage plot
Hamburg .	24/25 July	724	1,350	932	R.E.8 assessment data
	27/28 July	720	1,105	969	
	29/30 July	697	1,076	1,164	
	2/3 Aug.	399	640	705	
Mannheim .	9/10 Aug.	424	835	836	R.E.8 damage plot
	5/6 Sept.	546	773	813	
Munchen-Gladbach .	30/31 Aug.	588	1,094	1,257	R.E.8 damage plot
Nurnberg .	10/11 Aug.	589	879	862	C.I.U. damage plot
	27/28 Aug.	582	849	849	
Remscheid	30/31 Aug.	228	287	417	C.I.U. damage plot
9 Towns .	15 Attacks	7,704	12,506	11,879	—

¹ Assuming industrial population is 60% of the working population.

² Assuming that the working population of the towns is 47% of the total.

TABLE IA
Particulars of raids not considered in this analysis

Town	Date of attack	No. of aircraft engaged	Weight of weapons claimed dropped		Population	No. of dwelling units
			H.E. Tons	I.B. Tons		
Gelsenkirchen .	9/10 July	386	728	615	322,000	89,000
Hannover .	22/23 Sept.	636	1,142	1,118	473,000	141,200
	27/28 Sept.	563	961	1,208		
Mannheim .	23/24 Sept.	541	906	1,065	284,000	81,600
Munich .	6/7 Sept.	347	562	440	863,000	241,000
4 Towns .	5 Attacks	2,473	4,299	4,446	1,942,000	552,800

TABLE II
Areas and percentages of buildings seriously damaged

Town	Seriously damaged buildings					
	Industrial		Non-industrial		Total	
	Area (million sq. ft.)	Per-centage	Area (million sq. ft.)	Per-centage	Area (million sq. ft.)	Per-centage
Aachen . . .	1.0	6.7	6.5	22.5	7.5	17.0
Berlin . . .	1.6	0.4	9.0	1.2	10.6	1.0
Cologne . . .	0.4	0.6	2.0	1.6	2.4	1.2
Essen . . .	5.4	7.6	3.5	2.9	8.9	4.6
Hamburg ¹ . . .	27.0	(20.1) ²	117.0	(52.1)	144.0	(40.5)
Mannheim . . .	3.5	3.9	5.4	7.6	8.9	5.9
Munchen-Gladbach ²	(1.1)	(4.9)	(3.9)	(11.5)	(5.0)	(8.6)
Nurnberg . . .	0.3	0.9	2.0	2.8	2.3	2.2
Remscheid . . .	1.6	11.1	6.5	25.3	8.1	20.5
TOTAL . . .	41.9	(5.0)	155.8	(9.5)	197.7	(8.0)

¹ These figures include 4.6 million industrial and 15 million non-industrial in areas shown as unzoned in the zone information sheets.

² No precise information on zones in the town available.

³ % figures for the zoned areas only.

TABLE III

Numbers and percentages of dwelling units demolished, rendered uninhabitable and needing first-aid repairs

Town	Dwelling units						
	Number originally present (pre-raid)	Demolished or requiring demolition		Rendered uninhabitable for the duration		Requiring first-aid repairs	
		No.	Percentage	No.	Percentage	No.	Percentage
Aachen . .	47,300	6,500	13·7	9,800	20·7	17,500	37·0
Berlin . .	1,454,000	13,000	0·9	21,300	1·5	78,000	5·4
Cologne . .	229,000	1,100	0·5	1,900	0·8	7,900	3·4
Essen . .	157,900	1,900	1·2	3,000	1·9	10,600	6·7
Hamburg . .	528,500	159,000	30·1	226,000	42·8	192,000	36·3
Mannheim . .	81,600	3,600	4·4	5,800	7·1	17,600	21·6
Munchen-Gladbach . .	(35,000)	2,200	6·3	3,600	10·3	9,100	26·0
Nurnberg . .	119,700	1,800	1·5	3,000	2·5	10,900	9·1
Remscheid . .	31,200	4,100	13·1	5,900	18·9	7,200	23·1
TOTAL . .	2,684,200	193,200	7·2	280,300	10·4	350,800	13·1

TABLE IV

The effects of damage to housing

Town	Population ¹	People whose houses are uninhabitable	Other people whose houses have been damaged	Labour required for house repairs (man-months)	Cost of repairs to houses (£ sterling)	Labour force engaged during first 6 months after attack
Aachen . .	149,000	30,900	55,100	16,100	402,000	1,050
Berlin . .	4,466,000	65,400	239,500	71,800	1,794,000	4,700
Cologne . .	745,000	6,500	27,100	7,300	182,000	470
Essen . .	660,000	12,500	44,300	9,700	244,000	650
Hamburg . .	1,760,000	753,000	639,000	177,000	4,416,000	11,500
Mannheim . .	284,000	20,300	51,400	16,200	404,000	1,060
Munchen-Gladbach . .	123,000	12,600	31,900	8,400	209,000	550
Nurnberg . .	426,000	10,700	38,800	10,000	250,000	650
Remscheid . .	100,000	18,900	23,100	6,600	165,000	430
TOTAL . .	8,713,000	930,800	1,150,200	323,100	8,066,000	21,060

The labour force engaged and the cost of repairs are based on English experience. In this country the time to completion of repairs has in most instances been of the order of 18-24 months. Where a large proportion of houses in an industrial town has been demolished, necessitating repair of seriously damaged houses in addition to first-aid repairs, the labour force engaged and the cost have increased to the order of twice the level in less serious raids, without diminishing the period of repair. Allowance has been made for this effect. In order to complete repairs in 6 months the labour force would need to be tripled, but the cost would not be altered significantly.

¹ 1943 estimated.

TABLE V
Production loss in factories

Town	Production loss in man-months resulting from:			Working population estimated at 47% of total population
	Direct damage	Indirect effects	Total	
Aachen . . .	19,500	23,800	43,300	70,000
Berlin . . .	49,000	31,300	80,300	2,099,000
Cologne . . .	12,300	6,500	18,800	350,000
Essen . . .	162,800	21,100	183,900	310,000
Hamburg . . .	809,000	415,200	1,224,200	827,000
Mannheim . . .	74,700	22,300	97,000	133,000
Munchen-Gladbach . . .	41,900	6,800	48,700	58,000
Nurnberg . . .	6,400	7,100	13,500	200,000
Remscheid . . .	47,100	23,200	70,300	47,000
TOTAL . . .	1,222,700	557,300	1,780,000	4,094,000

TABLE VI
Labour required to repair damage to industrial buildings, plant, equipment, stocks and houses

Town	Industrial buildings repairs (man/months)	Replacement of industrial plant and stocks (man/months)	House repairs (man/months)	Total labour required (man/months)
Aachen . . .	17,100	14,000	16,100	47,200
Berlin . . .	54,700	26,900	71,800	153,400
Cologne . . .	13,700	6,700	7,300	27,700
Essen . . .	181,800	90,000	9,700	281,500
Hamburg . . .	903,400	444,900	177,000	1,525,300
Mannheim . . .	83,300	41,100	16,200	140,600
Munchen-Gladbach . . .	36,900	30,200	8,400	75,500
Nurnberg . . .	7,200	4,300	10,000	21,500
Remscheid . . .	52,600	26,900	6,600	86,100
TOTAL . . .	1,350,700	685,000	323,100	2,358,800

APPENDIX 25

Note by Air Chief Marshal A. W. Tedder, Deputy Supreme Commander, Allied Expeditionary Force, for Sir Charles Portal on Air Policy to be Adopted with a View to Rapid Defeat of Germany, 25th October 1944

1. As I see it, there are two methods of ending this war, one is by land invasion and the other is by breaking the enemy's power and control behind the lines. I, myself, do not believe that these two courses are alternative or conflicting. I believe they are complementary. I do not believe that by concentrating our whole Air effort on the ground battle area we shall shorten the war. Nor do I believe that we would shorten the war by putting our whole Bomber effort against industrial and political targets inside GERMANY.

2. As regards the land campaign, the primary objective is the RUHR. The Army Groups have now made it clear that what they would like the Air to do is to interrupt enemy reinforcement and supply across the RHINE. As a secondary object they wish the enemy's ability to withdraw heavy equipment across the RHINE reduced to a minimum. Up to the present, the direct strategic contribution towards this has been the Oil plan, the successful attack on the DORTMUND-EMS Canal, and some attacks on Ordnance and M.T. Depots. The other action, by the tactical forces, has been line cutting and attacks on trains by fighters, and some (largely abortive) attacks on Bridges. I am not satisfied that, on these lines, we are using our Air power really effectively. The various types of operations should fit into one comprehensive pattern, whereas I feel that at present they are more like a patchwork quilt.

3. With regard to the direct attack on GERMANY, here again I feel our efforts are rather patchwork. The various targets (Oil, cities, depots, marshalling yards, canals, factories, etc.) do not together build up into a really comprehensive pattern.

4. My views as to what should, and can, be done are as follows:

The one common factor on the whole German war effort, from the political control down to the supply of troops in the front line is communications. Leaving on one side Signal communications as being relatively invulnerable to air attack, rail, road, and water communications are the one common denominator. The city populations may have gone underground but without surface communications they will starve. Industries may have gone underground but their life lines remain on the surface. Industries have been dispersed, but the more they have been dispersed the more they depend on good communications. Governmental control depends to a very great extent on efficient road and rail communications as is only too evident today in BELGIUM and FRANCE. The Army's dependence on communications needs no comment.

5. In my opinion our primary Air objective should be the enemy's communications. Road, water, and rail are interdependent and complementary, and our Air operations should play on that fact. The present Oil plan is the key to movement by road and air, and, moreover, directly affects operations in the Battle area. It is supplemented by fighter attacks on M.T. The river and canal system in WESTERN EUROPE has been examined, and targets indicated. The successful attack on the DORTMUND-EMS canal is being followed up by attacks on further vulnerable points. The practicability of mining the RHINE and thus stopping the extensive barge traffic is being examined.

6. Except for a few incidental attacks on German Railway centres, the only systematic operations against the enemy rail system have been extensive fighter-bomber line cutting attacks, covering a period of more than six weeks. There has also been a certain amount of 'shooting up' of trains. Only within the past few days have these operations begun to show dividends. There have been a number of attacks on RHINE and MOSELLE rail bridges, but these have been largely abortive.

7. It is abundantly clear from French and German railway records (the latter kept with typical tidy thoroughness) that:

- (a) It was the heavy attacks on rail centres and marshalling yards which were the main factor in paralysing the rail system in NORTHERN FRANCE, and
- (b) The effect of these attacks was far more rapid and final than had ever been anticipated.

8. It is essential not to apply too literally to GERMANY the lessons of FRANCE and BELGIUM. In occupied territories it was possible for the enemy to maintain a flow of military traffic while the non-military and economic traffic died out. In GERMANY all losses of traffic is a dead loss to the war effort. In FRANCE and BELGIUM the enemy had prepared for precisely the form of attack he experienced by introducing large bodies of special labour and railway workers. In GERMANY now all the indications are that all man power that has not been thrown into the Army is fully employed on defence digging, and that even the normal running personnel of the railways have been drastically combed. In FRANCE and BELGIUM all available repair and salvage material and personnel could be concentrated on repair of railways; in GERMANY all such facilities are already more than fully occupied in repair and salvage of factories, public services, etc. In FRANCE and BELGIUM the programme of attacks on rail centres was severely limited, both as regards selection of targets and as regards weather conditions, by the need to avoid civilian casualties; no such limitations affect attacks on German rail centres.

9. I do not consider it necessary to spread attacks all over the German rail system. I am convinced that, with GERMANY in her present condition, we can obtain immediate results which have every prospect of being decisive. In my opinion, our main strategic concentration should be against the RUHR: rail centres, Oil targets, the canal system, and centres of population. I believe that on such a system it should be possible to maintain the attack under all conditions in which the Heavies can operate.

S.A.O.—IV—U

Alternative and supplementary targets should be selected, with the same primary object in view, in the appropriate alternative weather areas of the Middle and Upper RHINE, including BAVARIA.

10. The Tactical forces' operations against trains, embankments, selected bridges, etc., will then be complementary to the strategic operations, and will continue with a far greater prospect of producing immediate effect than they have had in the past while the heart of the rail system has been relatively untouched. The Combined Strategic and Tactical Air Forces will, in fact, be operating towards one objective.

11. I believe that the execution of a coordinated campaign against the communications system of WESTERN GERMANY such as I have outlined would rapidly produce a state of chaos which would vitally affect not only the immediate battle on the West Wall, but also the whole German war effort.

(Sgd.) A. W. TEDDER

APPENDIX 26

Report by the Joint Intelligence Sub-Committee on the Effects of Allied Attacks on the Enemy Oil Situation in Europe, 30th October 1944

As instructed, we submit our fortnightly appreciation of the effect achieved by attacks on enemy oil in Europe. We include an estimate of the effect of the oil shortage on the operations of the German U-Boat fleet during the winter.

PRODUCTION

2. During the period 1st-25th October, 32 attacks have been made by heavy bombers on a total of 26 oil plants. These include all the major potential producers. Reconnaissance has been much hampered by adverse weather and the present state of a number of the more important plants is not known. It is therefore impossible to give an accurate estimate of current oil production; but total production in October was almost certainly more than in September as the effects of repairs outstripped destruction at least during the first part of the month.

Synthetic Production

3. *Bergius Hydrogenation Plants* (producing mainly high grade petrol and aviation fuel). The results of attacks upon five plants are not yet known; making no allowance for damage that may have been done by these attacks, it is possible that four of these five plants may be in partial operation.

Of the remaining ten plants, one has recently resumed production at a reduced rate and the remainder are not operating.

Fischer Tropsch Plants (mainly lower grade petrol, diesel oil and important lubricants). One plant is known to be in partial operation; another that recently resumed production has since again been attacked but the results are not yet known. The remaining seven Fischer Tropsch plants are at present out of action; repairs are, however, progressing rapidly and several plants may be starting up again shortly.

Total Synthetic Oil Output. The actual total output of synthetic oil in October cannot be estimated until air cover reveals the results of recent attacks. Without making any allowance for damage inflicted by these attacks, the potential output of synthetic oil in October cannot exceed 190,000 tons, or 40% of normal output.

Mineral Oil Production

4. The refining of crude oil, and especially the production of petrol from crude oil, has been reduced to low figures, the present position in the producing countries being as follows:

Germany. The two important refineries at Hamburg resumed

operations during the month; they have since been attacked again but the results are not yet known. Of the other German refineries none is likely to have processed any useful quantity of crude oil during the month and probably only one is at present active.

Austria. Only a small quantity of crude oil has been processed during the month. Repairs to several refineries are being pressed forward; two of them may be ready to resume operations shortly.

Hungary. All the refineries are out of operation or in Russian hands.

Czechoslovakia. A small quantity of crude oil has probably been processed during the month. Three refineries may be active and another is under repair.

Total Production from Mineral Oil. Making no allowance for the damage that may have been done in the latest attacks on the refineries at Hamburg which account for the production of 70,000 tons, the total output of products from crude oil in October will not exceed 110,000 tons, or 16% of normal.

Other Sources

5. Total production in October from other sources such as benzol, alcohol, tar oil etc. is estimated at 175,000 tons.

Total Production from all Sources

6. Making no allowance for the effects of most of the recent raids, it is estimated that the total production of oil from all sources in October will not exceed 480,000 tons or 36% of normal. About half this production comes from the Ruhr area. Taking the best case that all the plants that have recently been attacked with unknown results have been put out of action, the lowest level to which production might have fallen would have been 375,000 tons. It is reasonable to estimate that production for October may have been about the mean of these figures or, say, 430,000 tons.

Rate of Decline of Production

7. The following table shows the estimated monthly output in metric tons since last April:

	<i>Total output of all products</i>	<i>Petrol</i>	<i>Lubricants</i>
April	1,344,000(100%)	532,000(100%)	148,000(100%)
May	1,082,000(80%)	417,000(76%)	95,000(64%)
June	800,000(59%)	273,000(50%)	62,000(42%)
July	671,000(50%)	239,000(43%)	50,000(34%)
August	526,000(39%)	170,000(32%)	50,000(34%)
September	316,000(23½%)	106,000(20%)	34,000(23%)
October	430,000(32%) ¹	164,000(30%)	48,000(33%)

¹ The mean of a maximum of 480,000 and a minimum of 375,000 tons.

RECOVERY OF OUTPUT

8. Except in Hungary, repair efforts are being pressed forward with the utmost vigour. We thus estimate that in the absence of further attacks total output in November may rise to over 600,000 tons. Even if the recent attacks have been completely successful the above figures indicate that they will not have sufficed to keep output down to the September level of 316,000 tons. It would appear that the enemy's repair effort has, for the time being at least, overtaken the downward trend of production since the attacks upon oil began.

9. Indeed, following the appointment of Geilenberg (formerly Speer's principal lieutenant, entrusted with the supervision of ammunition production) as Special Commissioner for organising the repair of the oil industry, repair efforts seem to have been redoubled. Reconnaissance has established the presence of new labour camps alongside the principal synthetic oil plants; there is little doubt that these house permanent repair gangs which set to work as soon as the bombers depart. Moreover, it is known that Geilenberg's functions enjoy complete priority for supplies of labour and material over all types of armament production.

10. At the same time it is known that the enemy has redoubled his efforts to protect these plants against further damage. For instance the heavy flak defences of Stettin and the Pölitz hydrogenation plant now number 310 heavy guns; the number of heavy guns deployed in the defences of Berlin is about 325.

SIGNS OF SHORTAGE

11. The intelligence received since our last report confirms the serious effect of the current fuel shortage on the operational efficiency of the German Armed Forces. The decline in production reached its lowest point in September and the effect of this great reduction in oil supplies has been reflected in current intelligence, covering chiefly the middle fortnight in October, which shows that the fuel shortage is having an increasingly serious effect on the operational efficiency of the German Armed Forces.

Army

12. In the West for a period of ten days in October and November, the daily allowance of petrol for the two Army Groups on the Western Front is apparently to be about 300 tons; roughly 5 tons or 1200 gallons of petrol per division, as against a normal allowance of, say, 30 tons in active operations. There is evidence that horse drawn echelons are to be formed to ensure the supply of Panzer and Panzer Grenadier divisions.

13. In the Balkans, no fuel deliveries can be counted on for the last week in October and the first fortnight in November and drastic measures of economy to meet the situation include the towing (by Diesel driven vehicles) of every second M/T vehicle in motorized columns. It appears that in Italy some Panzer units are getting only about 7% of their standard fuel allocation for active operations.

Air Force

14. The acute shortage of aviation spirit continues to restrict German air operations. For instance, fighter protection had recently to be withdrawn from the major naval units operating in the Baltic in support of the land fighting; similarly lack of fuel prevents the provision of air cover for transports by sea in the Norwegian area. In Hungary and S.E. Europe stocks of aircraft fuel are at a very low level and inadequate to support air operations on any appreciable and sustained scale. It is most probable that in the West fuel stocks are also insufficient to permit the maintenance of sustained close support operations at more than a bare minimum level, and almost certainly account for the present grounding of the remnants of the L.R. Bomber force. Even for testing aircraft engines and for ferrying aircraft from factories to units, petrol is sometimes not available. Moreover, the G.A.F. ground organization is being increasingly starved of motor fuel, and is on occasion being forced to use aircraft fuel in M.T.

EFFECT OF SHORTAGE OF OIL ON THE OPERATIONS OF
GERMAN U-BOATS DURING THE WINTER MONTHS

15. The production of diesel oil for Germany in September, 1944, is estimated to be about 70,000 tons. From all our intelligence it is apparent that stocks are low and allocations of diesel oil have been progressively cut since May, 1944; recently the allocation of fuel to U-Boats on training has been cut, but there is no reason to believe that restrictions have been imposed on U-Boats on active operations. Of the various consumers the U-Boats, up to a few months ago, used only a small proportion of the normal production, but, as the output has been steadily diminishing, the proportion of it required to maintain U-Boats training, working up, and on operations has steadily risen and they now use about 16,000 tons per month, or nearly 23% of the total output in September. Therefore, providing there is no recovery in diesel production, U-Boat warfare can only be maintained at its present scale at the expense of the allocations to other consumers such as other warships using diesel fuel, as well as the Army, Todt organisation, road and water transport and in industrial and agricultural consumption.

16. U-Boat warfare is likely to continue to enjoy high priority during the winter and a considerable increase in activity is planned. The attacks on the Fischer Tropsch synthetic plants which produce a high cetane value oil for blending with U-Boat fuel, have damaged these plants to such an extent that at present only one, and possibly a second, is in partial operation out of the total of 9 plants, 6 of which are in the Ruhr.

17. It is, therefore, apparent that the preservation of the output of some at least of these plants is an important factor in the provision of fuel for U-Boats, though it may be possible for a less efficient fuel to be produced without them.

Stocks of diesel oil in Germany as a whole are known to be low. In Norway, diesel fuel for 6 weeks U-Boat operations on the present scale is reported to be held in depots at Oslo, Bergen, Trondheim, Harstad and Tromso.

18. The quantity at present held in U-Boat fuel depots in the Hamburg, Bremen, Kiel, Kiel Canal and Danzig areas is not known in detail.

CONCLUSIONS

19. The effects of the sharp fall in production in September are now becoming apparent. Allocations to the German armies in the West at least for a period of 10 days in October and November are apparently to be only one sixth of what is normally required for active operations. The German armies in the Balkans and Italy are probably even worse off. Shortage of fuel has further restricted G.A.F. operations.

Sufficient diesel oil for U-Boats during the coming winter, taking into account the expected increase in their activities, can only be made available provided that the German Navy is given a high priority over the other consumers in the allocation of supplies and provided there is no substantial recovery in the production of diesel fuel. Local shortages may be brought about by attacks on oil in transit to Norway and on depots supplying the Norwegian and German operating bases.

Shortage of oil is contributing to the overall decline in German production of war material. Supplies are deficient even for indispensable uses such as aero-engine testing.

Germany continues to be able to repair oil plants very quickly and could nearly double the September rate of production within a month if attacks ceased. In view of the virtual absence of reserves and of the very low level of current allocations any substantial increase in production would probably be reflected in increased operational efficiency of the armed forces within a few weeks.

(Sgd.) V. CAVENDISH BENTINCK

J. A. SINCLAIR

I. M. R. CAMPBELL (for D.N.I.)

G. W. P. GRANT (for A.C.A.S. (I))

M. Y. WATSON (for C. G. Vickers)

APPENDIX 27

Letter from Air Marshal Sir Norman Bottomley,
Deputy Chief of the Air Staff, to
Air Chief Marshal Sir Arthur Harris,
on the attack on oil, 13th November 1944

Sir,

I am directed to refer to your signal dated 6th November, 1944,¹ in which you express the view that to destroy the synthetic oil plants at Politz and Leuna by night would require repeated large scale attacks entailing prohibitive losses.

2. In Air Ministry signal of the 3rd November, 1944,¹ attention was drawn to the need for missing no opportunity to inflict long term damage on the enemy's major oil production plants, and it was suggested that your Command should give special consideration to the destruction of the plants in the Ruhr and also of certain plants outside the Ruhr area including the two mentioned above. The following were the reasons underlying the suggestion.

3. In the summer it was possible to reconnoitre plants frequently, to determine within narrow limits when they re-started production after a previous attack, and also as necessary, to attack and put them out of action again. In this way we were able to reduce enemy oil production to 23% of the pre-attack output.

4. The weight of attack which the U.S. Air Forces could, for various tactical reasons, bring to bear against any one plant on any occasion was limited; it was barely sufficient to keep the major producers out of action between the fairly frequent attacks. Since the summer, two new factors have emerged which have seriously prejudiced the position. The enemy's repair organisation has been developed to a high pitch of efficiency. This has resulted in an increased rate of recovery, and a consequent need for more frequent attacks on each plant. On the other hand, the winter weather has reduced the opportunities for reconnaissance and subsequent attack.

5. As a result of these new factors, the enemy's oil production has already risen considerably; unless we adapt our methods to the new circumstances, his production will increase further.

6. If we are to prevent a further increase over the ensuing vital months, or to reduce production to the September level, it is essential to pursue a policy involving the following principles:

- (i) No opportunity of attacking oil plants must be lost. The opportunities are likely to be very few. Winter weather conditions promise

¹ Not printed.

- more opportunities by night than by day. We must therefore exploit the night opportunities.
- (ii) We can no longer afford to await confirmation that a plant is active before re-attack. We must attack whenever opportunity serves, unless we have very sound reason to believe that the plant cannot come into action again for a considerable time. The status of each plant will be reflected in the weekly priority signals which take into account all available evidence.
 - (iii) Whenever opportunity for attack occurs, we must endeavour to inflict much longer term damage than we achieved over the summer months, when frequent opportunities for re-attack existed. To this end the U.S. Air Forces are considering means by which they can increase their weight of attack.
 - (iv) We must develop to the utmost, successful technique for attacking by blind bombing methods.

7. It was against this background that you were invited to consider the night attack of targets outside the Ruhr. G-H attacks on Ruhr plants give promise of being successful, and this coupled with the general destruction which is being achieved in the Ruhr, suggests that the problem of holding down the Ruhr oil production will not be as difficult as in respect of the more distant plants.

8. The weight and density of attack of which your Command has shown itself capable, given adequate marking, far exceeds that normally achieved by the U.S. Air Forces. It is considered that one successful large scale concentrated attack by Bomber Command on an oil target should, on the basis of past experience, result in the long term immobilisation of activity which is now required. If therefore you can achieve damage on the scale of the 'KAMEN' attack of 11th September, 1944, upon plants such as Leuna and Politz, you will make a major contribution to the current vital oil plan, and will reduce the task remaining to the day bombers to an extent which should bring its successful completion within our capabilities over the winter months.

9. Leuna, Politz and the refineries at Harburg were put forward for your consideration in the belief that owing to their disposition and characteristics they constituted targets against which you might have reasonable prospect of success. The experience of the U.S. Air Forces suggests that the difficulties of locating both Politz and Leuna by H2S or H2X should not be unduly great. These suggestions did not of course exclude the possibility of your attacking other oil targets outside the Ruhr, should this be found feasible.

10. There seems no reason to assume that fighter casualties in attacks on Politz and Leuna would be heavier than on other targets involving similar penetration. One successful heavy concentrated attack should be sufficient to achieve the long term damage required. It is hoped, therefore, that frequent repeat attacks would not in fact prove necessary. Indeed weather conditions are likely to prevent these. Losses to flak should not prove heavier than those experienced against the Ruhr, Stettin or Berlin. In any event it is considered that losses on a scale equivalent to those

sustained in the series of attacks against Berlin last winter would be fully justified, particularly having regard to the magnitude and far reaching nature of the results likely to be achieved.

11. Politz is one of the largest potential producers of petrol. The importance of attacking it is further enhanced by the fact that this target is now likely to be beyond the range of the Eighth Air Force until February, owing to limited hours of daylight.

12. For these reasons it is hoped that you will find it practicable to undertake the attack of the targets referred to in paragraph 3 of [the message] of the 3rd November, 1944, and any other major oil targets outside the Ruhr which experience may indicate as suitable for attack. Selection of targets should be guided by the priority lists issued from time to time.

(Sgd.) N. H. BOTTOMLEY

APPENDIX 28

Letter from Air Marshal Sir Norman Bottomley to Air Chief Marshal Sir Arthur Harris on the attack of East German cities, 27th January 1945

Sir,

I am directed to refer to a telephone conversation of the 26th January, 1945 between the Air Officer Commanding-in-Chief and the Deputy Chief of the Air Staff in which the subject of the attack of the industrial areas of Berlin, Dresden, Chemnitz and Leipzig was discussed, in particular reference to the critical situation which confronts the enemy in the Eastern battle zone.

2. *Attached for your personal information and return in due course*, is a copy of a J.I.C. Paper dated 25th January, 1945.¹ This paper has not yet been considered by the Chiefs of Staff. The opinion of the Chief of the Air Staff, however, is that it would not be right to attempt attacks on Berlin on the 'Thunderclap' scale in the near future. He considers that it is very doubtful whether such an attack even if done on the heaviest scale with consequent heavy losses would be decisive. He agrees, however, that subject to the overriding claims of oil and the other approved target systems within the current directive, we should use available effort in one big attack on Berlin and related attacks on Dresden, Leipzig, Chemnitz or any other cities where a severe blitz will not only cause confusion in the evacuation from the East but will also hamper the movement of troops from the West.

3. I am therefore to request that subject to the qualifications stated above, and as soon as moon and weather conditions allow, you will undertake such attacks with the particular object of exploiting the confused conditions which are likely to exist in the above mentioned cities during the successful Russian advance.

(Sgd.) N. H. BOTTOMLEY

¹ Not printed. See Vol. III, p. 98.

SECTION V

German documents

1943-1945

INTRODUCTION

THESE documents have been included to show the kind of evidence given by the German sources. All except the last two are contemporary with the events described. The first three show the effect of the bombing of 1943 and 1944 on the aircraft industry and ball-bearing plants and the devastation of Hamburg by the area attack made on it in 1943. The rest are reports by Speer during the culminating phase of the offensive and are amongst the most important pieces of evidence as to its results.

The last two documents are records of the interrogations of Speer made immediately after the defeat. They are selected from the ninety-two which exist of Speer and the members of his organisation as they are, perhaps, the two which had most influence on the post-war surveys.

The translations from the German have been made either by members of the Survey teams or by the Air Ministry Historical Branch. The task was a difficult one. Not only is the exact equivalent of a technical word often hard to find but sometimes, and especially in Speer's reports, the meaning of the German text is obscure. The general purport of the text is, however, nearly always clear enough and it has been thought better not to discuss nice distinctions in footnotes. We are much indebted to the Air Ministry Historical Branch for revising the translations often hurriedly made in 1945 and for assistance in dealing with the technical language of the documents.

APPENDIX 29

Speech by Field-Marshal Milch at a Conference on the Problems of Aircraft Production, 25th August 1943

WE must definitely decide on priorities. That means the 109, the 190 and the 110,¹ which bears the brunt of night fighting. That is why I have said, in the case of the Do 217, for instance, that all aircraft requiring considerable outlay were to be put further down the list. Everything must be staked on the 110. Only the 110 in sufficient numbers can give us the necessary relief at night. Moreover, the 110 can also be used by day. Compared with other fighter types it has the great advantage of considerably longer range. After the raid on Regensburg, for example, the enemy bombers headed south, for Africa. Our T/E fighters pursued them to beyond Innsbruck and inflicted quite serious losses. That could not have been achieved with the 109 and the 190 because their limited endurance would have compelled them to land for refuelling and ammunition long before that. Thus the 110 is particularly important for both purposes. It has yet another advantage in that it is perhaps the most easy aircraft to adapt to high altitude work. We are very much afraid that enemy bombers will be appearing at very great altitudes above the effective ceiling of the 109 and 190. These types could reach such heights, but only for a very short time, just because their endurance is so limited. We are making every effort to develop a high-altitude type of 110 with the same basic engine.

I will take this opportunity to explain the basis of our policy. We are firmly convinced that our only chance of maintaining Germany's arms industry and labour lies in our hitting back at the enemy both by day and by night harder than before and above all harder than until a week ago. If we fail and the percentage of enemy aircraft shot down remains at the same level as up to the first half of July, we shall be crushed. I think it is idle to make long term plans for U-boats, tanks, aircraft and so on. Programmes of this nature can never be fulfilled; Germany would be brought to her knees.

There is only one remedy. That is for our fighters to hit the enemy so hard day and night that he is forced to abandon the policy of destroying our arms production. The chance is there. In the daylight raids on Regensburg and Schweinfurt our reports give 101 enemy aircraft brought down. We can show proof of these 101. As a maximum of some 400 machines were engaged on these operations, this is in fact a loss of 25%. This is the first time since the bombing offensive began that enemy losses have been so high. Our losses are between 60 and 70 aircraft, 27 of them total losses. It is clear from this that the struggle will not be without cost; and that in order to be strong again quickly we must first make a considerable outlay.

¹ Authors' note: Me.109, FW.190 and Me.110.

The raid on Berlin the day before yesterday cost the enemy another 60 aircraft, as far as we can estimate at present. I would further add that after the Regensburg raid some 120 or more enemy bombers flew to Africa, and in the course of their flight many were probably damaged and forced down. We cannot definitely claim such losses. But the enemy, who usually publishes his losses quite openly, was on this particular occasion extremely reticent. This is proof that the blow went home. So also is the fact that these daylight raids were not continued on the following days. Yesterday the bombers flew back to Britain from Africa but they avoided German territory, dropping their bombs on Bordeaux, where the weak defences cost them only one aircraft.

Enemy bomber losses in May and June amounted to about 4.4% of the total raiding force. In July there was a slight increase, the figure being 6.4%. It is clear that these losses are not enough to deter an enemy as resolute as ours. You know that the defence of our country is now in the forefront of our strategy. A large number of S/E and T/E fighter Gruppen has been brought back to Germany. In my opinion this is absurdly late in the day, but at last it has been done. Field-Marshal Goering, too, is now bringing pressure to bear in this matter.

The enemy could not stand losses of 25-30%. If we could keep on inflicting losses at such a rate, the raids would have to stop. But our present rate of production is not up to such a task. Production figures for last month were 1050 S/E fighters and about 200 T/E fighters. At our request 50% of this output was to go to home defence. The request was not complied with. Strong fighter reinforcements were required on other fronts, notably in Russia and in the Mediterranean. Furthermore, 100 aircraft were drafted to front line operations by special order of the Supreme Commander of the Armed Forces. There is nothing more to say about that. The second stroke of bad luck is that as a result of the raid on five of our largest fighter works and our two largest repair centres, we shall be at least 150 fighters down on last month, even with no further raids being made. We are therefore about 220 fighters short of our actual programme. This is very serious.

My own attitude is this: I would tell the front that Germany itself is the real front line, and that the mass of fighters must go for home defence. During the winter we must do still more by bringing the programme forward: we will discuss this in a minute. The figure of 2000 fighters must be reached by the beginning of March instead of July-August of next year. The day before yesterday we reached purely on the constructional side an agreement with the whole of industry whereby those firms not engaged on fighter production are to turn out fighter parts. We have also arranged to disperse some of the work to small firms in places which are not obvious targets. This scheme at any rate will lessen the disruption caused by air raids. In the meantime our fighter works have suffered a production loss of about 25% through the raids on Wiener Neustadt, Regensburg, Warnemunde, Kassel, Oschersleben etc. Isolated damage at different places soon mounts up. Another onslaught on the same firms—and we must expect one—would mean more than another loss of 25%; it would bring the works to a standstill. We are doing everything we can

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with smoke screens, A.A. and the recently reinforced fighter defences in the South to relieve the aircraft and other industries. How far it will be successful, I cannot say.

I would also mention another figure. Of the 4·4–6·4% of enemy losses, A.A. is always responsible for something over 1%. That is the maximum which has been achieved by A.A. in home defence; and it is in contrast to the front, where other conditions apply, with aircraft flying lower. We have never exceeded this ratio. With the fighters it is between three and five per cent. Both figures are wholly unsatisfactory. But it is possible for the fighters' figure to be raised more swiftly, as is proved by Regensburg and Schweinfurt, and by the raid on Berlin. One must remember that there is more to it than the numbers brought down by us; there are also dead and wounded in the raiders that return and badly shot up aircraft which cannot be made operational again immediately. I have said that our losses in the raid on Regensburg amounted to 70. A certain number of these will be repaired. If we were on the other side we would only know of the 27 total losses.

Taking everything into account, it is clear that Germany is left with only one means of prosecuting the war to a successful conclusion, whether that conclusion be achieved by the breakdown of morale, material superiority, or tactical skill. There is no other way. You can set up five times as many A.A. batteries; it will make no difference to the figure of 1–2%. But if we put twice as many fighters in the air, the number of successes will be at least twice as high. If we have four times as many fighters, the number of successes will be at least four times as high. But if we shoot down at least four times as many enemy bombers as now—and that is no astronomical figure, about 700 fighters would be required, which is less than one month's output—then I swear that daylight raids would have to stop. And if our night fighter forces are expanded to the same extent, I swear also that night raids will cease. This would be the first step towards Germany winning the war.

I am convinced that you all believe the same and that there is no other chance for us to swing the war back in our favour again. What always astounds me is that this is not fully comprehended by all alike. It seems so clear and simple to me!

If, for example, we could only knock Russia completely out of the war within a few weeks,—but I am a fighting man and fought in the last war and I can tell you that there is no chance of that in the near future. Russia will go under; of that I am convinced, provided we remain in possession of the Donetz Basin and the Ukraine this winter. The enemy will then be faced with three bottlenecks: food, coal and transport. These are Russia's only really vulnerable points. But the earliest date by which we can expect Russia to be completely defeated in the field—there will always be partisans to contend with—is the late spring of next year; as I have said, if we succeed in holding our position. As for the chance of our getting the British or Americans into a similar position, my own considered opinion as a fighting man is that such a prospect is unlikely. For this reason I feel that our proposals cannot be condemned as mere axe-grinding for the Air Force. Such would be far from my wishes. I am

only anxious that we should have a first-rate system of home defence ready as quickly as possible. It would be possible in a few months, and it must be done. Then, I feel sure, we should be able to deal with other armaments projects which may have had to give preference to the aircraft programme.

APPENDIX 30

Extract from the Report by the Police President of Hamburg on the raids on Hamburg in July and August 1943, dated 1st December 1943

THIS short account of the course of the raids cannot, even though illustrated by figures, maps and photographs, give any idea of the destruction and terror. Description of the course of the raids and their effects pales before the occurrences in Hamburg during those ten days. The impression made by a gutted area is colourless compared with the actual fire, the howling of the firestorm, the cries and groans of the dying and the constant crash of bombs. It seems important to record this. Because the calamity is as much perceived in the process of destruction as in the accomplished fact. Just as a great part of all Air Protection measures are in vain or incomplete in moments of danger, without the requisite human strength behind them, so experience of these Air Protection measures can only be discussed if account is taken of the extraordinarily heavy strain, both physical and mental, to which human beings are exposed during raids. If the efficacy of an Air Protection measure depends on a man and if he, by reason of *force majeure*, is powerless, this must receive consideration and attempts must be made to find a solution when a final decision is to be taken on the measure. The conduct of persons, whether good or bad, sound or misguided, can only be judged with a precise knowledge of the circumstances.

The cause of the enormous extent of the heavy damage and particularly of the high death rate in comparison with former raids is the appearance of firestorms. In consequence of these a situation arose in the second large scale raid during the night of July 27th/28th which must be regarded in every respect as new and unpredictable.

As a result of H.E. bombs and land mines, roofs were laid bare in large numbers, windows and doors blown in and smashed and the Self Protection Service was driven into the cellars. The incendiary bombs of all kinds then dropped in great concentration found ample food amongst the destruction already caused. More H.E. bombs and land mines drove the Self Protection personnel, who, despite the complete failure of the municipal water supply, had hurried out to fight the fires, back again into the shelters. This constantly alternating dropping of H.E. bombs, land mines and incendiary bombs made possible an almost unimpeded spread of fires. It should be observed that as a result of these tactics by the enemy and of the dropping of countless liquid incendiary bombs, fires occurred not only in attics and upper floors, but often at the bottom of buildings. The immediate fanning out thus made possible an immense number of individual fires caused within barely half an hour huge area fires. And these produced firestorms.

An appreciation of the force of these firestorms, transcending all human experience and imagination, can only be obtained by sober observation of the physicometeorological phenomenon. Only in this way can an appreciation be formed of the powerlessness of all personnel through the lack of water and of the special experiences of the so far unique major incidents in Hamburg. For it would be absurd and impossible to try and draw conclusions generally applicable to Air Protection from the major incidents in Hamburg, unless the special circumstances arising out of the many firestorms are taken into consideration.

The firestorm and its phenomena are clear and well known conceptions in the history of city fires. The explanation of the physical occurrence is simple. As a result of the confluence of a number of fires, the air above is heated to such an extent that in consequence of its reduced specific gravity a violent up draught occurs which causes great suction of the surrounding air radiating from the centre of the fire. Through this firestorm, and especially the tremendous suction, movements of air are produced of greater force than normal winds. With firestorms just as in meteorology, movements of air result from the compensation of differences in temperature. Whereas these amount in meteorology as a rule to from 20° to 30° Celsius, in firestorms, it is a question of differences in temperature of 600°, 800° or even 1000° Celsius. This circumstance explains the colossal force of firestorms, which cannot be compared to normal meteorological phenomena. Another result of this great force is that weather conditions, even the strongest wind, have no effect or influence on the development of the firestorm. This power of the firestorm to overcome ruling weather conditions together with the centripetal suction effect on surrounding masses of fresh air is also the reason that as a rule firestorms do not tend to spread sideways. These fires therefore only spread as a rule as a result of flying sparks or radiating heat. It should be remembered that the danger from radiating heat is not to be underestimated in view of the extraordinarily high temperature developed.

In this attempt, by considering the physicometeorological phenomena, to explain the origin, effect and the spread, which was to some extent apparent, of the firestorms in Hamburg, certain impulses must be taken into account which result from special circumstances. No special evidence is needed to show that conditions ruling locally may have great influence on the development of firestorms. Urban building conditions in the affected area may assist or delay the formation of firestorms, as may the nature, extent and size of the original individual fires. In Hamburg the firestorms originated in densely built up and thickly populated areas, where, therefore, by reason of the type of building and the densely massed houses affected, conditions were favourable for the development of firestorms. In the affected areas in Hamburg there were mostly large blocks of flats in narrow streets with numerous houses behind them, with terraces (inner courtyards), etc. These courtyards became in a very short time cauldrons of fire which were literally man-traps. The narrow streets became fire-loops through which the tall flames were driven.

In these areas, owing to the concentration of the enemy raid and the great number of bombs dropped an immense number of fires were caused.

And it should be noted especially that these were not exclusively attic fires but that, as a result of phosphorus and liquid incendiary bombs, at many points large blocks of flats were set on fire in a moment from the ground floor upwards. The fires spread with incredible speed, because, owing to the concentration of H.E. bombs and land mines, roofs were torn off, walls blown in, windows and doors torn from their frames or smashed and the flames were, therefore, fed unhindered. The intermediate stage of incipient fires, when in former raids fire-fighting was possible and had been carried out with success by the Self Protection Service in Hamburg, did not therefore occur. At many points area fires developed in this way in a very short time. In every one of these area fire zones, a firestorm developed for the reasons of physical laws given above. The suction of the firestorm in the larger of these area fire zones had the effect of attracting the already over-heated air in smaller area fire zones. The most powerful firestorm centres therefore attracted the fire from the smaller area fire zones. One effect of this phenomenon was that the fire in the smaller area fire zones was fanned as by a bellows as the central suction of the biggest and fiercest fires caused increased and accelerated attraction of the surrounding masses of fresh air. In this way all the area fires became united in one vast area fire.

In order to appreciate the force of this huge firestorm caused by the blending of great numbers of smaller firestorms, it should be recalled that, for example, in the raid on the night of the 27th/28th July the area affected was $5\frac{1}{2}$ Km. long by 4 Km. wide, an area therefore of 22 square Km.

It should further be remembered, in considering the situation described, that on account of the type of building in the city not only was there every opportunity for such firestorms to develop rapidly but that the particular way in which the firestorm developed was due to it. The particular structural conditions, the existence of the terraces (inner courtyards) and narrow streets naturally had the effect that the masses of air attracted could not be drawn to the centre in a geometrically precise centripetal direction. The masses of air had to find their way through locks formed by the streets, terraces, open windows and doors, etc. The bellows like effect of the draught on the fires on the outskirts, therefore, gave a concentric direction, though individually eddying to and fro, to the extremely overheated masses of air through the whole district affected. The extraordinary force of the currents of air is the obvious explanation of the fact that not only sparks but whole beams and parts of cornices, etc. aflame and of enormous size, were involved, leading of course to a spread of the fire in the districts they traversed.

Thus in a very short time there developed a hurricane of fire probably never known before, against which all human resistance seemed vain and was in point of fact, despite all efforts, useless.

Even this attempt to portray the situation in Hamburg will have given some idea of the extraordinary difficulties with which all personnel were faced. Small as were the opportunities of personnel for fire-fighting, they were further impeded by the complete absence of any water supply.

The struggle by all personnel against the fire as an overpowering enemy

increased in the course of the raids. It reached its climax in the last heavy raid during the night of August 2nd/3rd, in which the detonation of exploding bombs, the peals of thunder and the crackling of the flames and ceaseless downpour of the rain formed a veritable inferno.

The rapidity with which the fires and firestorms developed, made every plan and every prospect of defence by the inhabitants purposeless. Houses, which in previous raids might have been preserved by the courageous efforts of Self Protection and other personnel, now fell victims to the flames. Before the necessity of flight could be realized, often every path to safety was cut off.

After the alarm, Self Protection personnel in their shelters, fireguards of the Extended Self Protection and Works Air Protection Services in the places assigned to them, awaited the beginning and development of the raid. H.E. bombs and land mines in waves shook the houses to their foundations. Only very shortly after the first H.E. bombs had fallen an enormous number of fires caused by a great concentration of incendiary bombs—mixed with H.E. bombs—sprang up. People who now attempted to leave their shelters to see what the situation was or to fight the fires were met by a sea of flame. Everything round them was on fire. There was no water and with the huge number and size of the fires all attempts to extinguish them were hopeless from the start.

Many members of the Self Protection Service on their patrols or when courageously fighting the fires, were either buried by H.E. bombs or cut off by the rapid spread of the fires. The same fate overtook many fireguards in Extended Self Protection or Works Air Protection establishments while bravely doing their duty. One eyewitness report says: 'None knew where to begin firefighting'. The constant dropping of H.E. bombs and land mines kept driving people back into the shelters. The heat, which was becoming unbearable, showed plainly that there was no longer any question of putting out fires but only of saving their lives. Escape from the sea of flame seemed already impossible. Women, especially, hesitated to risk flight from the apparently safe shelter through the flames into the unknown. The continual falling of H.E. and incendiary bombs increased their fears. So people waited in the shelters until the heat and the obvious danger compelled some immediate action, unless action was forced upon them by rescue measures from outside. In many cases they were no longer able to act by themselves. They were already unconscious or dead from carbon monoxide poisoning. The house had collapsed or all the exits had been blocked. The fire had become a hurricane which made it impossible in most cases to reach the open. The firestorm raging over many square kilometres had cut off innumerable people without hope of rescue. Only those got away who had risked an early escape or happened to be so near the edge of the sea of fire that it was possible to rescue them. Only where the distance to water or to open spaces of sufficient size, was short, was flight now possible, for to cover long distances in the redhot streets of leaping flames was impossible.

Many of these refugees even then lost their lives through the heat. They fell, suffocated, burnt or ran deeper into the fire. Relatives lost one another. One was able to save himself, the others disappeared. Many

wrapped themselves in wet blankets or soaked their clothes and thus reached safety. In a short time clothes and blankets became hot and dry. Any one going any distance through this hell found that his clothes were in flames or the blanket caught fire and was blown away in the storm.

Numbers jumped into the canals and waterways and remained swimming or standing up to their necks in water for hours until the heat should die down. Even these suffered burns on their heads. They were obliged to wet their faces constantly or they perished in the heat. The firestorm swept over the water with its heat and its showers of sparks so that even thick wooden posts and bollards burned down to the level of the water. Some of these unfortunate people were drowned. Many jumped out of windows into the water or the street and lost their lives.

The number of deaths is still not finally settled. This is not due to faulty methods of investigation but solely to the unimaginable immensity of the destruction and the limited amount of staff available. The fact that even now up to 100 bodies are found and recovered on some days, will give some idea of the situation. The destruction was so immense that of many people literally nothing remains. From a soft stratum of ash in a large air raid shelter the number of persons who lost their lives could only be estimated by doctors at 250 to 300. Exact information will only be available when everyone at that time resident in Hamburg if still alive, has reported himself.

The scenes of terror which took place in the firestorm area are indescribable. Children were torn away from their parents' hands by the force of the hurricane and whirled into the fire. People who thought they had escaped fell down, overcome by the devouring force of the heat and died in an instant. Refugees had to make their way over the dead and dying. The sick and the infirm had to be left behind by rescuers as they themselves were in danger of burning.

This sad fate, which befell Hamburg, exceeded in effect and extent any catastrophic fire—with the exception of Tokyo—of the past. It is distinguished in the first place by the fact that never before in a city of a million inhabitants everyone, prepared and equipped for fire-fighting, supported by great experience and great success in fire-fighting in many earlier raids, was waiting at the signal of the sirens for duty and the necessity of fighting the fire. In earlier cases it developed as a rule gradually during many hours or days from a small incipient fire. Here a population ready and prepared for the alarm were literally overwhelmed by the fire which reached its height in under an hour.

Even taking the conditions of those days into consideration, the fire in Hamburg in 1842, bears only a faint likeness to the fire in Hamburg in 1943. The catastrophes of Chicago and San Francisco, the fire in the Paris Opera house, all these events, of which the scenes of fantastic and gruesome terror have been described by contemporaries, pale beside the extent and the uniqueness of the Hamburg fire of 1943. Its horror is revealed in the howling and raging of the firestorms, the hellish noise of exploding bombs and the death cries of martyred human beings as well as in the big silence after the raids. Speech is impotent to portray the measure of the horror, which shook the people for ten days and nights

and the traces of which were written indelibly on the face of the city and its inhabitants.

And each of these nights convulsed by flames was followed by a day which displayed the horror in the dim and unreal light of a sky hidden in smoke. Summer heat intensified by the glow of the firestorms to an unbearable degree; dust from the torn earth and the ruins and debris of damaged areas which penetrated everywhere; showers of soot and ashes; more heat and dust; above all a pestilential stench of decaying corpses and smouldering fires weighed continually on the exhausted men.

And these days were followed by more nights of more horror, yet more smoke and soot, heat and dust and more death and destruction. Men had not time to rest or salvage property according to any plan or to search for their families. The enemy attacked with ceaseless raids until the work of destruction was complete. His hate had its triumph in the firestorms which destroyed mercilessly men and material alike.

The Utopian picture of a city rapidly decaying, without gas, water, light and traffic connections, with stony deserts which had once been flourishing residential districts had become reality.

The streets were covered with hundreds of corpses. Mothers with their children, youths, old men, burnt, charred, untouched and clothed, naked with a waxen pallor like dummies in a shop window, they lay in every posture, quiet and peaceful or cramped, the death-struggle shown in the expression on their faces. The shelters showed the same picture, even more horrible in its effect, as it showed in many cases the final distracted struggle against a merciless fate. Although in some places shelterers sat quietly, peacefully and untouched as if sleeping in their chairs, killed without realization or pain by carbon monoxide poisoning, in other shelters the position of remains of bones and skulls showed how the occupants had fought to escape from their buried prison.

No flight of imagination will ever succeed in measuring and describing the gruesome scenes of horror in the many buried air raid shelters. Posterity can only bow its head in honour of the fate of these innocents, sacrificed by the murderous lust of a sadistic enemy.

The conduct of the population, which at no time and nowhere showed panic or even signs of panic, as well as their work, was worthy of the magnitude of this disaster. It was in conformity with the Hanseatic spirit and character, that during the raids, friendly assistance and obligation found expression and after the raids an irresistible will to rebuild.

APPENDIX 31

Report by Philip Kessler to Reichsminister Speer on the ball-bearing position, 6th April 1944

Re: Third report on past development of the ball-bearing speed campaign.

Sehr verehrter Reichsminister,

In my report of 5.2.44 I had informed you about the output of the German roller-bearing industry, covering the period from October 1943 to January 1944.

In spite of the losses which production suffered at ERKNER through the bombing on 23.12.43, it can be presumed, (on the strength of the extensive repair work at ERKNER and of the steady progress made in proportion to output in dispersal plants) that during the months February, March and April the total output will increase considerably. Unfortunately, the enemy has, after February 21, 1944 carried out a whole series of well aimed major attacks on our roller-bearing industry.

(1) roller-bearing plant	17.8.43	day attack	250	aircraft
SCHWEINFURT	14.10.43	„ „	300	„
	24.2.44	„ „	} 1,200	„
	25.2.44	2 night attacks		
	24.3.44	day attack	—	
	1.4.44	night „	150	„
(2) roller-bearing plant	21.2.44	night attack	—	
CANNSTATT	25.2.44	day „	—	
(3) roller-bearing plant	13.12.43	night „	200	„
ERKNER	8.3.44	day „	300	„
(4) roller-bearing plant	23.2.44	day „	—	
STEYR	24.2.44	„ „	—	
	2.4.44	„ „	200	„

I have always made short reports on these attacks which, viewed as a whole, have caused heaviest losses in output in this industry; therefore, I need not repeat details.

The figures on page 317 give you a picture of the so far favourable outcome of the struggle in the priority drive against enemy activity.

Total output of the German roller-bearing industry

	Smallest bearings incl. joint and special bearings	Small bearings	Medium bearings	Large bearings	Chain track needle bearings	Total output incl. all bearings
Average 2nd quarter '43	3,444,306	3,341,460	1,762,405	11,199	1,117,778	9,756,694
October 43	3,593,853	3,055,235	1,180,298	7,028	981,889	8,818,303
November 43	3,889,490	3,430,455	1,284,622	13,276	900,284	9,518,127
December 43	3,476,719	3,441,766	1,316,164	16,283	1,018,577	9,269,509
January 44	3,247,360	2,820,999 ¹	1,390,231	20,519	1,182,011	8,661,120 ¹
February 44	2,944,982	2,412,261	1,289,181	14,022ca	1,100,000	7,760,446 ²
March 44	2,787,258	1,848,090	969,618	6,934 ,,	1,200,000	6,811,900 ³
<i>Programmes concerned:</i>	FLUG, A 4, Electro-technical products, general equipment, generators		Panzer motor-vehicles, aircraft-gear, aircraft-technics, weapons vehicles on rail tracks, ship construction, machines	Aircraft-gear, Panzer weapons, general equipment, machines	Heavy tractors	

¹ Losses through attack on ERKNER.² ,, ,, ,, ,, SCHWEINFURT, CANNSTATT, STEYR.³ ,, ,, ,, ,, as above, and renewed attack on ERKNER.

Towards the end of February 1944 the main production places of the German roller-bearing industry, SCHWEINFURT, ERKNER, CANNSTATT and STEYR, had come to an almost complete standstill. Those works, which have remained intact, have embarked on the March production programme at full pressure and the severely damaged plants have in accordance with my directions made gigantic efforts to repair the damage and carry out further dispersal. In spite of all production losses, a March output of about 70% of the average output in the second quarter of 1943 was thus achieved despite all interruptions. In this connection I must point out that on that occasion the behaviour of the staff of the ball-bearing plants after these fearful attacks was splendid. The slogan which I emphasized at numerous meetings on reconstruction and on output is: 'Not a single fighter or panzer less through lack of ball-bearings!' Thus, requirements of roller-bearings for panzer- and fighter production were met, also for the month of March, which, however, necessitated many superhuman efforts. Precisely in the March production the remaining undamaged bearing plants, such as STEYR, have achieved excellent results in view of the heavily damaged plants at SCHWEINFURT, CANNSTATT and ERKNER. On April 2, 1944, also STEYR was attacked and we are still occupied on reporting in detail on the effects of this attack on output in April, soon after we had just taken all measures in order to cover

completely April requirements of bearings for fighters and panzers. Already in my first report I had pointed out, that the total figure of bearings alone is not decisive, but that the main problem lies in the production of specially difficult bottle neck types. Therefore I decided to aim at straightening out, primarily, the bottle necks in the production of bearings, and to impose compulsory production on individual plants through the *SONDERRING WALZLAGER*. If in the past good management was the dominating factor in production, i.e. one turned out a large series with a correspondingly long process time, then what is required now by the present situation is the quickest possible adjustment, smaller quantities and shorter process times, combined with speedy, repeated resetting of the machinery. As the machine capacity is often insufficient—on the availability of which I shall make special reports later—I have ordered that outside industries should assist: this applies specially to production of the cages (*KAFIG*) and the initial turning (*VORDREHEN*) of ball-bearing rings. In this way the final processing, hardening, grinding and polishing remains to be done by the roll-bearing plants as a specialists' job.

The determination with which *SCHWEINFURT* in particular, will be attacked again and again, has caused us to take special measures for preserving the most valuable automatic lathes and special grinding machines. As the underground projects *WELLEN*, and lately *NECKARZIMMERN*, *ROIGHEIM* and *SECKACH* which are under construction are still not ready to take in machines, I have asked Field-Marshal *MILCH*, to cede to us a part of the *LUFTMUNITIONSANSTALT* (Institute of Aircraft Ammunition) *ROTTERSHAUSEN* near *SCHWEINFURT*. About 9000 sq. m., i.e. about 30 bunkers and a number of work sheds and store houses, have been obligingly transferred to us. The first part of the production could already be taken in hand by means of emergency current generators. Further despatches of special machines from *SCHWEINFURT* to this place and the procuring of a sufficient quantity of electrical power are already in full swing. Generaloberst *FROMM* has acceded to our request that a part of the *HEERESMUNA* (Army Munitions Institute) *BAMBERG* should be temporarily ceded for the same purpose. This covers about the same number of bunkers with several munition huts amounting to about 11,000 sq. m. According to experience gained so far production in the '*MUNAS*' should be considered as fairly safe.

In the *BERGWERK* (mine) *WELLEN* which comprises in the first construction stage 20,000, in the second stage 40,000 sq. m., constructional work, laid out on the simplest lines, must be speeded up. The dates for completion depend entirely on the rapid use of 1500 building labourers. Planning for the supply of current and water, heating and air-conditioning is terminated. In July, 1300 men are to start production there.

Whilst *WELLEN* is the main evacuation place for *KUGELFISCHER* (*FISCHER*'s ball bearings), *NECKARZIMMERN* is the biggest underground project for the *VEREINIGTE KUGELLAGERFABRIKEN*. Here, 50,000 sq. m. are available which are already partially constructed, i.e. the floor is cemented and the electric lighting cables are installed. The possibility of an extension to 100,000 sq. m. exists. Also direct rail connection is available.

The splitting up into too many small above-ground and underground projects cannot be approved in view of the fact that the number of administrative staff is insufficient. Therefore, the size of the two projects mentioned implies for future production, not only safety, but simplification of organisation. There are also about 10,000 sq. m. in a gallery project (STOLLENPROJEKTE) at ROIGHEIM and about 23,000 sq. m. in a gypsum mine at SECKACH which is allocated to the firm FICHTEL & SACHS, chiefly for the production of chain track (GLEISKETTEN) needle bearings.

The former production of CANNSTATT has already been partially dispersed to dispersal points above ground of the VKF. in the WUERTEMBERG district, which were already in existence. A considerable proportion will now go to NECKARZIMMERN and ROIGHEIM respectively, so that only a comparatively small part will for the present remain at CANNSTATT.

A maximum of 5000 sq. m. in the form of galleries will be opened in the RUEDERSDORFER KALKBERGWERKE (chalk mines) for ERKNER. In one tunnel sector the first automatic lathes could already be put into operation. The big KARUSSEL-BREHBAENKE (vertical lathes) and grinding machines, undamaged by the latest attacks on ERKNER, for production of the big SCHWENKLAGER (bearing for revolving mechanism) for panzer turrets are being protected by surrounding bunkers and the most important grinding machines are being stored in existing caves of about 4,000 sq. m. which are reinforced on the top by concrete. The remainder of the production will be transferred from NECKARZIMMERN to this underground site after completion.

In view of the overwhelming pressure, under which the roller-bearing production exists and of the decisive part which the underground production will and must play in a few months, in no circumstances can setbacks be tolerated regarding this vulnerable production in bomb-proof factory sites. I have therefore studied intensively with skilled builders, heating and air-conditioning technicians, and with the roller-bearing specialists in the Paris district the naval underground production there. The result and experience of a positive and also negative kind, will be utilized for the big underground evacuation productions. Furthermore the cave of TAVERNY was thoroughly inspected.

The speedy transfer of production installations into protected premises is especially urgent, for while it is possible to repair destroyed buildings in a makeshift way with a greater or smaller amount of material, burned-out lathes and special grinding machines cannot be replaced at all within the short time necessary. Owing to unfortunate circumstances for instance one machine shop in CANNSTATT and one in ERKNER were burned out. In SCHWEINFURT during the attacks of February and March the works leaders and A.R.P. put up an exemplary fight for the preservation of their machine shops. The German machine tool industry has made an outstanding effort to repair the damaged machines in the shortest possible time. In order to ensure the replacement of machinery which has been rendered totally useless, and also to increase the machine capacity in order to fulfil the increased programme for production of ball-bearings, I have arranged for intensive conferences between the machine tool

industry and ball-bearing works. After arduous deliberations and work a programme for machinery production has been set up, which also takes into account the fact of decreased imports. Unfortunately the negotiations with Sweden have, as I am informed, resulted in the delivery to us during the current year of ball-bearings to the value of only 14.5 mill. marks, whereas in the preceding year the value of deliveries was 33 mill. marks. We must therefore ourselves construct a series of special machines, which so far were only manufactured in Sweden.

During the coming months the effect of the systematic attacks on our ball-bearing industry will doubtless cause shortages in our armaments programme. I have therefore arranged with the Chief Commissions for panzer and driving-gear works (TRIEBWERKE) to appoint an expert as liaison for the SONDERING WÄELZLAGER (special ring-ball-bearings) for each panzer- and motor type, in order that we do not get an SOS only after valuable time has been lost, but that my 'bottle-neck-commission' can deal with the matter at least 14 days earlier.

I am fortunate in having the collaboration not only of the departments in your Ministry but also of the chief Reich offices, in taking measures for repairs after heavy air-raid damages and transfers of works to above- and underground sites. Your decree of the 4.3.44 on the urgency of the fighter programme has however, led various intermediate offices to discuss the question of priority for ball-bearings production. The position now is that in view of the fact that this is the hardest hit of any industry there should be no question as to absolute priority, and I should be grateful to you if in an addendum to your decree of the 4.3.44 you would again stress the priority position of the ball-bearing industry.

One circumstance in SCHWEINFURT causes me great anxiety. During the numerous alerts not only is working time lost for the period of the actual alerts, but even more time is lost owing to the fact that at the first notification of approaching danger the workers, among them many foreigners, stream in panic into the open and do not return until long after the all clear. It is naturally difficult to overcome this fear psychosis after such numerous attacks, but to close a factory for so long a time until the bunkers which were put into construction after the October attacks are finally completed, is not feasible. I have therefore ordered that the completion of this protection of the workers—closely allied to production—must be forced through with all energy, in order to ensure the essential calm in the work.

Primarily bomb-damage repairs and the dispersal underground of the ball-bearing industry which will ensure to the armaments industry the supply of this important production, depend in the first instance on the carrying out of the necessary constructional work to a time schedule. I must ask for your support in this matter.

With this I close my report of today. The harder the attacks on this essential war industry, the more determined are we in our unshaken effort to supply German armaments with sufficient ball-bearings.

Heil Hitler!

Ihr sehr ergeben

(Signed) KESSLER

APPENDIX 32

The Reports by Speer to Hitler on the Effects of the Attacks on Oil

'In the course of the offensive against the oil plants Speer submitted five reports to Hitler detailing the damage done and the counter-measures being taken. Translations of these reports are given below. In some of them a certain amount of unimportant detail has been omitted. Many of the figures given by Speer check with statistics that have been obtained from other sources, and these letters consequently provide an authoritative account of the effects of the attacks. The italics are as given in the original documents.'¹

(i)

Report of 30th June, 1944

State Top Secret, Berlin.

'My Fuehrer,

The enemy's attacks on the hydrogenation works and refineries were intensified during June; his current air reconnaissance and espionage enabled him to damage severely, mostly soon after they had started up again, those works which had been hit in May.

Although *Herr Generalfeldmarschall* Keitel reports precisely to you on the weight of the attacks and on the results, I feel it is my duty to send you an overall report on the losses of the German fuel production since May this year and of the vital measures resulting from them.

I. The focal point of the attacks in May and June was the German aviation spirit production.

In these attacks the enemy succeeded on the 22nd June in increasing the effect on aviation spirit by 90 per cent. Only by the most speedy reconstruction of the damaged works—which was well below schedule—can the effects of this catastrophic attack be eliminated.

Nevertheless, aviation spirit production is at the moment utterly insufficient.

In April the Luftwaffe used 156,000 tons and 175,000 tons were produced.

The average daily production for April was 5,850 tons daily.

¹ *Oil as a Factor in the German War Effort.*

In May the daily production was as follows:

<i>May</i>	<i>Tons daily</i>
1st to 11th	5,845
12th Attack on Leuna and Bruex	4,821
13th	4,875
14th	4,842
15th	4,775
16th	4,980
17th	4,839
18th	4,920
19th	5,010
20th	4,975
21st	5,025
22nd	5,075
23rd	5,051
24th	5,073
25th Leuna again in production at 20 per cent.	5,487
26th	5,541
27th	5,550
28th Second attack on Leuna, result 100 per cent.	5,526
29th Attack on Poelitz, result 100 per cent.	2,775
30th	2,743
31st	2,794

In May altogether 156,000 tons aviation spirit were produced, compared with an essential production of 180,000 tons.

In June the following production is shown:

<i>June</i>	<i>Tons daily</i>
1st	2,476
2nd	2,535
3rd	2,580
4th	2,555
5th	2,511
6th	2,226 ¹
7th	1,823
8th	3,718
9th	2,756
10th	2,873
11th	3,052
12th	2,120
13th Gelsenberg ² drops out 100 per cent. Welheim ³ slight damage	1,078
14th	1,587
15th Scholven slight damage	1,527

¹ Figure not clear in original document owing to overtyping.

² *Authors' note:* i.e. the Nordstern plant near Gelsenkirchen.

³ *Authors' note:* Shown on Map 1, Vol. III, as Ruhroel A.G. near Bottrop.

<i>June</i>	<i>Tons Daily</i>
16th	1,275
17th	1,214
18th Scholven again attacked, slight fall-off in production	1,323
19th	1,278
20th Through the attack on Poelitz re-opening of the plant postponed till August	1,392
21st	1,268
22nd Scholven fall off in production 20 per cent. Wesseling 40 per cent.	632
23rd	868
24th Leuna again in production at 20 per cent.	1,268
25th	1,223
26th Moosbierbaum production fall-off 100 per cent.	1,204
27th	1,252
28th	1,241
30th	1,218

Total production in June therefore only 53,000 tons aviation spirit as against the requirements of 195,000 tons in May.

After the first attack of the 12th May this year a production figure of 126,000 tons aviation spirit was reported to you in the Obersalzberg for June.

This quantity would certainly have been exceeded, due to the increased speed of reconstruction, but owing to the continuous attacks in June production was well below the estimated figure. Attention is drawn to the fact that production during the second half of June again decreased considerably and only corresponded to a monthly production of 42,000 tons; should the attacks continue an extraordinary falling off in July can already now be foreseen with certainty.

II. *Reich* production figures for carburettor fuel are:

	<i>Tons</i>
In April	125,000
In May only	93,000
In June estimated at only	70,400

Including imported fuel the June result should be 96,000 tons, with an April consumption of 205,000 tons.

Diesel fuel in Germany was:

	<i>Tons</i>
In April	88,900
In May	74,000
In June	66,300

Including imports, resources available in June are 94,000 tons with an April consumption of 194,000 tons.

S.A.O.—IV—Y

Attacks on the hydrogenation plants resulted in the following production and consumption figures for *Treibgas*—the most important substitute for liquid fuel in the country:

	<i>Tons</i>
April production and consumption	37,600
In June decrease to	10,400

Calculations based on the results in June show when the small reserves of liquid fuel will be used up.

The losses in aviation fuel are especially serious in this respect, since almost the entire production of such fuel takes place in Germany and therefore import deliveries can result in little improvement.

Since we must reckon that, according to the extent of the damage, the capacity of the hydrogenation plants, now considerably reduced, could not be restored, even in the most favourable circumstances, for at least 6–8 weeks, every week that goes by without any additional protection for the plants being made available would have dire consequences. For without a doubt the majority of the reserves of aviation and other fuels will be consumed as a result of production loss in June and the low rate of production to be expected in July and August, if the air attacks continue on the present scale.

If, therefore, we do not succeed in protecting the hydrogenation plants and refineries by all possible means, the reconstruction of these works, as is shown in June, will not be successful. Inevitably by September this year the supply of the amounts necessary to cover the most urgent requirements of the *Wehrmacht* will no longer be assured; i.e. from this moment on an impossible situation will arise which must lead to tragic results.

I have, for my part, issued *inter alia* the following orders:

- (1) The most speedy repairs of damaged plants, utilising labour and materials to the best advantage.
- (2) Air raid shelter buildings to ensure the safety of the most important entities of the plants and of the workers who must carry on during attacks. Geilenberg, together with Dorsch, have set up an emergency plan for which 800,000 cbm. of concrete will be rapidly used.
- (3) The *Wehrmacht* Motorised Transport Commander has authorised a drive for the construction of generators in *Wehrmacht* vehicles. The requisite generators are forthcoming from industry and the timber supplies are ensured by wholesale felling.
- (4) My Planning Office have cut down liquid fuel requirements in the home country, including inland and sea shipping and construction work, to 35 per cent. in June, a further 23 per cent. reduction is planned for July, that is 42 per cent. of the May allocation.

Doubtless the *Wehrmacht* have taken steps rendered necessary by the present situation. I believe it my duty, however, to draw attention to the following facts:

- (1) Flights must be curtailed to the minimum essential; every ton of

fuel wasted now may in two months be bitterly regretted, since the increasing fighter programme bears no relation to the decreasing fuel production.

- (2) The strictest measures are essential to control the use of carburettor and diesel fuel in the *Wehrmacht* itself. In this connection it must be determined how the war can be continued when only a part of the present fuel supply is available.
- (3) Fighter protection of industrial plants must be strengthened, since the *Luftwaffe* must realise that a successful continuation of the attacks will mean that in September only a proportion of their fighter planes will be able, owing to lack of fuel, to fly.
- (4) The reconnaissance planes make it easy for the enemy to ascertain when plants have restarted work and hence in a short time they can stop production again. Without such reconnaissance the enemy will not realise that we have restarted the hydrogenation works in this comparatively short period and will leave longer pauses between his attacks and we shall then at least be able to resume partial production.
- (5) A considerably increased supply of smoke units [is necessary] even at the expense of other important items. Consideration should be given to ensuring better camouflage by setting up a dummy plant with the same smoke screen as well as the white smoke which points to the existence of the actual plant.
- (6) In spite of the recent increase in the Flak, it should be strengthened still more, even at the expense of the protection of German towns.

This supplementary protection must be provided for all hydrogenation plants and refineries, even those which are under construction and will be in production in 1-2 months (e.g. Heydebreck¹ and Blechhammer in Upper Silesia).

If we do not succeed in protecting the hydrogenation works and refineries better than formerly, then in September of this year an impossible situation in the fuel supply for the *Wehrmacht* and country will arise. The protection ordered up till now has already brought about some alleviation in recent attacks, though not decisively improving the situation. It does, however, show that it must be possible even now to go a long way towards protecting hydrogenation plants and refineries by the use of concentric control of all possible means of defence.

I had to draw attention, My *Fuehrer*, to the dire developments in the production of fuel.

I ask you to order the additional protection of these works by the sharpest measures.

SPEER.'

¹ *Authors' note:* There were two plants of I.G. Farbenindustrie at Blechhammer. Heydebreck is the junction linking them and is probably used here to describe the southern one.

(ii)

*Report of 28th July, 1944**State Top Secret. Berlin.**'My Fuehrer,*

The attacks on the synthetic oil plants and refineries in July had the most dire consequences.

It was possible for the enemy, in most cases, to destroy the plants so effectively, shortly after work in them had been resumed, that instead of the expected increase there was a decrease in production, although the reconstruction measures taken lead to the anticipation of a substantial increase.

Development of production was as follows:

<i>I. Aviation spirit</i>	<i>Tons</i>
In April the air force consumption was	165,000
In April the production was	175,000
Daily average production in April was therefore	5,850
Production in May was	156,000
Production in June was	53,000
Production in July was	29,000

After the latest attack on Leuna the production figure can be reckoned at only 15,000 tons aviation spirit, although the guaranteed amounts, owing to reconstruction work had been: for August, 43,000 tons; for September, 69,000 tons again, as prior to the attack on Leuna of the 28th and 29th July, a total of 93,000 tons had been hoped for in September.

	<i>Tons</i>
For October are anticipated	120,000
For November are anticipated	150-160,000

These figures are anticipated with the proviso that no further attacks occur or that they are fully averted, which under present conditions is not to be expected.

That the reconstruction of the synthetic oil plants in July would have been a complete success, without the occurrence of further attacks, is shown by the fact that in spite of numerous smaller attacks in July, production on the 17th July had already reached 2,307 tons, but four days later the reconstructed work was again completely destroyed by an attack, so that on the 21st July the record low production of 120 tons was reached.

Daily production figures for July were as follows:

<i>July</i>	<i>Tons</i>
1st	1,043
2nd	1,086
3rd	954
4th Attack on Scholven	1,065

<i>July</i>	<i>Tons</i>
5th Attack on Scholven	1,393
6th Attack on Scholven	1,645
7th Attacks on Scholven, Leuna, Luetzkendorf, Boehlen, Heydebreck	916
8th Attack on Scholven	600
9th Attack on Scholven	870
10th Attack on Scholven	961
11th	751
12th Resumption at Leuna	1,133
13th	1,278
14th	1,271
15th Increase at Leuna	1,714
16th Switch-over to special fuel at Leuna	1,588
17th Increase at Leuna	2,307
18th	1,378
19th Attacks on Wesseling and Scholven	856
20th Attack on Leuna	970
21st Attacks on Welheim and Bruex	120
22nd	140
23rd	140
24th Resumption at Leuna	600
25th	417

II. *Carburettor fuel*

Production figures are:

	<i>Tons</i>
For April	125,000
For May	93,000
For June	76,000
For July	56,000

Anticipated production figures in the *Reich* after reconstruction measures, provided there are no more attacks:

	<i>Tons</i>
For August	84,000
For September	101,000

III. *Diesel fuel*

Production figures in Germany are:

	<i>Tons</i>
For April	88,900
For May	74,000
For June	66,000
For July	62,000

Estimated production figures:

	<i>Tons</i>
For August	93,000
For September	110,000
For October	125,000
For November	142,000

IV. Bottled Treibgas

Production of this, the most important substitute for fuel at home, reckoned in fuel-tonnage, shows the following figures:

	<i>Tons</i>
For April	37,600
For June	10,400
For July	5,000

Estimated production owing to Leuna being non-productive:

	<i>Tons</i>
For August	3,800
For September	8,200
For October	17,400

With these production figures—mainly in the field of aviation spirit supply—it would be impossible in September to gear production to the reserves which have been used up, if the allocation of fuel is to remain the same for August.

If, on the other hand, further attacks are made on the synthetic oil plants, and the enemy succeeds in throttling the aviation spirit production as hitherto, then a planned use of the air force in September or October will be impossible.

The strengthened protection of the synthetic oil plants, through A.A. and artificial fog units, did not prevent the most successful attacks in the last few days.

The fighter protection, which alone is decisive for the protection of the synthetic oil plants, did not increase since the 1st June, but *decreased!*

This is shown by the following comparisons:

<i>In the Reich</i>	<i>1st June,</i> <i>1944</i>	<i>1st July,</i> <i>1944</i>	<i>27th July</i> <i>1944</i>
Fighter (<i>Jaeger</i>) total	788	388	460
Ready for action	472	242	273
Destroyer (<i>Zerstörer</i>) total	203	156	94
Ready for action	83	64	42

This means, therefore, that in spite of the high production figures of fighters and destroyers in the months of May, June and July the number of planes available, or ready for action, has not risen at home, but *considerably decreased*; the result of this is that the enemy can reach his targets at will and with very small losses only.

The total number of *all* fighters on *all* fronts was:

On the 1st June, 1944	1,789
On the 27th July, 1944	1,754

so that increased production did not make itself felt appreciably at the front.

I cannot judge if it would not be possible to allocate a larger part of the new fighter production to the home country, despite the emergency position at the fronts and if it would not be of greater advantage to use the fighters at home, as the losses at the front are much greater (destruction on the ground, fighting with enemy fighters, &c.) and therefore it is perhaps better to use the fighters at home.

I can only state that with the continuation of the attacks, judging by our experiences in June and July, the air force can reckon at the very most, in August and September, with *a new production of 10-20,000 tons of aviation spirit.*

Is it not more to the point to protect the synthetic oil plants for the moment so well with fighters that a part production, at least, will be possible, instead of the usual method where one knows with certainty that the air force, at home, as well as at the front, will be ineffectual owing to lack of petrol and that there is not the slightest possibility of rebuilding a substantial fuel production in a short time. This is irrespective of the far-reaching results which an unprotected home country would have in other spheres of industry and war production (Nitrogen, Synthetic Rubber, Powder, Explosives, Electricity Power Plants, &c.). . . . So the absolute necessity remains of protecting the German synthetic oil plants, in the next few months.

At the same time it is necessary to reduce the consumption of aviation spirit in August and September still further, with the greatest energy, and indeed only to allocate fuel for the training of fighter pilots and the use in action of fighter and pursuit planes. With the reduced areas now at our disposal, it should not be necessary to maintain a passenger and courier air service, as long-distance telephones and teleprints are available.

On my part the further installation of producer-gas generators is being carried on with the greatest pressure, as well as the rebuilding of the synthetic oil plants and the building of the underground installations carried on with all energy. . . .

In order to obtain success it is necessary:

- (1) To strengthen the fighter protection at home, in order to increase the losses during the flight to the synthetic oil plants.
- (2) To increase the A.A. protection and the smoke units.
- (3) To reduce to the minimum, at once, the use of planes.

Hail, my Fuehrer!

SPEER'

(iii)

*Report of 30th August, 1944**State Top Secret. Berlin.**'My Fuehrer,*

The last air attacks have again hit the most important chemical works heavily. Thereby the three hydrogenation plants, Leuna, Bruex and Poelitz, although only recently in commission again, have been brought to a complete standstill for some weeks.

As the home defence against enemy air attacks promises no appreciably greater results in September as against August, chemical (oil) production in September must now be considerably lowered.

Nevertheless, no effort will be spared to restore the hydrogenation plants so that past production, at least, can be made possible in a short time.

The effect of these new raids on the entire chemical industry are extraordinary as severe shortages will occur not only in liquid fuels but also in various other important fields of chemistry.

(1) Methanol Production

The production of Methanol dropped, as a result of the air-attacks, from an estimated essential production of 34,000 tons in August to 8,750 tons, and will at the outside only attain this figure in September.

The reserves of Methanol will only be 9,000 tons at the end of August with the result that heavy inroads will occur in the following essential chemical fields in September if this reserve is completely used.

In the powder and explosives sector, the estimated production of precious explosives (Hexogen and Trinitrotoluol) will drop 30 per cent in spite of the use of emergency measures and what is more, this notwithstanding that Methanol will be reserved for powder and explosives and use of it greatly reduced in other branches.

A particularly severe inroad is to be expected in artificial resins and plastics, the production of which will drop from 4,000 tons a month to 2,700 tons a month due to the shortage of raw materials.

The production of melamine glue will reach about half the requirements, while solid fuel for the *Wehrmacht* (for spirit stoves, &c.) will now be completely counted out in September.

(2) Buna Production

By the failure of hydrogen from Leuna for Schkopau and the air raid damage in Ludwigshafen, Buna production sank from an estimated possible total of 13,000 tons to 5,400 tons in August.

After the new attack on the 24th August on Leuna, this figure cannot be improved in any way in September.

The Buna reserves, which we were able to increase in the monthly production during the last months before the attacks, stood at 9,000 tons on the 1st October so that October is secure as far as Buna is concerned.

About one-third of the anticipated production for November will not be sufficient.

(3) *Nitrogen Production*

Here also the new attack on Leuna has meant a considerable decrease in production, so that against an anticipated output of 85,000 tons for September, the highest possible figure will be 45,000.

This decrease in production will hit agriculture which at the moment holds only about 45 per cent of its last year's allocation, which means that next year's harvest will suffer unusual losses.

Even worse are the effects in the field of liquid fuel as the hydrogenation plants and oil refineries have again been heavily hit in the last few days in the Protectorate and round Hanover.

I. *Carburettor Fuels*

Before the April attacks the carburettor fuel production in the *Reich* stood at 125,000 tons. In August, as a result of air attacks, at the most 60,000 tons were produced in August instead of the 84,000 tons estimated at the end of July.

If similar attacks continue the highest figure to be expected in September and October is 40,000 tons.

II. *Diesel Fuels*

Before the April attacks the diesel fuel production figure stood at 88,900 tons.

Due to air attacks only about 65,000 tons were produced in August as against 93,000 tons estimated at the end of July. If similar attacks continue the highest figure to be reckoned with for September and October is 60,000 tons.

III. *Bottled Treibgas*

In April the production of bottled gas stood at 37,600 tons (reckoned in terms of gasoline).

Only about 3,000 tons were produced in August due to air attacks.

If similar attacks continue a figure of 2,500-3,000 tons is the highest to be reckoned with in September and October.

IV. *Aviation Spirit*

While 175,000 tons of aviation spirit was produced in April, production fell to 12,000 tons, i.e., to two normal days' production in August due to the destruction of the aircraft fuel installations at Leuna, Poelitz and Bruex which had only recently been restored to working order. For September production, because of the re-building measures, was still estimated at 101,000 tons even on the 15th August.

After the new attacks production will not rise above 10-15,000 tons because of insufficient home defence.

With these results the enemy has hit the chemical industry so heavily that only by abnormal changes in the conditions is there any hope for the retention of the bases for powder and explosives (Methanol), Buna

(Methanol) and nitrogen for explosives and agriculture. At the same time the loss in carburettor and diesel fuels is so widespread that even the severest measures will not be able to prevent bad effects on the mobility of the troops at the front.

The possibility of moving troops at the front will therefore be so restricted that planned operations in October will no longer be able to take place. With this fuel situation offensive moves will be impossible.

The flow necessary for the supply of the troops and the home country will therefore be paralysed in the late autumn of this year, since substitute fuels, such as producer gas, are also inadequate to provide the essential help in all sectors.

There remains only one possibility, and this only with a large amount of luck:

If the enemy—

- (1) As was his former custom, begins his new attacks only when the plants, at present damaged, are again in commission, i.e., in about three weeks, when
- (2) The German fighter weapon at home can be so considerably strengthened in this three to four-week breathing space as to inflict heavier losses on the enemy and to hinder the compact carpet bombardments by splitting up the bomber formations.
- (3) In the coming autumn months, operations are restricted through bad weather conditions and both enemy and German air weapons are more restricted in operation.

We shall do the troops a bad service by sending pursuit planes from home to the front and thereby allow the vital materials for the front (powder, explosives and fuel) to be battered.

If it were possible to combat the attacks with some good measure of success in September, then it is feasible that there will be—

Only a 10 per cent production drop in powder and explosives in October;

A rise in Buna from 5,000 tons in September to 10,000 tons in October;

A rise in nitrogen from 45,000 tons in September to 60,000 tons in October;

A rise in carburettor fuel from 40,000 tons in September to 65,000 tons in October;

A rise in diesel fuel from 60,000 tons in September to 90,000 tons in October;

A rise in aircraft fuel from 10–15,000 tons in September to 75,000 tons in October.

If, however, the homeland is protected only by Flak, then, despite the greatest concentration, no substantial results from defence can be obtained as the attacks on Leuna, Bruex and Poelitz have proved. In this case the production level in October will remain the same as in September but will not exceed it.

The *Luftwaffe* must be ready for this last great stake by the middle of

September at the latest. It must throw into this undertaking all its best personnel, its flying instructors and its most successful fighter pilots. At least 1,200 of the most modern machines must be made available for this operation.

If this course is taken it will, if successful, mean the beginning of a new air force or it will mean the end of the German air force.

If the attacks on the chemical industry continue in the same strength and with the same precision in September as in August the output of the chemical industry will drop still further and the last stocks will be consumed.

This means that those materials which are necessary for the continuation of a modern war will be lacking in the most important fields.

Hail, my *Fuehrer*,

Always yours,

SPEER.'

(iv)

Report of 5th October, 1944

State Top Secret. Berlin.

'My *Fuehrer*,

After the last attacks on the hydrogenation plants and refineries repair of those works is still found to be possible in relatively short time as the number of men employed on this work has been increased.

If no new attacks take place we may count in October on the following quantities, which include the fuel gained from the German and Hungarian mineral oil production:

	<i>Tons</i>
Aviation fuel (September production: 9,400 tons)	64,400
Carburettor fuel (September: 48,400 tons)	60,600
Diesel fuel (September: 77,300 tons)	100,300

The following quantities could be produced in November and December:

	<i>November</i>	<i>December</i>
	<i>Tons</i>	<i>Tons</i>
Aviation petrol	91,900	106,900
J.2. (Fuel for the jet fighters, which is composed of carburettor and diesel fuel)	20,000	24,000
Carburettor fuel	65,000	66,200
Diesel fuel	71,700 ¹	87,100

These production figures include the requirements of industry and agriculture.

¹ The reduced production of Diesel fuel is due to time required for refining of further Mineral Oil Stocks.

An exchange of aviation fuel and of J.2 against carburettor fuel is, of course, possible.

These figures represent the quantities *theoretically* possible after rebuilding and reconstruction, *if no further successful air attacks take place.*

As, owing to the insufficient air defence, further air attacks of equal importance are to be expected, only the following production can be relied on:

	October Tons	November Tons	December Tons
Aviation fuel	12,000	10,000	9,000
Carburettor fuel	40,000	40,000	45,000
Diesel fuel	75,000	80,000	80,000

As far as the figures for aviation fuel are concerned these might fall rather than rise in November and December, as the continuous new attacks disorganise the system in the plants and thereby make rebuilding considerably more difficult after every attack.

No higher production can be expected in the month following these three months, on the supposition of further air attacks on the hydrogenation plants.

The underground plants for aviation fuel are not yet in operation, while the protected small plants for carburettor and diesel fuel are already producing the following:

	October Tons	November Tons	December Tons
Carburettor fuel	5,000	10,000	10,000
Diesel fuel	20,000	40,000	40,000

These figures are included in the preceding estimates.

That the estimated higher production is possible is shown in the table for the month of September 1944 (see supplement),¹ which gives the estimated *Daily Production* of Aviation Spirit and the actual quantities produced.

The table shows that on the 10th September the forecast figures were reached as several plants were working again, but it shows also that the enemy succeeded in stopping all fuel production *completely* between the 11th and 19th September.

By changing the method of attack, which has so far always been timed shortly after the restarting of the plants, allowing us thus always a few days of production, to a time shortly before the restart of work, the enemy could, without further ado, bring the aviation fuel production *completely* to a stop.

As the following plants will recommence work on the dates given below:

 Poelitz DHD² on 20th September;
 Moosbierbaum DHD on 2nd October;
 Poelitz on 6th October;
 Leuna on 10th October (DHD 2nd October);

¹ *Authors' note:* see p. 336 below.

² DHD is a process for making a high octane component for aviation fuel.

Bruex on 1st November;
Blechhammer on 8th October;

it will be necessary to build up in good time before above dates the strengthened fighter protection in such a way that at least 1,000 fighters can ward off successfully the attack which is to be expected shortly.

If this is not carried out the most *we can count on will be the production quantities given for continuation of air attacks.*

Simultaneously with the insufficient production of fuel at the hydrogenation plants, the picture of the production of the chemical industry, so essential for powder and explosives; for Buna, &c., has continued to deteriorate correspondingly, so that already difficulties of the severest kind in these branches can be foreseen, if we do not succeed in protecting the chemical works more efficiently.

Admittedly, orders have been given to erect concentrated A.A. protection at some of these plants, which were constructed with particular care (such as Leuna, Poelitz, Bruex, Blechhammer, Ludwigshafen, Oppau). Experience has shown, however, that only the fighters in spite of heavy losses are in a position to inflict equal punishment on the enemy.

The troops will forgo fighter support, which cannot give them essential relief nowadays, if they know that in this way their fuel basis is secured and that munition supplies will not cease owing to lack of powder and explosives.

Front officers in the West, whose supplies of weapons, tanks and munition have improved during the last fortnight, know only one concern and question: Will it be possible to supply the fuel for future operations or will the air attacks of the enemy prevent this?

The employing of all fighter forces at our disposal for the protection of home production has become even more vitally important since the transport situation in the Ruhr regions has deteriorated quite considerably.

Whereas in September 1943 an average of 19,900 waggons of coal could be transported daily in the Ruhr region, this transport fell off during these last days owing to air attacks to 8,700 to 7,700 waggons daily. This means that after 8-12 weeks the stocks within the industry, which amount to four weeks' supply, will be exhausted, so that during this winter an exceptionally serious coal and consequent production crisis will arise, while, on the other hand, the dumps of coal in the Ruhr region mount up continuously. It must be stressed that these figures include the circulation of waggons within the Ruhr region, so that the figures for coal actually sent out of the region must be reduced correspondingly.

There is, therefore, for the next months only one problem: to raise the effective fighting capacity of the German fighter force to such a height as is absolutely possible, to add all available machines to its strength, and then to concentrate this fighter force for the protection of the home armaments and war production.

Hail, my *Fuehrer*,
SPEER.'

(Copies of this letter, and the figures attached, were sent to Goering, Keitel, Doenitz, Galland, Krauch and Geilenberg.)

Aviation spirit production, September 1944

	Production target		Actual Production			
	Daily	Total	Daily	Total		
Sept. 1	230*	230	—	0	* Poelitz, Ludwigshafen, Huels, Schkopau commenced work.	
„ 2	—	460	80	80		
„ 3	—	690	—	80		
„ 4	—	920	—	80		
„ 5	—	1,150	720	800		Ludwigshafen, Oppau, air attack.
„ 6	—	1,380	38	838		
„ 7	—	1,610	529	1,367		
„ 8	—	1,840	375	1,742		
„ 9	—	2,070	427	2,169		
„ 10	—	2,300	303	2,472 ¹		
„ 11	—	2,530	—	2,472	Boehlen, Gelsenberg, air attack, Scholven attacked.	
„ 12	—	2,760	—	2,472		
„ 13	—	2,990	—	2,472		
„ 14	—	3,220	—	2,472		
„ 15	—	3,450	—	2,472		
„ 16	670	4,120	360	2,832		Planned change over from motor to aviation fuel. Gelsenberg, Scholven.
„ 17	—	4,790	—	2,832		
„ 18	—	5,460	—	2,832		
„ 19	—	6,130	—	2,832		
„ 20	—	6,800	176	3,008		
„ 21	—	7,470	186	3,194		
„ 22	—	8,140	385	3,579		
„ 23	—	8,810	216	3,795		
„ 24	—	9,480	—	3,795		
„ 25	—	10,150	260	4,055	Anticipated start of Welheim and Moosbierbaum. Welheim attacked.	
„ 26	1,570	11,720	—	4,055		
„ 27	—	13,290	261	4,316		
„ 28	—	14,860	—	4,316		
„ 29	—	16,430	258	4,574		
„ 30	—	18,000	626	5,200		
	—	18,000	—	5,200		
	—	4,200 (Benzol)	—	4,200 (Benzol)		
	—	22,200	—	9,400		

¹ All production was stopped on this day.

(v)

*Report of 19th January, 1945**State Top Secret. Berlin.*

'My Fuehrer,

The following comparative figures of production results discussed in my report of 5.10.44 and actually shown in the fourth quarter, prove how enduring the effects of the continued air attacks on the hydrogenation plants and the refineries have been.

	<i>Theoretically possible Tons</i>	<i>Estimated if inadequate Air Defence Tons</i>	<i>Actual Tons</i>
<i>October</i>			
Aviation spirit . . .	60,000	12,000	18,000
Carburettor fuel . . .	61,000	40,000	57,000
Diesel fuel (with J.2) . . .	100,000	75,000	66,000
TOTAL . . .	221,000	127,000	141,000
<i>November</i>			
Aviation spirit . . .	92,000	10,000	41,000
Carburettor fuel . . .	65,000	40,000	50,000
Diesel fuel (with J.2) . . .	92,000	80,000	73,000
TOTAL . . .	249,000	130,000	164,000
<i>December</i>			
Aviation spirit . . .	107,000	9,000	25,000
Carburettor fuel . . .	66,000	45,000	51,000
Diesel fuel (with J.2) . . .	111,000	60,000	75,000
TOTAL . . .	284,000	134,000	151,000

It was possible to improve slightly supplies for the *Wehrmacht* by finally exhausting small reserves. Moreover, Army Group South took direct from Hungarian production:

	<i>Carburettor fuel Tons</i>	<i>Diesel fuel Tons</i>
October	8,900	2,300
November	16,300	2,400
December	9,800	3,300

Since 13.1.45 a new series of heavy attacks have been made on the mineral oil industry, which have, up to now, led to the elimination of the large hydrogenation plants of Poelitz, Leuna, Bruex, Blechhammer and Zeitz for a considerable period: this after the last quarter of the previous year when all the plants situated in the West, especially Scholven, Wesseling, Welheim and Gelsenberg, fell out completely. After each attack.

owing to the need or the destruction of reserves of machinery and apparatus, the repair of the plant becomes more difficult and takes longer. Moreover, it has now been determined that the attacks which take place so often at night now, are considerably more effective than daylight attacks, since heavier bombs are used and an extraordinary accuracy in attaining the target is reported. Consequently, even if during the first quarter of 1945 the repair work and the plants are completely untouched, the theoretical production figures, which seemed possible in the last quarter, will not be reached. The underground plants for the production of aviation spirit and carburettor fuel now under construction will not yet be in production in the near future. The small plants, as substitutes for non-productive refineries were tried out to some extent in December.

For January–April 1945 the following total supplies can, according to the present position, be reckoned with, that is—including the Hungarian production:

	<i>Theoretically possible Tons</i>	<i>Estimated if inadequate Air Defence Tons</i>
<i>January</i>		
Aviation spirit . . .	13,000	12,000
Carburettor fuel . . .	68,000	60,000
Diesel fuel (with J.2) . . .	73,000	65,000
	<hr/>	<hr/>
TOTAL . . .	154,000	137,000

Of this, from Hungarian production:

Carburettor fuel . . .	15,000 = 22·1%	15,000 = 25·0%
Diesel fuel . . .	8,000 = 11·0%	8,000 = 12·3%

February

Aviation spirit . . .	22,000	9,000
Carburettor fuel . . .	73,000	53,000
Diesel fuel (with J.2) . . .	93,000	66,000
	<hr/>	<hr/>
TOTAL . . .	188,000	128,000

Of this, from Hungarian production:

Carburettor fuel . . .	18,000 = 24·7%	18,000 = 34·0%
Diesel fuel . . .	10,000 = 10·8%	10,000 = 15·2%

March

Aviation spirit . . .	56,000	12,000
Carburettor fuel . . .	85,000	50,000
Diesel fuel (with J.2) . . .	100,000	68,000
	<hr/>	<hr/>
TOTAL . . .	241,000	130,000

Of this, from Hungarian production:
(Figures are omitted from text.)

	<i>Theoretically possible Tons</i>	<i>Estimated if inadequate Air Defence Tons</i>
<i>April</i>		
Aviation spirit	68,000	12,000
Carburettor fuel	85,000	50,000
Diesel fuel (with J.2)	108,000	68,000
	<hr/>	<hr/>
TOTAL	261,000	130,000

Of this, from Hungarian production:

Carburettor fuel	18,000 = 21.2%	18,000 = 36.0%
Diesel fuel	10,000 = 9.3%	10,000 = 15.0%

It must be emphasised that the Hungarian crude oil is of special importance in connection with the supplies of carburettor fuel for the Army, since it contains 30 per cent. of carburettor fuel as compared with only 9 per cent. in German crude oil; from the Hungarian crude oil production of about 60,000 tons, 18,000 tons were obtained as against only 13,000 tons carburettor fuel from the 160,000 tons German crude oil.

The requirements of the Army are considerably higher than the estimated production figures which will decrease somewhat owing to the inadequate air defence:

Aviation spirit (without J.2) estimated according to present consumption:

	<i>Tons</i>
January	45,000
February	40,000
March	45,000
April	45,000

Carburettor fuel estimated according to present consumption:

	<i>Wehrmacht Tons</i>	<i>National economy Tons</i>
January	55,000	8,000
February	50,000	7,000
March	55,000	6,000
April	55,000	5,000

Diesel fuel with J.2 (estimated according to present consumption and future consumption of J.2):

	<i>Wehrmacht</i> Tons	<i>National</i> <i>economy</i> Tons
January	60,000	24,000
February	60,000	23,000
March	65,000	25,000
April	70,000	25,000

In the *Wehrmacht* requirement put forward, the following is calculated for J.2:

	Tons
January	20,000
February	20,000
March	25,000
April	30,000

The small reserves of aviation fuel still available will soon be exhausted. There exist no further stocks of carburettor fuel or diesel fuel.

The aviation petrol output is especially exposed and in danger, since production is only possible in four hydrogenation plants, whilst other fuels are on a wider supply basis. It is technically possible to guide production within certain limits, so that the maximum become aviation petrol. The result, of course, is a corresponding limitation of the supply of carburettor fuel and diesel fuel, including J.2.

The deficit of the Leuna, Poelitz, Blechhammer and Bruex works is outstandingly lasting. In spite of the especially strong *Flak* defence of Leuna, it has been heavily hit several times. Fighter protection has not, at any attack, been sufficient to enable the enemy to be beaten off.

Even now it will still be possible to cover approximately the *Luftwaffe's* requirement from April onwards this year, if the reconstruction and the works of the four plants named can be completed without substantial interruption by further air attacks.

Since production from underground or other dispersed plants cannot be reckoned with during the next months, the fuel supply must depend entirely upon above ground installations. The undisturbed repair and running of the above ground plants is therefore an essential for further supply. The past months have shown that this is impossible under the present conditions of plant production.

Hail, my *Fuehrer*,
SPEER'

APPENDIX 33

Speech by Albert Speer to the Fighter Staff (Jägerstab) on its dissolution, 1st August 1944

COLLEAGUES! On 1 March this year we set up the Fighter Staff as the result of a situation which probably could not have been more desperate and with a great deal of optimism and perhaps a little recklessly we have succeeded in overcoming a problem which was at first believed to be insuperable. While this Fighter Staff has existed we have more than doubled the output previously available to the Luftwaffe. You all know the rates of output up to the month of June and later Herr Saur will inform you of the result for July, which has far outstripped that of every previous month. Thanks to the Reichsmarschall's perception we have succeeded by means of the Fighter Staff in achieving our ultimate aim, that is to obtain a unified Ministry for Armaments and War Production. With the attainment of this objective we once again have fresh possibilities to exploit; the co-ordination of the entire armaments industry can again give us fresh potential.

Now that the whole aircraft industry has been taken over by our Ministry the Fighter Staff in its old form is no longer really practicable. I have already spoken with Saur and expressed the conviction that the basic procedure which developed with the Fighter Staff and enabled us to work and come to decisions rapidly should be retained. With effect from today the Fighter Staff is dissolved; its place will be taken by the Armaments Staff. This Armaments Staff will operate on similar lines to the Fighter Staff but will now also deal with all of the most important programmes throughout the armaments industry and will ensure that output in all of the most important sectors is raised as quickly as possible without recourse to bureaucracy and by the old method of improvisation.

The Armaments Staff will first of all carry out the following tasks. First the Luftwaffe programme, the importance of which need not be discussed further at this point. Then the naval programme, about which I will make the following comments. In the industry which supports the naval programme we do not have the youthful energy which we have found or were able to arouse in other fields of industry. The naval armaments industry is obsolete and so steeped in its traditions that it will not of itself develop basically new ideas either in general or in particular which will enable us to achieve an appreciable improvement of its results to date. We have found in Merker, the chairman of the main committee, a man who has passed over all these traditional hide-bound views with great courage and found new ways of carrying out naval armament. However, one man alone cannot succeed in face of the stubborn resistance which he will encounter not only from the naval armaments factories but also from the Navy itself. We must therefore overcome all this opposition on the broadest basis in one general assault so that with the resources which

we have gained from the rest of industry we may show the Navy and the shipyard bosses what production really is. I am convinced that if we take this action on a broad basis we will succeed in bringing to full fruition the excellent beginnings which Merker has already made in naval armament.

The infantry programme is also part of the Armaments Staff's work. Moreover, it must be noted that it should not be particularly difficult for us to carry out the infantry programme if the situation remains relatively normal. The infantry programme was ordered by the Fuehrer at our request because, during tours of front-line areas everywhere and according to all the comments which reached us from the front, we were obliged to come to the conclusion that industry was not delivering weapons in the required quantity. We became aware of this deficiency—not from the competent authorities—and ourselves took the lead in pressing these demands, thus anticipating action on the part of those whose job it was to put them forward and who then associated themselves with these demands in a very energetic manner some months later. I believe that on the whole it will be possible to fulfil demands regarding infantry armament. We must always bear in mind that at the present moment the infantry programme is one of the most important programmes of all. If the release today of 1,000 carbines held by the Todt Organisation to the Army Chief of Staff is a matter of some importance because it is thus possible to equip 1,000 Marines in East Prussia, it indicates how urgently necessary it is that this side of production be increased in the shortest time possible. Later Saur will show by July's results that in this case we too have already created a satisfactory basis for the infantry programme in the shortest possible time. Difficult though it may be, it is essential that July's figures be at least maintained in August and even further increased if possible.

You are aware that the vehicle and assault-gun programmes are included in the infantry programme. You also know how important vehicles are. In this respect I should like to make special reference to the fact that the labour problem in the vehicle industry will be overcome in the next few weeks by the provision of 12,000 concentration camp prisoners, so that the components industry will probably be faced with exceptional difficulties and obligations. I request the components industry to contact Herr Schaaf in his capacity as chairman of the main committee for vehicles as he will otherwise wish to release and transfer to his own components plants workers from the 12,000 concentration camp prisoners to be sent into the vehicle industry.

Furthermore, the Armaments Staff controls the tank programme, and no words need be wasted in describing the importance of this project, as well as the locomotive programme which can be assisted mainly by the improvement of engines. I am not convinced that everything which could be done in this programme is already being done. It is true that the Reichsbahn maintains that every effort is being made. However, Degenkolb,¹

¹ *Authors' note:* Degenkolb, chairman of the Locomotives Special Committee, was a close associate of Saur. For a different criticism of his participation in the V-weapon programme see Major-General Domberger, *V2* (Eng. trans. 1954), pp. 79 ff., 83 ff., 90 ff., 145 ff.

I believe that even more reserves could be made available if we exerted even greater pressure in this sector. I should be grateful if, with regard to locomotive repair, plans were quietly made in the next week or two for a general review of Reichsbahn repair installations, action then being taken upon the issue of a code word.

The flak and artillery programmes are further tasks for the Armaments Staff. In the last few months the flak has shown that in massed raids on cities even more enemy aircraft can be shot down than had ever been believed possible. It will acquire an ever greater importance. In view of the expected shortage of aviation fuel we do not know how defence will fare both at home and against enemy aircraft at the front. However, the flak will at least force enemy aircraft up to greater altitudes and reduce their aiming accuracy accordingly.

You are all aware of the importance of the artillery programme and I need not make special reference to it. You all have a detailed knowledge of what has to be achieved in this programme. In the case of the artillery programme it has been observed that as a result of the ability of main committee chairman Tix and also of our Weissenborn exceptional results have been achieved in the last few months. Today our artillery programme is far beyond the target originally set us by the Fuehrer. As Saur will show later from the individual figures, we have again achieved production records in July which, in the case of all the important weapon types, is approximately equivalent to 8-10 times the figures for 1941 and even we would have regarded this rate of output as impossible if it had been demanded of us in the spring of 1942.

The V-weapon programme is to be incorporated into the Armaments Staff, which I believe has quickly brought it under a special committee. The effect of the V1 is well known and this will be greatly exceeded by subsequent types which Degenkolb has taken so much trouble to bring in and which he regards with optimism.

The last to be considered is the repair programme. In this respect it must be especially emphasised that the provision of spare parts of all types for the front is of particular importance and has not been neglected by us. The activities of Herr Oesterreich, which are very highly appreciated by the service men, have resulted in more spare parts than before being allocated where they are needed. The nearer the fronts come to Germany the sooner will it be possible to distribute spare parts to those needing them according to a sensible system and through direct channels. In my opinion there are still exceptional possibilities in this sector and I should like to request that not only the delivery of spare parts but also the strongest condemnation of their misuse in any way at the front be considered as the objective of the repair programme.

The Armaments Staff has the same full authority previously vested in the Fighter Staff and may therefore make decisions in my name in any matter concerning the Ministry. I would next like to thank the Fighter Staff for the manner in which it has carried out its work in the last few months. During these months the Luftwaffe has remained unreservedly at our service and by acting unconditionally and without regard to matters of prestige was instrumental in making our work possible. We know from

other branches of the services the number of difficulties which may arise where co-operation is concerned. In this case co-operation developed exceptionally smoothly from the outset. I also thank my friend and present representative, Milch, who, from the commencement of my activity, understood completely how to avoid the differences which would of necessity have arisen between the aircraft industry and the rest of industry.

We all regret—and I believe this applies most of all to those responsible in the Air Ministry—that the solutions which we have found in recent months were not put into effect some time ago. We must learn from this example what serious consequences mistakes in organisation, which are basic, can have for the entire system. Although we now speak of our system of so-called industrial self-responsibility, I should like to add something fundamental on this occasion. In 1942 and 1943 we were often derided when we were establishing the system of committees, commissions and syndicates. To counteract this we were frequently rather inclined to laugh at ourselves and said that we were about to bring back the parliamentary state. However, this system of compulsorily bringing together everybody with something to settle had great advantages, for these meetings enabled frank discussion round a table of every type of basic difficulty existing in any particular sector of industry. I am convinced that such varied matters cannot be settled by rigid military procedure and this also applies to our organisation. We must provide the necessary safeguards in these sectors so that the errors which can arise in a system such as this can be immediately eliminated. Thus the system which we have established in industry provides one of the principal prerequisites which will make it possible to counteract the defects which can occur in an authoritarian system—and this also applies to the Wehrmacht system from its early beginnings. There is also the safeguard—and I ask that it be borne in mind by the main committee chairmen assembled here—that this group is headed by a man who will permit full discussion of the pros and cons of every case, but who will finally reach a clear and expert decision and will also ensure that this decision is put into effect. Thus, the Armaments Staff will also operate in this manner. Essentially it is also intended to be one of these groups and although the thunderous voice of Saur will be dominant, unrestricted and frank expression of opinion and intensive discussion will nevertheless be its principle.

In the next few months we will doubtless be faced with exceptionally difficult situations. I believe that we cannot master these situations unless we expose the immense basic difficulties existing in other sectors and in so doing mobilise reserves as well. I am convinced that we will win the war if we make fewer mistakes than the other side and that the war will be lost by whoever makes the most mistakes. To date we have made a relatively large number of mistakes. In the organisations of the Wehrmacht and the State we have set up monsters which are apparently no longer under our control. One of the most important tasks of our ministry, having a deep insight into Wehrmacht matters on the one hand and into its economic relations with the state on the other, is that its members take active steps to ensure the solution of the colossal basic problems on hand.

In this respect I must emphasise that at the present moment the removal of defects in all sectors in the shortest possible time is at least as important as our armament production. I am convinced that for the very reason that Dr. Goebbels is not too well versed in administration—he knows just as little about it as I did about armaments when I started—he will find the right means if the right suggestions are submitted. At all events he has the nerve for the job.

I recently used the following analogy. If a factory is not paying its way an efficient director will first compare the ratio of productive to non-productive hours. Next he will eliminate non-productive hours which probably, over a period of a year or eighteen months, he can ill afford to do without and thus by producing a more favourable ratio of productive to non-productive hours puts his factory on its feet again. We find ourselves in the same situation in the Reich today. The ratio of productive to non-productive hours is staggering. Consider the following figures! As you are all aware, we have 2,100,000 workers in aircraft production, 1,900,000 on Army production, 500,000 on naval production and about 2,000,000 in basic industries, totalling approximately 6,500,000 workers turning out the most important armaments and war production items. Agriculture and transport could also be added to these figures as productive. These three factors—agriculture, transport and armaments—are the only ones at present enabling the essential prerequisites for maintaining our fighting fronts to be provided here in Germany. All the rest are unproductive, serving only to maintain the productive section in one way or another. However, unproductive employment in the Reich also includes 3,100,000 workers in administration, including the Wehrmacht administration, 3,200,000 in banks, insurance companies and home and foreign trade and 1,400,000 employed as domestic servants. These are a few figures and are not comprehensive in themselves. There is a large number of subsidiary trades which could also easily be counted as unproductive. Since 1942 we have repeatedly demanded of industry that a change be made in the ratio of productive to unproductive hours; we make this demand in every Gauleiter's speech. If now at the last moment there may still be a chance for us to push through extreme measures in this respect then we must continue to retain the initiative. For this purpose I need your suggestions in all of these matters. I believe that the way in which we have set up our organisation has been completely wrong in that we have with typical thoroughness brought in a large number of controls, some of which overlap, to prevent any possibility of the State being defrauded in any department, whether with regard to ration cards or the revenue. The system is undoubtedly excellent and I think that generally speaking it would be hardly possible to avoid this form of control. However, what we have forgotten is that the German people do not need this control at the present stage. The Minister of Finance happened to tell me that at Revenue offices where records have been burned, taxes were still being paid in full although it was known that the records were not available and this shows that confidence can and should be placed in the German people. If there were a total departure from this attitude which is characterised by the controls so far imposed and instead

some measure of confidence were placed in the German people, this change in basic policy would in my opinion result in the redundancy of a million administrative employees.

In conclusion, I should like to ask you all to be a source of optimism and equanimity as has been the case since the ministry was established. I remember with what drive we started in 1942 when there was a wave of depression throughout the Reich and the administration and how, simply by our almost excessively confident work, we succeeded in defeating this depression and replacing it with our optimism. We must not only continue with this policy but also intensify it by our belief in our future achievements so that we will demonstrate to the rest that we still have something in hand and that we will ultimately attain our objective. In the next few months the psychological task which we have to perform in this respect will be of at least equal importance to the actual task of increasing armaments production. We cannot give everyone a detailed account of what our output will be from month to month, nor can we discuss in detail the basic difficulties which have perhaps existed to date in the distribution of weapons and equipment and which will certainly be rectified in the immediate future. However, it is essential that by our morale we show that we are still the same and that we will achieve whatever is necessary to assure the future of Germany. I rely on you to maintain this old morale and never to abandon it whatever may happen in the next few months. As far as armaments are concerned we will be and remain a sworn society. I am convinced that just as there were societies which held together and surmounted every danger at the time of the war of liberation, so will our society constitute a very active centre of resistance together with the other centres of resistance which are developing everywhere. Capable men are now appearing everywhere and the rest are handing their work over to them. I name Himmler and Dr. Goebbels as the most important of these men. I am convinced that they will cooperate closely and that Germany's future prospects will be improved by these men.

APPENDIX 34

Telegram from Speer to Martin Bormann on the reconstruction of oil plants, 16th September 1944

To: Parteigenosse Bormann at the Führerhauptquartier.

From: Reichsminister für Rüstung und Kriegsproduktion, Berlin W.8.

16. September 1944.

Pariser Platz 3.

Geheime Reichssache.

Dear Parteigenosse Bormann,

The idea is spreading that the reconstruction of the synthetic oil plants and refineries is purposeless since the enemy always finds a suitable moment, soon after the resumption of work, to destroy these installations again by air attack.

Had I not, however, from the very beginning made every endeavour to re-construct the synthetic plants and refineries, many thousands of tons of fuel, produced in the intervals that the enemy has granted us, would have been lost to us. This fuel has moreover made an important contribution to our fuel reserves.

All means must therefore be employed to ensure that the workers engaged on the reconstruction of the synthetic plants shall not be crippled in their efforts.

I ask you, also, to do everything in your field to strengthen the determination of those engaged in reconstruction, and to see that their efforts for the quickest possible resumption of work shall be increased.

It is a fact that we are in process of setting up underground installations more especially for aviation spirit and that we are simultaneously developing very small crude oil processing plants so as to safeguard this production as far as possible from air attack.

These measures would, however, come too late, or alternatively, would definitely not suffice from a quantitative point of view, if the synthetic plants had not already resumed production.

After a fair weather period of extraordinary length we may from experience expect a season of predominating bad weather and fog. The bombing of synthetic plants cannot then be carried out with the same precision, our own air force will need less fuel in the same period, and may without disturbance strengthen and reorganise itself, aided by the ever increasing production of fighter aircraft.

We must not allow ourselves to give up hope that we must eventually be successful in gaining mastery over the enemy air forces over Reich territory, and developments during the last few days have shown that a large number of bombers can be destroyed by the use of a comparatively small number of fighters. A few weeks quiet in the air will show a considerable increase in our fighter strength.

On the other hand, in spite of the really considerable damage done, we can, in a period of five to six weeks, restore production to about two-thirds of the level attained by the synthetic plants and refineries before the attacks. This production would suffice to cover the fuel requirements of our entire air force, considering the present reduced areas of activity and operational possibilities.

It is therefore incorrect to regard the reconstruction of these plants as a fruitless task; on the contrary, from a long term point of view, the successful prosecution of the war depends in the final analysis upon this achievement.

All resources must therefore combine to support measures for the reconstruction of the synthetic plants and refineries.

Heil Hitler!

Yours,

(Signed) SPEER.

APPENDIX 35

Situation in the Ruhr Area. Letter from Speer to Hitler, 11th November 1944

My Führer,

The situation in the Ruhr has reached such a critical stage that it has been necessary for the Central Planning Board to determine what effects this situation will have on armaments and war production.

Before I discuss these effects, let me summarize briefly the relief measures I have already taken in respect of the Ruhr:

1. At my insistence, the Reich Minister of Transport appointed Dr. Ing. Lamertz of Essen, the President of the Reich Railways Regional Executive and a man held in high esteem in the Ruhr, to be Reich Transport Commissioner-General for the industrial area of Rhineland-Westphalia.

In this capacity, he is responsible for decisions affecting transport over the whole industrial area including local services and inland waterways. He is also authorised to exercise control over the Railway Executives at Münster, Essen, Wuppertal and Cologne, over inland shipping offices in the Ruhr, and over local traffic commissioners in the Münster and Düsseldorf areas.

It was very necessary to take this step, as the situation at that time demanded unified control and even distribution of all available means of transport in the industrial area of Rhineland-Westphalia. Moreover, constant dislocation of communications made it impossible to maintain a unified programme controlled from Berlin.

2. As a result of experiments which I ordered to be made, it has been found possible to run the 55 h.p. and 45 h.p. Lanz-Bulldogg on coal tar oil and naval fuel oil. I have stated that I am prepared to allot 5000 tons a month to the industrial area of Rhineland-Westphalia until further notice.

This quantity will enable 4000 Bulldogg tractors to be brought into operation, each with a traction power of 15 tons. This would go some way towards bridging the gap, and would at least assure food supplies for the population. The number of tractors which can be mustered inside the Ruhr area will be ascertained. The rest will be transferred there temporarily from other parts of Germany.

This measure, however, can only be put into effect when agriculture can spare the tractors, that is during the winter. 4000 Lanz-Bulldogg tractors represent about 10% of the total number of tractors available in Germany.

3. In addition, 8300 anthracite and low-temperature coke generators will be allocated to the Ruhr. These will be installed by self-aid and will serve to provide extra transport capacity despite the shortage of oil fuel.

The competent administrative offices in the Ruhr will make every

effort to remedy difficulties connected with the supply of solid fuel in the Ruhr. I have asked Party officials with the rank of Gauleiter to co-operate accordingly.

4. At my request, Reichsleiter Bormann has transferred a labour force of 50,000 foreigners from trench-digging to repairing damage to the transport system. A labour force of 30,000 will be drawn from the German armaments industry for the same job and for restoring badly hit industries in the Ruhr.

5. 4,500 workmen taken mainly from the trades of electrician, pipelayer and welder, will be drawn from the rest of Germany to do repair work in the Ruhr.

At my request, Reichsleiter Bormann has also ordered Party officials of Gauleiter rank to resort, if necessary, to a public levy to restore communications.

I have also arranged for 10% of the total force of mineworkers to be made available for immediate relief work. If this number is not sufficient, a further labour force will be drawn from the mines at the expense of cuts in mining.

6. The repair of waterways, which is just as important as that of the railways, has not gone ahead quickly enough. The following measures have been introduced to ensure immediate assistance when damage occurs:

- (a) Parties of young waterway engineers with long experience in the Organisation Todt will be posted at danger points to supervise construction work.
- (b) The appropriate transport will be placed at their disposal.
- (c) Herr Pleiger is personally responsible for assigning the extra labour forces from the mines to do repair work. He also has my authority to initiate repair work on the spot.
- (d) Clay and bales of straw are being dumped at danger points along the waterways for sealing off breaches in the embankments. This would require co-operation from the populace in an emergency, similar to a dyke community in flood disasters.

7. In order to have the approved number of 1000 A.A. guns defending transport centres, 500 heavy A.A. guns will shortly be made available at the expense of A.A. defences for important arms factories even in the Ruhr itself. A further 350 A.A. guns from November's output are to be used for this purpose. The remaining 150 will also come from November's output if possible, otherwise they will have to be diverted from elsewhere. The transport centres to be given protection have been agreed upon with the Reich Ministry of Transport.

On the waterway system, the point where the Mittelland Canal crosses the Weser at Minden is to be given A.A. cover, as it has been attacked several times.

8. Shipping has recently been subjected to low-level air attack in the same manner as railway trains. An urgent request was made for convoys of barges to be given light A.A. cover in the same way as goods trains (20 mm. A.A. in concrete cupola mounting). This has now been seen to.

g. 20 mm. A.A. must also be mounted at danger points along the canals. I have submitted requirements to the Air Force. If these are not complied with shortly, the matter will have to be discussed and a decision reached.

These measures, however, will make little impression on the situation which the loss of the Ruhr creates for German economic life. Some improvement will be effected, but not quickly enough to make a fundamental difference.

Since my verbal report on 3 November the crisis in production has become even more acute, and will inevitably result in a very serious breakdown in finishing schedules.

Judging by the report which the Reich Coal Federation submitted to the Central Planning Board, we are on the verge of the most serious coal production crisis since the beginning of the war. This is indicated by the figures for the top-priority supply of service coal to the railways during the past two months:

Level of winter stocks

On 10 September 1944	.	.	1,839,750 tons = 19 days
On 5 November 1944	.	.	1,026,520 tons = 10.9 days.

Winter stocks have thus fallen by 813,000 tons during this period, that is almost by half, and the serious transport crisis in the Ruhr did not arise until the beginning of October.

As a result of the supply shortage, the Reich Railways' stocks of service coal are at present diminishing at an average rate of some 40,000 tons a day. The Reich Railway Executives in the west of Germany are particularly hard hit and other Reich Railway Executives have stocks well below average, some with as little as 5 days in hand (Berlin 5 days, Stuttgart 2 days).

I have therefore decided that all coal suitable for railway use shall be diverted to the Reich Railways irrespective of the needs of other consumers. But even with this priority allocation it is not certain in the present transport crisis that adequate deliveries of service coal can be made to districts in Germany where communications are difficult.

The railways' coal requirements are very great. They amount to 96,000 tons a day, i.e. 25% of the total daily load carried; and since railway coal has to be of special quality, the requirements amount to about 80% of all available stocks of this quality coal in Germany.

Similar difficulties are arising in supplying bunker coal for shipping in the north-west of Germany. For some weeks now the Reich Commissar for Shipping has reported a state of emergency in Hamburg and the ports of Schleswig-Holstein to the considerable detriment of shipping. Also the supplies for electricity works, which should be treated as a matter of priority, are so much in arrears that the winter stocks have sunk

from 1,237,100 tons (3.8 weeks) on 1.8.44
to 865,000 tons (2.5 weeks) on 28.10.44

that is, by 372,000 tons.

Many important electricity works are struggling to carry on unable to obtain sufficient supplies and with stocks which have already fallen below the 10-day limit (Hamburg, Farge, Herrenhausen, Marbach, among others). Various power stations are on the point of closing down (including Kiel, Afferde, Gevelsberg). One or two power stations are at a standstill (Oldenburg, Hanau).

Supplies for gasworks have reached a particularly critical stage, since it is not possible to make good the loss of Ruhr fuel with supplies from other coal stations. Stocks in numerous gasworks in western and central districts of Germany have fallen below the 10-day limit. In many areas gasworks are already being forced to close down. Even gas rationing, mainly for domestic consumers, can only delay the end for a short time, as the flow of supplies to the gasworks is well below daily requirements.

Urgent calls for help have been received from industrial areas in western and central Germany, and there is no effective means of assistance to hand.

Important works in the iron industry are in imminent danger of closing down (Ilseeder Hütte, Peine—8 days' stocks; Norddeutsche Hütte, Bremen—8 days' stocks; Hermann Göring Werke, Watenstedt—7 days' stocks).

Supplies for chemical industries in the Wiesbaden area have had to be suspended.

A large number of very important armament works are on the point of closing down (e.g. Deutsche Waffen-und Munitions A.G., Lübeck; Phönix, Harburg; Miag, Brunswick).

In the present circumstances there is no possible way of preventing these stoppages.

Most food manufacturing plants have managed to keep production going on the stocks available. Supplies to the sugar industry in the Hanover area are, however, insufficient, with the result that the continuance of the product is no longer guaranteed. Oil and margarine works in the Hamburg area are faced with closing down.

There is an increasing number of food manufacturers in the west, such as bakeries and small dairies, who are normally supplied from the household quota, but whose supplies can only now be maintained by requisitioning measures because of inadequate deliveries of brown coal.

Deliveries of coke to civilian and military hospitals in central and southern Germany are also totally inadequate because of the shortage of supplies from the Ruhr.

Despite increased demands arising from rebilleting and the accommodation of refugees, the general situation in respect of household fuel will probably remain the same until the middle of December. After that, only a substantial improvement in supplies will avert a serious emergency in respect of cooking and heating coal for the population; and as things stand at the moment it will not be possible even to keep up the present volume of supplies.

As the movement of service coal for the railways must be given first priority, the emergency in household coal, far from improving, is bound to become even more serious.

The situation with regard to German armaments and war production is

being further aggravated by the fact that, in addition to raids on transport installations, systematic attacks are being made to eliminate Germany's steel potential. One blast furnace after another is being attacked with effect.

As the labour force available in the Ruhr is not large enough for restoring these works, labour is being drawn from armament industries and war production throughout Germany.

It is evident from an aircraft leaflet that the enemy is following a definite plan aimed at crippling our steel production. This leaflet states: 'Three of the most important steel works, the Hermann Göring Werke at Salzgitter, the Ilseder Hütte at Peine and the Georg-Marien Hütte at Osna-brück, which all receive their smelting coke via the Dortmund-Ems Canal, have only limited stocks left and will have to lie idle if the canal is not repaired soon.'

As, however, at the moment it is not even possible to move semi-manufactured goods from the industrial area of Rhineland-Westphalia, where they are piling up at the works, the matter of systematic raids on production centres is secondary to the problem of transport.

Moreover, as stocks of component parts in the German armaments industry are comparatively good, it should be possible to maintain the situation for a few weeks yet. But an ammunition crisis is likely in November. According to estimates which are certainly not too pessimistic, the entire production of ammunition may fall by 25-30% in November.

For more than 6 weeks now, in the matter of transport the Ruhr district has become more and more cut off from the areas it supplies.

While it seemed for a time as if the allocation of trucks for coal in the Ruhr district would recover from 7000 trucks a day to at least 11,000-12,000 a day, in fact it has fallen to the record low level of 4,000-5,000 a day.

The number of trucks used for coal per day in the Ruhr district should amount to 18,000-21,000, to cover both the Ruhr district's internal requirements and deliveries to northern, south-western and central districts of Germany. The present number of trucks, however, is nowhere near sufficient even to serve internal transport in the industrial area of Rhineland-Westphalia, which in normal times amounted to 10,000 trucks.

Hopes that the Mittelland Canal would be navigable again 8 days after the first attack have been nullified by renewed attacks. As things stand at the moment, the Mittelland Canal will be navigable again by 20 November, provided no further damage occurs.

The Reich Coal Board has exhausted possible relief measures such as using coal from Upper Silesia or other districts to assist the most important works in the distressed areas, namely north-west, central and southern Germany.

According to latest reports, reserves for industry in the distressed areas, which amounted on an average to 4-5 weeks at the beginning of September, have now fallen to under 8-10 days in districts supplied with West German pit coal. These reserves will be exhausted by the end of November, unless there is a distinct improvement in the movement of

supplies. A further aggravating factor is that this reserve of 4-5 weeks, which is now being consumed, is earmarked every autumn to allow for transport hold-ups on the inland waterways due to ice and for increased consumption during the cold season.

Whatever misgivings there may be at present, the basis of long-term planning must be that the present catastrophic situation in transport is only a temporary phenomenon: for in the past it has always been possible to get transport moving again within a short while, if only on a makeshift basis. Experience gained in the past, and the constant training undertaken, will help to improve the situation.

On the other hand, we must face what might happen. It is much better to do this now than to put off planning for 2-3 weeks, by which time we might find not an industrial area but a heap of rubble.

Important as it is not to let present transport difficulties impair long-term planning, where an optimistic view of the future must be taken, it is nevertheless imperative that an emergency programme for armaments and war production be drawn up, taking existing conditions into account. For these reasons:

1. Supplies of components are not at a complete standstill everywhere, since they are dispersed over the whole of Germany and thus only partly affected by the present restrictions. These supplies, if properly managed, would facilitate the finishing off of certain armament items which would otherwise be lying around half-finished or fit for scrap in the factory yards.
2. Many armaments factories have stocks of steel plate and other component parts in hand. The U-boat steel industry, for instance, has enough ready-processed steel plate for 230 large and 140 small U-boats.

The emergency programme must ensure that this ready-processed material is not wasted.

3. Stoppages must also be expected in the building industry, as the hold-up in coal supplies will shortly bring cement production to a standstill throughout much of Germany. For the time being, no iron supplies will be getting through to the building sites from the Ruhr district. Here, too, emergency plans will have to be made in order that the most important buildings nearing completion can be finished off. This will also enable building workers to be released to clear up damage in the industrial area of Rhineland-Westphalia, and will help to speed up the repair of buildings forced to close down.
4. In areas where industry is at a complete standstill due to the breakdown of the Ruhr there are one or two vital factories which must continue their output even under an emergency programme (e.g. one or two factories in Stuttgart or the ball-bearing plant in Franconia). These will be incorporated in the emergency programme, and an attempt will be made to move coal supplies to these works even from Upper Silesia.

5. If the present situation continues for any length of time, steel works in the Brunswick area (Peine, Salzgitter) will have to close down. The emergency plan will first close down the furnaces producing steel for primary products (ammunition etc.) so that the electro-steel capacity of these works can be used to the full to ensure production of more important armament items. Stocks of ammunition cases in hand amount to $1\frac{1}{2}$ -2 months; moreover, ammunition can still be produced in those parts of Germany where there is no coal shortage.

Even if the Ruhr is put permanently out of action, every endeavour must be made to maintain some form of limited production.

It is difficult to coordinate things within the framework of production still remaining so as to ensure finished products.

The emergency programme for this will be ready in a week's time and will be submitted to you then for approval.

In this connection, I may say that I have absolutely no intention of taking the present negative picture as the basis of overall long-term planning, for by doing so we would lose the initiative in many spheres.

The coal shortage is particularly serious for armaments and war production because supplies of service coal for the railways and of coal for the food industry must be maintained at almost their present level, although the quota of coal supplies which can be guaranteed for the whole of Germany is only 55% of the present level. Nor can gas and electricity works be allowed to come to a complete standstill, as this would have catastrophic consequences for the population.

Hence the percentage of coal available for armaments and war production in areas supplied by the Ruhr is only a fraction of the previous quantity. This does not mean that production will show a corresponding fall, as there may be a considerable difference in the level of reserves in different areas.

Factories will be informed of the curtailment of supplies under the emergency programme only when it is absolutely necessary. It is not intended to issue a general directive on the matter. Our objective is still at least to maintain the current production level in armaments. However, in certain areas where stoppages may be caused by the coal situation, it is essential for it to be recognised what arms production must be maintained within the framework of such an emergency programme, no matter what the circumstances.

Up to now, goods trucks have been allocated haphazardly, but I have ordered strict control to be exercised over the movement of available trucks from now on. All other production must be channeled through this control system by industry itself but in the event of an emergency it will be channeled according to the provisions of the emergency programme.

In the present situation with its bad communications, the use of coal, electricity and gas and the production of iron, metals and semi-manufactured goods can only be fitted into this control system on a local basis.

S.A.O.—IV—AA

In allocating goods trucks, coal obviously takes priority over anything else and coal for the railways has absolute priority.

It is clear from Germany's overall economic structure that in the long run the loss of the industrial area of Rhineland-Westphalia would be a mortal blow to German economy and to the conduct of the war.

In actual fact, at the present time the Ruhr area can be completely written off as far as the German economy is concerned except for goods still manufactured within the inner network.

We have observed that transport quickly improves during bad weather periods, even if they last only a few days: and once the extra labour force which our combined efforts have raised begins to make itself felt on transport installations, recovery should be even more rapid. We should be able to keep up with the damage better. In such a situation and in spite of all the destruction one must remain steadfast in the belief that it will be possible to get, in some measure, the wheels turning again. Total recovery is no longer possible.

In the spring of 1943, when the dams were attacked, we fought and ultimately won a bitter battle for the Ruhr production. True, that was on a smaller scale, but we must go on in the same way to win this one. All authorities involved must be quite clear as to what is at stake.

All that remains now is to mention the consequences which the loss of the Ruhr would have for the whole of Germany.

Relief measures that we can take for various areas throughout Germany are certainly not exhausted yet. If one takes into account the fact that continuation of present circumstances will inevitably result in unemployment and the standstill of whole branches of industry, it is clear that no assistance from outside can be too great and any temporary loss arising directly from this assistance must be accepted.

It is essential that the industrial area of Rhineland-Westphalia should feel that the rest of Germany is helping it. On no account must pessimism become widespread there. Reports indicate that a pessimistic outlook is already gaining ground, as persons in authority feel, with some justification, that they can no longer cope with the situation on their own.

It must be made absolutely clear to all concerned that the relief measures provided for the industrial area of Rhineland-Westphalia represent the utmost that can be done in the circumstances. Never let it be said of us that we have wasted a single day in this struggle.

However difficult the situation, however hopeless it may seem at first our efforts must not tire. We shall do everything within our power to win the battle of the Ruhr, the outcome of which will determine the fate of our Reich.

Heil my Führer!
(Signed) SPEER.

APPENDIX 36

Speech by Reich Minister Speer at Rechlin¹ on the situation in the Ruhr, 1st December 1944

COLLEAGUES! For the next few months our anxieties are governed by the transport situation which has deteriorated to an extraordinary extent in the West and South West of the Reich during recent months. Our production is to a great extent dependent on how far it will be possible to put transport back into some sort of order. Although transport is the responsibility of the Ministry of Transport and not ours, I want to point out and to make it clear on this occasion that it is the duty of all of us to help as far as possible to overcome at least part of the difficulties caused by daily air raids. Every few days I meet Secretary of State (Staatssekretär) Ganzenmueller to discuss the necessary measures and I ask you too to make the closest possible contact in your district with the competent local authorities, since certainly in many cases more help could be given than was expected.

My last journey to the Ruhr, made together with Secretary of State Ganzenmueller, has shown that in various districts, owing to the lack of 300, 400 or 500 workers, the damage to the transport system at various very important junctions could not be repaired in the shortest possible time. When you look further to the Ruhr, where millions of people are working, and when again you look towards the rest of the Reich, cut off from the Ruhr, where also an enormous number of people are working, you will say it would really be a shame if this problem could not be solved and if the few hundred people needed to put a traffic centre in order in 3 or 4 days could not be found. You must not think that everything is alright, just because the officials concerned tell you the Reichsbahn has obtained everything it needs. If you look into the matter on the spot and ask the man on the job what is still missing, you will get quite another picture of the possibilities for help. We need every available hand in the Ruhr.

Sitting at your desks you cannot judge what difficulties are to be overcome and what problems are to be solved. You can only judge what can be remedied, sometimes by relatively easy measures, when you see the work on the spot and become acquainted with the difficulties to be overcome. Therefore I ask you to co-operate closely with the men responsible for transport. They will gladly accept our initiative too. There will be no red tape either from Secretary of State Ganzenmueller or from myself. In many cases a traffic junction could be restored perhaps one or two days earlier. For this purpose it is necessary to bring an abundance of labour into action. It may happen in the Ruhr that perhaps at such a site no work at all needs to be done for several hours and the workers idle about until the next job can be started.

¹ *Authors' note:* The Research Centre of the *Luftwaffe*.

For the next few months the transport situation will become decisive for the armament output. The inspection of the Ruhr has shown the possibility of repairing transport damage much more quickly than was ever expected, when once the repair squads have been trained. It was the same in armament production, where after the heavy air raids on our factories we were at first very much afraid of the effects and after the first raids on Hamburg never thought it possible to maintain armament production at all, if these raids were to continue. Nobody who has witnessed the collapse of the works in Hamburg would then have believed that a multitude of these attacks could be directed, and very well directed, against our arms production and that we nevertheless would be able to maintain production. Everybody would have said that it was impossible.

Fortunately, in armaments production we had enough time at our disposal and the enemy did not increase his attacks step by step so that we were able to try to keep in step with our counter measures to some extent. But it is another thing with the transport. The main difficulty is that the heavy raids on the transport system have started from 'one day to the next' so that the position differs from the armament industry, where naturally we have already tried everything in air raid damage repair work. Therefore it is necessary for everybody to help, and to exploit all possible means, putting our experiences at the disposal of the works so that we can speed up matters.

Owing to the crisis in transport, which, in itself, could easily be overcome (I must underline that) if only the air raids would stop for a short time, owing to this crisis quite a lot of circumstances have combined to cause us extraordinary difficulties in armament and war production. In the first place, the enemy is trying to cut off the Ruhr from the rest of the Reich. He has two reasons for this. Firstly to dislocate supplies to our front in the West, and secondly, as he openly admits, to deal a blow at the same time to our armament potential. You must realize that those people of the enemy who work out the plans for the economic bombing attacks know German industry very well and that there is here a clever and far-reaching planning in contrast to our earlier air raids on England. We have been lucky in that the enemy did not make methodical use of this detailed planning until the last half or three-quarters of this year and that before that he gave us enough time. This in fact has been a blunder from his point of view. At the moment, however, he is going all out to attack again and again our bottlenecks which are vitally important to us. He has destroyed both the Weser-Ems Canal and the Mittelland canal just when they had been repaired, and thereby deprives us of the possibility of relieving the transport by rail from the Ruhr by transfer to inland water transport. He declares openly that by these methods Salzgitter, the Peiner rolling mill and the other steel plants in Central Germany will come to a standstill and he is trying to seal the Ruhr from the remaining Reich by systematically destroying Hamm, Osnabruock, Bielefeld, Muenster etc. When we previously tried to rebuild the bombed hydrogenation plants, raided again and again 4 or 5 or 6 times, I was blamed by many people (not only of the Party but also by others) for doing something that was senseless because when the repairs were finished a new

attack would be made. They told me: why on earth have you done it, you cannot help it, the odds are so heavy against us that there is no sense in rebuilding. At that time we fought hard against that frame of mind. Herr Geilenberg has taken up the fight against all this opposition, some of which came from the works managements themselves. We have been able to produce a relatively respectable quantity of aviation fuel every month and about a week ago we again reached half of the fuel production we achieved before the bombing. You will see from this example the absolute necessity of trying again and again and of building up again and again even if the enemy returns the next day and smashes things up again. You must not think that the enemy, during half or three-quarters of a year, will obstinately attack the same target again and again. It is quite possible that he will change his targets so that by a sudden cessation of the raids a place which was hitherto always believed to be the object of the attack will be given a rest, and that we will then again be able to benefit by our constant reconstruction work.

The transport situation in the Ruhr is the cause of our inability to send to the rest of the Reich more than a fraction of the quantity of coal which we have previously dispatched. Previously about 20,000 waggons daily were provided for coal transport in the Ruhr. That was the minimum demand we could make and in fact far less than we have demanded of the Reichsbahn based on the daily coal output figures. The figure of 20,000 waggons daily has decreased on account of the raids to 6,000. That means we are already one third below the figure previously considered absolutely essential for the needs of our armament and war production. Unfortunately many consumers must be supplied in priority by these few waggons, all of them coming before armament production. Under no circumstances for instance, can we neglect the supply to the Reichsbahn. It has already occasionally happened that the Regional Executive of the Reichsbahn in Berlin and two other Regional Executives had a supply of coal sufficient for two days only and had to rely on stocks. If such cases occur again they are more than likely to result in the whole industry in the district concerned coming to a standstill, and cause a transport catastrophe which it will be impossible to stop. This would lead to enormous difficulties owing to the limited means available today and possibly to further catastrophes. Everybody who knows how extremely difficult it is to make good a break-down in the electric power supply and to restore the electricity supply of the grid system, will understand that coal for the use of the Reichsbahn must have first priority and that this first claim decreases the small number of waggons available in the Ruhr. The remaining quantities for our armament and war production, for the power plants etc., show a much more unfavourable balance than previously. The ratio was formerly 2 to 3 but today it is 1 to 6 or 7. We obtain from the Ruhr only one-sixth of what we previously obtained and the possibilities of obtaining compensation from Upper Silesia have long since been exhausted, as a long time ago already we tried to extend the limit for the dispatch of coal from Upper Silesia as far westward as possible because the Ruhr has always given us cause for worry in regard to the coal supply of the Reich.

It is, however, a fact that a pause in raids on the Ruhr of 3 days only has raised the figure of waggons provided from 6,000 back to 12,000. You can see from this the quick reaction, and I am convinced that the possibilities of restoring destroyed targets are not yet by a long way exhausted; if there are any pauses we will always quickly come to an increase enabling us to help here and there.

With regard to this lack of coal it is quite evident that we have in any case to restrict ourselves to a minimum in the armament industry if we are still to obtain useful results in this sphere. It is no use indulging in any illusions if the result is that we, by these illusions, would be able to produce on the largest basis in all sectors only fractional productions amounting to 20% or 30% or 40%. We must therefore have a clear idea of the result. In this connection it is particularly important to point out that both the authorities responsible for the distribution of coal and the Party authorities will save any quantity of coal which can possibly be saved, even if the population is faced with privations, and that for such privations the Party must accept responsibility. When for instance the gas situation in Berlin begins to reach a critical stage, it will be necessary first of all to switch off the gas supply for the population, at least to a considerable extent. It must not happen that in such a case armament production is cut off first for reasons of political convenience and that only afterwards is the much more difficult problem of switching off the supply for the population tackled. The local load distribution officers (*Bezirkslastverteiler*) will on my orders adopt a much more stringent policy. At the first instance I cannot help the fact that these people will be heavily blamed, but they must above all show enough backbone and must simply realize as distribution officers that these principles must be put into practice. If the Party authorities are unwilling to act on these principles then at least a conflict would arise, giving me the opportunity to decide the matter or to let the Fuehrer decide. If, however, in the beginning, not this stringent policy but an easier line is followed by the intermediate authorities (*Mittelinstanz*), we in the Head Office would not be able to help the armament industry at all, because we would not obtain any knowledge of these matters. I, therefore, ask the distribution officers for gas and electricity to act accordingly and to try to maintain war production as long as possible even if the population has to endure extreme shortages.

You have only to go to the towns of the Ruhr to see what calamities the population is able to endure. All would be futile if we could not manage to maintain our war production. Otherwise the enemy front would be pushed mile after mile into our territory and the privations which at present people refuse to put up with, would in a few months be forced upon the population in a much more terrible manner.

The Ruhr needs special help which is only starting now. We have to give up something from the rest of the Reich because we must not give up the Ruhr. The Ruhr is the vital base for at least half of the war production, enabling us to maintain our production for a long time ahead. It is, therefore, necessary, apart from the present drive for 30,000 auxiliary workers, to find another 450,000 skilled workers, which will be an additional help for the Ruhr. I have now ordered that the Ruhr is to obtain

an additional monthly supply of 100,000 shoes out of the shoe production, which quantities naturally will be lost for the population of the other districts of the Reich. It is, however, necessary that these people who in the Ruhr not only have to suffer non-stop air raids but have been for some time already without gas and electricity and, therefore, without light, and who are compelled to live in the most primitive conditions, that these people are aware that the rest of the Reich is fully aware of its moral duty to help them generously. That will doubtless necessitate cuts in many sectors of the Reich which, however, must be put up with.

We have in preparation a so-called emergency or supplementary programme for the whole armament industry. This programme is based on the following facts:

Our programmes hitherto drawn up and ordered for all important branches of armament and war production have not been achieved in the last few months, as you know. The supply of basic materials for these programmes has however continued for many production processes in the required quantities. If you go to the factory yards you will see huge stocks of components (Vorlieferungen), sometimes sufficient for 3 to 6 months of the current production. For the transitional stage the transformation of these components into finished equipment must be managed, i.e. the necessary complements must be provided and we estimate that with about 20% of the total long-term quotas (Kontingentsmengen) a 100% completion can be obtained for some months. This may, of course, cause a corresponding gap in armament production, when the supplementary programme has been carried out. That, however, does not interest us at all. We want to finish what we can finish in the next few months. Think for instance of the U-boats: thanks to the efficiency of Herr Merker of the Stahlbau we have been able to finish enough Stahlschuesse (steel sections) to last us until May next year. The problem is, therefore, to carry out the necessary completion of these sections, i.e. to provide the interior installations, and this problem must be pressed forward accordingly. How that is to be carried out in detail is the subject of detailed discussions and plans. The committees (Ausschuesse) and rings (Ringe) which have been tackling this problem energetically for about a fortnight have to solve these problems. I want, however, to ask you, of the intermediate grades (Mittelinanz), also to support all these efforts to the utmost in such a way that you utilize the huge stocks, stored by the various firms, to straighten matters out. We must make it possible to fight on under the present conditions for a long time by thawing these stocks.

Nevertheless we need not worry too much about future production; the last few months have shown what an immense toughness we possess in the arms industry and to what an astonishing extent we have kept production going, in spite of all the difficulties daily showered upon us. All planning estimates made by us (in some cases we are no longer making them to such an extent, as the results are mostly much more favourable than we in the Head Office could expect on the basis of our calculations), all these estimates have been greatly exceeded and we will, therefore, take care not to restrict anyone in his programme.

The emergency and supplementary programme is not intended to restrict the initiative of the works managers in any way, but guarantees that we obtain the parts required under all circumstances. As the supply of these parts comes from the Ruhr, it is mainly a question of transport. Since in the first place coal must be dispatched from the Ruhr, the products of the iron producing industry must remain in the background at first. Our most important task is to transport the last ton of coal we can get. We have arranged with the Reichsbahn to introduce a special voucher system (Markensystem) for products needed for finishing work. This voucher system will pass through the main committees and rings to the firms on a long-term basis and it will be possible to cover with these vouchers the way-bills for products from the Ruhr or from the other districts of Western Germany or South-West Germany which must at all costs reach the firms for the finishing processes. At the same time these vouchers should give us a hint as to where the most important bottlenecks are in the filling up of existing stocks. Big mistakes are quite possible, if we establish this programme on a purely theoretical basis. Therefore we, in the Head Office, will watch, through the Main Committees and Rings, which items we obtain by these transport quotas from the firms and we will be able by a compilation of these items to discover that for instance in the Ruhr this or that department of the Mannesmann Roehren Werke (Tube Works) is receiving extraordinarily high demands and that therefore in the Ruhr such and such sizes of Mannesmann tubes must be produced as long as possible; that, however, all the other departments apparently are unimportant for the supply and, therefore, have to take only second or third place. We can see in this way that for instance the firm Bosch in Stuttgart repeatedly obtains orders for a third or quarter of its production capacity for any particular item so that it may possibly be necessary, if there is no other way, to bring coal from Upper Silesia in a few waggons across Germany to Stuttgart, to maintain the production of the necessary supplies there under any circumstances. Thus we hope by this regulation of transport, not only to obtain a survey, entirely lacking as yet, of the traffic with the Ruhr and to prevent bottlenecks, but we think on top of this that this transport quota system will enable us to tackle the present real bottlenecks. I believe this the most important part of the problem. It is, however, important to deal most economically with these quotas so that only those products will be covered by quotas which are really essential complements.

On top of this we intend (this is also in agreement with the other Regional Executives) to delegate to each Regional Executive of the Reichsbahn a Transport Commissioner (Verkehrsbevollmaechtigtter) from industry. These commissioners will on principle be appointed and assigned to their posts by me as Minister of Armament and War Production. They have to discuss in close contact with the heads of the Reichsbahn Regional Executives (Reichsbahndirektionspraesident) and their colleagues what is to have priority in dispatch. The selection of these personalities for which the Presidents of the Armaments Commissions (Ruestungskommissionen) are still to make recommendations must be well considered, since, as I may point out, for the next six months cer-

tainly, the distribution of the transport capacities still available is more important than everything at the moment, more even than the distribution of coal and electric power. The better the selection is, the better will be the result for you. You must not choose anybody but take a person who possesses the necessary knowledge of industry and of whom you are convinced that he is able, owing to his special knowledge, to adapt himself to his work in the Reichsbahn and to establish his authority.

As for the Head Office (Zentrale), in the Central Waggon Office (Zentralwagenamt) a man will also be selected from industry to co-ordinate these representatives and to discuss the collective results daily with the Central Waggon Office.

An especially difficult problem is what has to be done with the districts situated directly behind the front line. I am thinking of the Saar, the district left of the Rhine, of Cologne and the industrial districts of Baden too. On my last journey to the Ruhr and the Rhine-Westphalian industrial district I found that left of the Rhine, especially in the Cologne-Aachen area, the idea already prevailed of dismantling the industrial plants ruthlessly and dispersing them to the area right of the Rhine. Two reasons argue against such a dispersal:

- (1) Everybody who loses confidence in himself in this war sufficiently to disperse his industry will never get on in the world after the war. If for instance the city of Cologne were to give up all its industrial plants to-day, it would probably cease to be of any importance in the future, for in the eyes of the population its steadfastness in the war will also be judged.
- (2) (and that is much more important) that these front line towns which have doubtless to suffer heavily, that these cities have to fulfil an extraordinarily important task. They have constantly to take care that the daily rhythm of supply for the troops at the front line is maintained. That is an immense problem and has to be tackled in the right way. It is indeed possible to help the troops to such an enormous extent and perhaps by such measures to increase the overall effect of our production at the front by 30% or 40%.

You know that the monthly figures for repair of motor vehicles, for instance of tanks etc., constitute about 30% to 40% of our total monthly output. If industry were to abandon these towns and no longer exist, the armed forces themselves with their repair squads would have to keep things in order. We all know, however, that industry is able to tackle this work with quite different means than those at the disposal of the armed forces. Therefore it is at all costs necessary to have in the districts near the front line some production of essential spares so that the necessary supply will be guaranteed. Therefore we have to try to organize this type of production on the largest possible scale and with the skilled workers available. The troops are extremely grateful for such action and will for their part see to it again and again and with all their strength, not only out of thankfulness but also in their own vital interest, that a city like Cologne, a city like München-Gladbach etc. will be kept going somehow.

An ideal solution for this type of co-operation with the troops has been found in the Saar. There, Herr Kelchner and Herr Roechling have organized a real customers' service with the troops. Roechling, who is already an old man, goes every day to the front from division to division and writes down what, as he says, his customers need. Then he delivers the goods. You would not believe to what extent the troops can be encouraged by such measures, against, as I must, however, point out, the fierce resistance of all bureaucrats in all branches of the armed forces who do not like this direct contact and believe that such proceedings are to their disadvantage. That is not so. For the pressure on these people near the front is immense and efficiency would decrease considerably, if, as hitherto, any order from the Heereswaffenamt (Army Weapons Office) were dropped onto the desk of the works manager and circulated in a routine manner by him after indifferent perusal. If the population knows that from this or that tank division, stationed 10 or 20 Km. distant, anybody may come with an order, industry would be keyed up and especially the masses will, out of anxiety for their homeland, achieve results which, otherwise, if we have the system of anonymous orders, could not be obtained at all, as they exceed their physical power. Therefore we must not care what these army bureaucrats say, but must carry out these methods. The assaults from outside directed against you will be stopped in Berlin and we will protect you. We must produce as much as possible in the districts near the front line directly for the troops, in order also to overcome the transport difficulties. We will, therefore, demand more and more from many presidents of Armaments Commissions (Ruestungskommissionen), who have moved up nearer to the front line, that their districts must manufacture completely as many things as possible; i.e. if we continue to produce in the Ruhr cases for all different calibres, send them from the Ruhr to the East, add the fuses from the Black Forest and then dispatch powder and explosive charge from another district and transport the finished product back again to bring the ammunition through the Ruhr to the front line, that would today be pure nonsense. We must see to it that, for example, what can be completely manufactured in the Ruhr must be made there. In other words, in these areas near the front we must see to it that we do not as hitherto move the complete gun to a small optical instrument, rather do we move the small box with the optical instrument to the Ruhr and try to complete the gun there. We will not worry if the Muna (ammunition establishment) is now in danger or if a house close by could perhaps be destroyed if the Muna blows up. Such obstructions have to be removed with the help of the front line troops. It is understood that in this case you must have close contact with the front line troops and also with the commanders of the army troops, with whose help any difficulties which may then arise can be removed. Naturally you have to consider carefully what you may be able to complete in your districts and to dispatch directly to the troops to ease the transport difficulties. The same applies to Italy; there the Brenner will doubtless become such an obstacle for us one day that we will not be able to bring back to the Reich what we have in Italy and that we had better organize things beforehand so as to produce there

everything that can be completed there. The same applies to the Saar, to Upper Silesia, Upper Danube etc.

It is understood that these problems of completion of equipment for the troops must be co-ordinated with the main committees and in the last instance with Herr Saur. Herr Saur will within the next few days delegate someone exclusively for this task, and this man will see to it that these matters, so far seldom put into practice, will actually be put to the practical test.

You have obtained today a small insight into the various new developments of recent date. You have seen, however, that we have no miracle weapon at our disposal and probably never will have. We of the technical branch have always made it clear to everybody who wanted to know, that in the technical sphere miracles such as the layman expects are hardly possible. We are doubtless able to maintain our advantage, our technical advantage, in many directions, and, where this advantage has been lost, to gain the lead again in a great bound. One has, however, to point out to the layman that this would be possible only if the fighting spirit is there. My inspections of the front have shown again and again that the divisional commanders and regimental commanders are worried because the troops cling more and more to the belief in miracles. I think this is disastrous and quite unnecessary and that the slogan given by Churchill after Dunkirk, when he promised the population blood, sweat and tears, that this is a slogan suitable for every Teutonic people. I am therefore thankful that the propaganda line has recently been changed and now points out that such a miracle weapon will not come. The engineers, in particular, however, must underline again and again: technical progress is possible and we can doubtless achieve this progress if we can work undisturbed, but there are no miracles. What you have seen today is only a small sector and we have shown you things which are really already or about to be in serial production. The tanks you have seen, the Jagdtiger and Jagdpanther, are doubtless tanks which will be treated by the enemy with some respect. The fact is that first the Russians and now the English have themselves named the so-called Tiger II which they know from its previous use, the 'Royal Tiger' (Koenigtiger) and we have adopted this title, since it is really a 'royal' tank. A short time ago it was written in the 'Times' that a duel had taken place between their heaviest PAK, the 9.2 cm., very respectable indeed, the Sherman-tank and our Koenigtiger and that by a hair's breadth a catastrophe for the Americans had been avoided and that our tank's superiority has been clearly shown. On this occasion they described ours as the best tank in the world. I personally have, in the battle of Aachen, visited a tank repair shop near Julich of tank detachment 506 (a detachment equipped with Tiger II only) and have seen that the Tiger II could easily deflect a shell of the 9.2 cm. PAK fired at short range. What you see today, Jagdtiger and Jagdpanther, are types which surpass even the Tiger II as regards armour. The troops and we ourselves are not quite sure what would be the best: a light mobile tank or a super-heavy tank. Both of them have advantages and great disadvantages, but we think that we have found in our long-term tank programme, on the one hand with the fast, very mobile 38 to., which is

almost exclusively the work of our Colonel Schaede, and, as a light tank, will be produced in maximum numbers of, we hope, some thousands per month, and on the other hand with the heavy tank types of the Panther, Tiger II, Panther Jaeger, Jagdpanther and Jagdtiger, that we have found with these types the right mixture for our tank forces and for our infantry divisions.

I know many of you are groaning under the many changes we have to make, gentlemen! We too would prefer to come out with huge figures and we know very well that, if we were now to stick stubbornly to the Panzer IV or if we had stuck to the Panzer III or originally to the Panzer II, that we would have production figures at least 50% or 60% higher than the present figures, and we know that the continuous changes which we are obliged to impose on all branches of industry reduce our production figures enormously. Since we, however, have not the slightest chance of reaching the production figures of the enemy, we have in any case to utilize any possibility of technical progress even if the production figures were to decrease somewhat. One Tiger II has certainly the same effect as 25 to 30 Shermans (as the troops—for instance General Manteuffel at Aachen a short time ago—have confirmed). He thinks he can join battle with 10 Tiger II against 200 Shermans because the penetration of the Sherman gun is not sufficient and that he can open the engagement with the Sherman at a much longer range, the penetration of his gun being then sufficient to knock out the Sherman. You will see from this example that it would be of no use to produce, let us say, the same number or double the number of Panzer IV as of the Tiger II, for the former stands in the ratio of 1 to 1 only to the Sherman. The Panzer IV has its advantages and disadvantages as compared with the Sherman, we have therefore to enter the field with an equal number to have corresponding successes. You see by this example that the Tiger II with three times the weight of the Panzer IV has about 20 times the fighting value. This means that, if we replace the Tiger II by the Panzer IV, we put into action 7 times the fighting value. For this reason we must always make allowance for these technical changes in design.

You, as the pioneers of our technical ideas, must, however, not forget outside that you are not engineers only, but must have a techno-political point of view (*Techno-Politische Auffassung*), i.e. you must apply your technical ability to the political sphere. You must prepare the soil for these technical doctrines, for these facts resulting from practical experience, that technical progress must always be for us the only guide in dealing with the enemy and that many difficulties must be put up with.

The figures reached in November are again a wonderful result for us, and one can in no way compare them with the results which we could justifiably have expected as the result of our efforts at the Central Office. We ourselves are surprised at the November results, just as we were in the previous months. And even the Fuehrer, when these figures were phoned through to him, emphasized his astonishment in view of the situation which we made clear to him in an objective manner, perhaps rather more objectively than was really necessary. I will to-day for the first time announce the figures really reached by us. I will do it for the reason that

percentages figures are no longer any great help to you. After speaking too often of percentages it is necessary to divulge the real figures to you and these will confirm to you, too, our opinion that the figures are really grand. I ask for your discretion. Nobody will, as I must point out, believe our figures and now you are going to hear them you will say: where on earth does all this material go to? I have to reply: We had one withdrawal after another and each withdrawal has cost us nearly the whole equipment of the army group concerned. When I, after the withdrawal in those critical days, when our 'Marne-miracle' happened and the enemy did not advance further, when I in those days went to the front, I was informed by the troops of the Army's stocks of weapons and equipment. That was an alarming picture. One army had no more than 3 to 4 tanks, 80,000 machine guns, 30, 40 or 50 LFH (light field howitzers). That was all that was available. 4 weeks later, when I visited the same army again, the equipment of these armies had again reached 30% to 40% of their normal strength. You must not, however, believe that this completion came from stores, prepared in anticipation of these events, in fact it was the current production which came to the front. If your current production had not been so high, it would not have been possible, since the catastrophe which happened to the army groups Centre and North in South Russia last winter and to the army groups in France, for them to build new resistance lines again and again.

I have once had, worked out weapon by weapon, how many divisions could be re-established by the production of one year, in order to compare our total production of armaments with the number of men in the army, which is of course limited by the total population figure. This calculation has shown that we are able to re-equip by our armaments production 3.6 million soldiers, i.e. in practice we are able to re-equip the total regular field army in one year. Unfortunately we have actually had to do this in the past few years. Since, however, there is no longer any possibility of making further great withdrawals, it can be supposed that future losses will not be on the same scale. The losses in such battles as that of Aachen are insignificant as compared with the previous losses. They are slight for us and can be made good with a fraction of about 10% only of the production, i.e. if we continue to produce as before it would be a very easy matter (that is not exaggerated) to equip fully all front line forces with about 80% to 90% of their required strength in 4 to 5 months, not including new formations. That is in itself a fact which illustrates the results we have achieved in the armaments industry. The argument, made again and again, that the figures given by Speer and his people must be wrong, can best be refuted by pointing out that in every case the acceptance of weapons by a branch of the armed forces is based on the examination of the weapon, i.e. the declaration of its suitability for combat use will not be given by us (though we too are an authority of the Reich) but by the branch of the forces itself. For these reasons inspection by the army as well as by the air force and the navy has remained independent and we have by this arrangement a partner who accepts the weapons and declares independently that the weapon is suitable for combat use. Only when the partner has taken over the weapons are they counted as

delivered. The figures, therefore, are figures for weapons actually taken over by the armed forces. At the end of the month sometimes 40 or 50 Flak or tanks are available. They are, however, not included in the figures and not acknowledged, if for any reason there is no possibility of obtaining a train for transporting these guns somewhere for testing. It goes so far that at present we have 700 completely finished aircraft which could not make their inspection flight solely because of bad weather. They could not be included in our figures, but have so far only been counted as accepted by industry. The figures are, therefore, indeed real figures, not propaganda figures; we need no propaganda figures because our figures are the best propaganda for us. After these long preparations I will tell you the figures, but ask you not to write them down.¹

These figures give a survey of the American and of our own production. The Americans are attacking in the West at present with a superiority of 10 : 1. The ratio of artillery fire on the fronts which are relatively quiet and without special actions is about 1 : 5 according to the reports of the divisions, i.e. they fire 5 times the quantities we are able to fire. When the Americans attack with 500 tanks we can oppose them with 50 tanks only. When they appear somewhere with 1,000 fighters we have only 100, whilst we actually reckon with a ratio of at most 1 : 2, adding England and the Russian front and subtracting on the enemy side his commitments against Japan.

America and England, [un]like ourselves, had no battles to fight from 1941 onward and could use their production of 1941, 42 and 43 and half that of 1944 almost exclusively to bring the combined totals into undivided use. We too had in 1939, as you know, a ridiculously low production compared with the present figures and were nevertheless able to carry out two campaigns in the years 1939 and 1940, because we had the output of the years 1937/38 which the enemy lacked at that time. If the enemy was compelled in 1939/40 to throw into the front its month-by-month output of a fully stepped-up armament production, while we were able to bring to bear the full weight of 2 or 3 years' production, to-day the position is reversed. He faces us with the weight of 2 to 3 years' rearmament.

One thing is clear: in a technical war carried out with technical weapons, the wear and tear of these weapons is enormous. You know that an aircraft engine must be replaced after 100 to 150 flying hours. You know, as everybody knows who has to deal with tanks, that the life of a tank generally does not exceed, for various reasons, $\frac{1}{2}$ to $\frac{3}{4}$ of a year.

So far as powder and explosives are concerned, the strain on the enemy also exceeds by far his monthly capacity as we wish to examine still more exactly. In May he dropped on the Reich alone more than 89,000 to. of bombs with an explosives production of roughly 45,000 to 50,000 to. He has, however, dropped bombs on other fronts too. He must transport all his supplies, he must continuously supplement his ammunition stocks which are on the same level as ours and, therefore, amount to at least 35,000 to., he must drop bombs on Japan and bring up his explosives, he

¹ *Authors' note:* Since the figures were not written down, the paragraph has been omitted.

must put mines at the disposal of the navy. We believe that the Americans are at present using 2 to 2½ times as much as they produce each month. We cannot anticipate how long their reserves will last and when they will reach the state in which we unfortunately, have already been for 2 years. It is, however, certain that one day the moment will come when the Americans can no longer live on their 3 years' reserves, when these reserves must be exhausted and when they will be compelled to base their tactical plans on their monthly production. You see by this that doubtless they too are worried about this problem. At present the enemy (Eisenhower, Churchill, Roosevelt) is making pessimistic statements, not so much because he is really pessimistic but in order to step up his armaments production. He must do this, because he faces the same difficulties as we did after the campaign in France, when our whole industry was worrying about the coming postwar production and when everybody believed in a speedy end of the war and the start of a boom. The enemy is in a similar condition to-day and the supply difficulties of the Americans will be considerable in a quarter or half a year. It is, therefore, necessary for us to force them to commit as much of their material as possible for as long as we can.

The quality of our troops would make this possible but only on the condition, and this is the main point, that we obtain a new air force which will enable us to fight the final battle. This condition will be fulfilled in the not too distant future, as you have seen, based on the figures as they stand. In aviation, he who is still engaged in development and builds fighters with a fraction of expenditure of material, men and fuel as compared with the bombers has an advantage once he has turned out more than a certain number. The most important problem, therefore, is to increase the production of fighters again and again and especially that of the planes you have seen to-day, the superfast planes with a speed of 850 to 900 Km. per hour.

Furthermore, it is our duty to increase the output of Flak because in danger zones like the Ruhr the Flak can give us some sort of protection at least for the most important centres and factories.

Besides the things you have seen, we have some others in preparation which we believe will go into action as early as next spring. We believe that by then we will be able to produce the self-steering anti-aircraft rocket (Flakrakete, die sich selbst auf das Flugzeug steuert) still in development, and go over to mass production of A4, the present V2.

If you hear of this development anywhere and are in the position to help somehow, please do it as it is most important for us to obtain a weapon which can be used against the enemy through cloud cover in bad weather. The enemy is enabled by his radio technical equipment to fly even in bad weather. The development, therefore, of air rockets (Flugraketen) reaching a height of 11 to 12,000 m. is a most important problem which must have special priority.

I have given you a survey of the achievements of our armaments industry in November and you will admit that these achievements are extraordinary. The figures of the next few months will reach the same level, if the Ruhr remains, at least to some extent, intact. We have throttled the

supply of things which are not directly connected with armament production, the so-called indirect needs of the war industry, though we know that this throttling cannot be carried out in the long run but only for $1\frac{1}{2}$ years without a far-reaching effect for the whole war industry. With this throttling of the indirect requirements we are able, if we can maintain the Ruhr at its previous production, to increase the armament programme. In the next few months we cannot expect to have the full Ruhr production at our disposal, nevertheless we must meet this situation by carrying out our production on the previous level by means of our supplementary programme.

I ask you to be optimistic for the future too just as we are always optimistic in spite of all difficulties. None of us would have believed that we could reach this production level at all, considering the difficulties showered on us in October and November and even in September. Everybody would have thought it absolutely foolish, if we had made such demands under present conditions. Nevertheless they have been fulfilled because we always started with immense optimism. That must go on. Because without optimism, by cold calculation only, we would probably have reached to-day only half the figures we have in fact reached. Therefore, we must always in this difficult period be conscious, based on these experiences, that much more can be achieved with German toughness, than anybody could ever do through sober reflection alone.

APPENDIX 37

(i)

*Interrogation of Albert Speer, former Reich Minister
of Armaments and War Production.*

(6th Session—15:00–17:00 hours, 30th May 1945)

1. Speer was asked about his and the German official view taken in 1942 of Germany's long-term prospects of keeping up with Allied war production after the failure of the Russian winter offensive and the entry of the U.S. into the War. Speer began by stating that very soon after these events Hitler had issued a strict order banning any discussion of the above topic, official or private. The Wehrwirtschaftsamt, then in charge of economic intelligence, had been instructed not to give out any information on Allied war production, not even to government agencies with official interest in this question.

Unofficial discussions, of course, took place and to Speer's knowledge it was universally admitted that Germany would be unable to avoid a steady deterioration in her relative armaments potential. Speer himself, however, took the view that Germany's quantitative inferiority could have been offset by qualitative factors. In certain fields of armaments Germany had a lead in quality at the time, and he thought that German industry was more versatile than American, and would find it easier to keep changing over to better and better weapons.

Asked to specify his views on the relative qualitative position at the time for the principal categories of weapons, Speer admitted that in 1942 Germany was clearly inferior in tanks, as the PzKpfwg III and IV were no match for the Soviet KV-1 and T-34. The immediate employment of heavy tanks by the Soviets came as a great surprise to Speer, and he declared that the T-34 had been completely unknown to German intelligence until it was encountered in battle. As regards A/Tk artillery, Germany was similarly inferior, as it had only the 5 cm. Pak, which was not heavy enough against the Russian tanks. An immediate effort was made to rush through the first batch of 1,000 7.5 cm. Pak, and as an emergency measure 700 captured French 7.5 cm. barrels were converted to A/Tk use and rushed to the front. It is still inexplicable to Speer how the German army at that time was able to withstand the Soviet tanks.

The subsequent development of the Tiger and later Panther has already been described in an earlier interrogation. These types, coupled with progressively longer and heavier Tk guns, later established qualitative superiority over the Russian tanks. Simultaneously a race went on in A/Tk guns, and Speer considers that the last Krupp 8.8 cm. A/Tk piece was the best in the field, although it was too heavy and immobile.

In ammunition, even after the elimination of tungsten carbide cores

(see below), the quality was approximately equal to the Allies', and German aircraft ammunition was better.

In fighter aircraft, Germany had a superior type in the FW 190. Speer's chief efforts later were directed towards getting the Generalstab der Luftwaffe and Goering to commit themselves to a definite defensive policy. Speer was backed by Galland and Milch. The opponents, and also Hitler, however, insisted on retaliation against England. He considered that even losses of one fighter for one enemy bomber were fully justifiable, in view of the weight and cost ratio of 1 : 9 in production, and the total loss of bomber crews. Even the Allied production potential would not have been able to keep up with a 1 : 1 loss ratio. Having talked to German pilots who had flown in the Battle of Britain, Speer also considered that no Air Force's morale could in the long run stand up to losses of more than 10-15% per operation. When the daylight attacks were intensified in summer 1944, Speer still remained optimistic. He attached great importance to Galland's plans of concentrated fighter defense forces of 2,000 or 3,000 planes each. Although he took issue with the Führer in the controversy on the employment of jet planes (see earlier report), he did not expect very much from the jets, as from his experience in other fields he knew the difficulties usually encountered when entirely new designs were first tried in operations.

2. On the quantitative inferiority, and its inevitability, Speer never had any illusions. He took the relative steel capacity as principal measure of the relative potentials. The recuperative powers of Russian industry, after the loss of the Western territories, came as a surprise to Speer and everybody in Germany. He still fails to understand the speed of Russian industrial evacuation and re-location. On tours of inspection in Rostov and elsewhere he found that heaviest machinery had been moved in a time which was amazing to him and which was never approached in later German attempts at evacuation.

3. On the subject of German losses of equipment at the fronts, Speer observed that German armaments production (as explained in his *Rechen-schaftsbericht*)¹ in 1944 was equivalent to the complete equipment of 250 Inf Div and 40 Pz Div, while Germany had only the equivalent of 150 full divisions (12,000 men each) in the field. He attributes the steady deterioration in the weapons strength which nevertheless ensued largely to the losses of equipment and ammunition during the continuous German retreats, but also to a considerable extent to faulty distribution policy of the OKH. Fromm, as *Chef der Heeresrüstung und Befehlshaber des Ersatzheeres*, was in charge of supply as well as the formation of new units. The latter received 90% of all new equipment produced, while only 10% went to the front as replacements. In consequence, 'green' units newly formed were fully equipped with brand new equipment, while experienced troops at the front had to go short. During a visit to the *Heeresgruppe Kesselring*, Speer found that it was 1,500 machine guns below strength, while monthly production at the time was running at 30,000.

¹ *Authors' note:* Stocktaking report.

Equipment losses at the front were further increased by a chronic shortage of traction power, due to the insufficient production of MT.

In Spring of 1944, the Generalquartiermeister Wagner prepared an estimate of the replacements of equipment which he would require to meet losses anticipated in further withdrawals on the E. Front, when it was approaching Warsaw. His estimates were several times higher than what Speer would have been able to produce. Wagner's estimate, according to Speer, was prepared for his personal re-insurance against future blame, and Speer retorted to Wagner that there would not be enough room for him to retreat anyway to incur his estimated losses.

4. Speer estimated in September 1944 (as laid down in a memorandum in his records which is available) that the loss of peripheral European territories, especially the Balkans, would not immediately paralyse the German economy. The most serious effects were foreseen (by Backe) in respect of food supplies; the minimum required by a hard-working population would not have been insured in the long run. Industrially, according to Speer's estimates, Germany could have held out until early 1946, though not much longer—all this assuming absence of air attacks.

It is important to note, for subsequent evaluation of Speer's memorandum, that the stock figures may be partly misleading. Thus, the 450,000 tons stock of copper, according to Speer, includes 'copper registered but not yet mobilized', e.g. church bells. He insisted, however, that copper stocks were satisfactory, and in the final phase of the war copper was even used in the place of aluminium, as it had been estimated that bauxite stocks would otherwise give out earlier than copper.

5. Asked whether the scarcity of steel-alloy metals had resulted in a qualitative deterioration of military equipment or in manufacturing difficulties, Speer replied that despite reductions in the alloy content of armor and gun steels, their quality had been maintained on the 1939 level. It was realized that in some cases the quality would have been improved by a higher alloy content, but the Army never attempted to insist on specifications for such steels. If it had done so, Speer would not have been able to meet their requirements. Asked whether the short life of German aero-engines was due to low alloy content, he stated that he had never been aware of this. If the Luftwaffe had asked him to increase alloy allocations for the specific purpose of extending the life of aero-engines, he would have gladly made them available, as such a policy would in the long run have resulted in an economy of alloys. It was customary to manufacture the experimental O-Series with materials containing more alloys than were later used in serial production in order to eliminate low alloy content as a possible source of errors in tests. The same was done with turbine blades for jet engines.

Supplies of tungsten-carbide tips for machine tools could only be maintained at the necessary minimum by stopping production of carbide-core A/Tk ammunition. Speer was uncertain of the time of this decision; he thought it was taken in May or June 1944. The Germans considered that carbide cores considerably improved the performance of ammunition of small calibers up to 5 cm. 5 cm. Pak carbide-core ammunition was the only type which was allowed to remain in production as it had been found

that such shells were just able to penetrate the armor of heavy Russian tanks. Carbide cores were also permitted for 3·7 cm. AP shot for aircraft cannon, used mostly in Russia. In addition to stopping production, the Germans blocked and called in all stocks of other types of carbide-core ammunition, which produced several tons of tungsten for use in tool tips. The use of carbide-core ammunition for heavy calibers was apparently considered much less essential. After this measure, tungsten supplies for tool tips were secured, but continuous difficulties were experienced owing to the scarcity of chrome. Speer thought that there was a considerable demand for both tungsten and chrome on behalf of the chemical industry for use in catalysts. They had no difficulties with platinum, which according to Speer was used, inter alia, in catalysts for R-Stoff (rocket fuel) manufacture.

6. Asked about the effects of the US air attacks on the German ball-bearing industry, Speer expressed the view that they would have knocked out this industry with very serious general effects, if the first attack had been followed up and repeated at shorter intervals or if the attack had been carried out earlier. Seventy to 80%¹ of the German ball-bearing industry was concentrated at Schweinfurt at the time of the first attack, but a dispersal scheme had been initiated before this attack, which ultimately was to have reduced the share of Schweinfurt to 10%, largely by dispersal of manufacture to approximately eight small plants in the Schweinfurt area. This scheme had not advanced very far when Schweinfurt was first attacked, as the Germans were always slow in pre-attack dispersal, being reluctant to accept the production losses involved in re-location (the average production loss in an evacuation project was put at eight weeks). But the existence of the scheme was a great help on this occasion.

7. The attack on the tank engine plants caused considerable difficulties. It had no effect on the rate of tank output, but the spare engine situation remained extremely difficult after the attacks, especially for heavy tanks. At the time of the attacks, Maybach at Friedrichshafen and Nordbau, Berlin were the only large scale tank-engine manufacturers. M.A.N. at Nuernberg was to take up tank engine manufacture, but had as yet only started on a very small scale. Maybach made the heavy HL230 engine for Tiger and Panther, and Nordbau the lighter HL 120 type. Speer suggested that the effects would have been much more serious if both plants had been attacked at the same time. Repairs at Maybach were undertaken with exceptional speed as a special Fuehreraktion. Engineer troops and other Wehrmacht units were mobilized for this job, and production was resumed very soon. Later on, one of the principal dispersal plants for tank engines was to have been installed in an underground site at Leitmeritz.

8. The attack on oil plants on and after May 12, 1944, was the 'first heavy blow' struck against German industry. Here again, however, Speer suggested that the intervals between the attacks were too long. The speed of repairs, which probably had been underestimated by the Allies, had been made possible by Geilenberg's able direction and the exceptional

¹ *Authors' note:* This is an exaggerated figure. The amount was about 52%.

scale on which labor was mobilized for oil plant repairs. Two hundred to three hundred thousand repair workers were ultimately employed. In the usual interval of 6 to 8 weeks, between attacks, Geilenberg was generally able to get output equivalent to 10/14 days' normal production.

The problem of placing synthetic oil plants completely underground was solved in stages. In the first plans, the stalls were to be placed in 'wells' in a vertical position. Later on, the entire plants were planned below ground, with the stalls in a horizontal position in underground galleries. Three such plants were planned (code name Schwalben).

9. The raids on Henschel produced the most serious effects in the offensive against tank assembly plants. As a result of these raids, output of Tigers fell from 100-150 monthly to about 50 to 60. Speer claimed that the total tank production was numerically maintained to the end, through expansion of output in the Protectorate, but he admitted that only the light 38 (t) tank was manufactured there, so that the maintenance of production was essentially numerical and not qualitative.

10. The attack on the Eder Dam had no effects except some slight flood damage. The Moehne Dam attack would have had serious consequences only if the Sorpe Dam and two other small dams had been broken at the same time. The chief factor which prevented serious reduction in industrial water supplies to the Ruhr was the existence of a pumping system from the Rhine up the Ruhr valley designed to supply the whole District as far upstream as Essen. The pumping plants were silted up by the flood-wave from the Moehne, but were quickly restored. Repairs to the Moehne Dam were then rushed through in time for catching the autumn rains. Restrictions on water consumptions were imposed on the Ruhr industry during the summer, but otherwise the attacks had no effect except that of giving the Germans 'a big scare'. The Ruhrstab was set up in order to enforce the water rationing scheme.

11. Speer considers that the gradual build-up of the Allied night air offensive contributed to what he describes as its initial failure. The steady increase in the weight of attacks served as a 'training' for the Germans, both as regards defense methods, A.R.P. and repair organization. The civilian population also got hardened to the raids in a gradual way. 'Shock effects' were produced by the first 1,000-bomber raid on Cologne, and especially by the series of attacks on Hamburg in summer 1943. After the latter attacks, Speer had voiced the view that if another six big German cities were similarly devastated, he would not be able to maintain armaments production. He changed his view, however, when he saw the speed with which Hamburg industry recovered from the attacks, which came as a surprise to him.

The purpose of the night attacks directed exclusively against city centers had been 'incomprehensible' to Speer; their effects on industry were very slight. Later on, when attacks were sometimes directed on industrial areas, damage to plants tended to become more widespread, but Speer considers that area bombing alone would never have been a serious threat. He particularly emphasizes the factor of civilian morale, and especially labor morale, which was excellent throughout, and resulted in rapid resumption of work after attacks. He admits, however, that after a series of attacks

like that on Berlin in fall, 1943, fatigue effects made their appearance and labor discipline began to flag. The dislocation of civil services after such attacks was also a serious factor.

The only type of night attacks which, according to Speer, had serious direct effects on industry were those undertaken with special aiming devices against selected targets. Speer had been much impressed by the first Mosquito attacks of this type against the Goldenberg and Bochumer Verein plants. The Germans at first suspected that some new guided bombs were used in these attacks, but then found that the U/X bombs¹ which they examined were of standard pattern. He was much impressed by the bomb plot of one of the RAF attacks on Krupp, where the accuracy was such that a high proportion of the bomb hits were on the centers of the factory buildings. (It was not clear to which attack he was referring.)

12. Speer prefaced his reply to a question on the efficiency of Allied transportation bombing with a general statement of his views on bombing strategy directed against the economic system. He considers that selection of end product industries as target systems is always wrong. The attack should be directed either against basic raw materials such as steel or basic chemicals, as 'it is much easier to dam up the river near the source than at the delta'. Speer agreed, however, that such an attack would have the desired effect only if it was sufficiently comprehensive to destroy all capacity in the selected target system, as a partial stoppage of production could be cushioned in the end product phases by manipulation of priorities. Speer includes transportation among the basic target systems susceptible to such an attack, while admitting that an offensive on a sufficient scale to paralyze transport requires very great effort.

The attacks on the Ruhr transportation system caused the Germans the greatest difficulties. A memorandum on this subject which he wrote in 1944, and which is said to be among his files, sums up his views on this subject.² The cutting of the Dortmund-Ems Canal had most serious effects, especially as railroad carloadings had already declined heavily owing to previous bombing, and speeded up the collapse of German transportation. Once again Speer noted that the intervals between the canal attacks were too long. Even if they had the canal open for only two or three days before it was cut again they were able to rush through the coal barges which had been accumulated in the Ruhr in anticipation of the reopening of traffic.

13. Speer's discourse on general bombing strategy led to a discussion of the industrial pipeline concept, with which he was broadly familiar from his industrial planning activities. He gave the following rough estimates which, he stressed, were only very approximate as he had never studied the subject intensively. The period, in each case, is from crude steel to the finished product:

Ball-bearings	3-4 months
Motor (tank and aero)	6 months
Tanks	4-5 months

¹ *Authors' note:* i.e. unexploded bombs.

² *Authors' note:* see above, App. 35.

Speer emphasized, however, that the additional pipeline from factory to front was extremely long in Germany owing to the clumsy supply system of the Army and Luftwaffe. Guns, for example, were accepted by the Heereswaffenamt Abnahme at the factory without sighting equipment, and were then sent to an Ordnance Depot, where the sights were installed. Only in late 1944 Speer persuaded the HWAA to reverse this system, and to send the optical equipment to the gun, instead of vice versa. Aircraft, after leaving the factory, went into a Luftwaffe depot for a process known as 'Umrüstung' in which minor modifications were carried out. In late 1944 Speer obtained through the Generalquartiermeister the serial numbers of a sample of miscellaneous equipment which had just reached the front, and had them checked with the factories to obtain the dates of completion. The pipeline to the front was found to be two months on the average, which to Speer seemed excessively long. Towards the end of the war, he insisted on various measures to speed up delivery to units. To avoid the delays involved in taking guns to testing ranges, the test firing was sometimes done from the factory. Thus, 17 cm field guns made by Hanomag were test-fired straight from the plant across the city of Hannover, whose inhabitants were used to air raids and did not mind. Similarly, flak guns were often test-fired in cities. Speer's ideal was to introduce what he describes as the Russian system of direct delivery from factory to front, and he also favored an organization of Army supply based on the feeding of each Army Group from the nearest industrial area. However, the OKH, with its policy of first concentrating all production in Heereszeugamter and Munitionsanstalten and then disseminating it to units, would not accept his suggestions until shortly before the end. Speer encouraged direct dealings between unit commanders and factories in obtaining equipment and spare parts, although the Army bureaucracy frowned upon such procedure.

14. Questioned on the organization of spare parts production and supply, Speer referred to Direktor Oestreich, who was in charge of the matter and organized it very efficiently. Speer's own knowledge on this subject was sketchy. He thought that in the early days a certain quota of spare parts was produced with the complete item. Later on, under Oestreich, a certain proportion of capacity in each industry was set aside for spares manufacture, and production was based on statements of requirements received from the Army. He thought on the whole not enough spare parts were made in relation to complete items.

15. Speer said that it would be extremely difficult to obtain precise figures on the labor force engaged in bomb damage repair at different times, because there was usually a good deal of improvisation in the handling of repairs, and nobody had time to bother about collecting statistics. He suggested that up to mid-1944 the total thus employed might have averaged 1-1.5 millions, but stressed that this was merely a guess. For the same reason, Speer never attached any weight to the Fliegerschaedenstatistik on man-hour losses through bombing put out by the Planungsamt. He thought it was unreliable, and based on a lot of guesswork. He himself had issued orders that plants should not be bothered

with statistical inquiries and questionnaires after they had been attacked, so that they could concentrate on restoring production.

16. Speer confirmed that in some cases it was necessary to suspend repair work in one place in order to divert the labor to work on more recent and more critical incidents. Thus, after the first attack on Schweinfurt, repairs to the Siemens transformer plant at Nuremberg had to be interrupted, although they were regarded as very important.

(ii)

Interrogation of Albert Speer, former Reich Minister of Armaments and War Production. (18th July 1945)

THE EFFECTS OF THE ALLIED BOMBING OF GERMANY

1. The following information on the effects of the Allied bombing of the Reich was obtained from Albert Speer, the former Reich Minister for Armaments and War Production.

2. The information was obtained in reply to specific briefing which was answered in a signed statement by Speer; a full translation of this document is appended in the form of question and answer.¹ It must be noted that when Speer refers to the German chemical industry he includes in this term the synthetic oil industry.

3. The interrogation was carried out under the auspices of C.I.O.S.,² to whose good offices and assistance all due acknowledgement is made.

S/J. P. C. TOOTH S/Ldr
for S. D. FELKIN Group Captain

INTERROGATION OF REICHSMINISTER ALBERT SPEER

1. Q. At what stage of the war did strategic bombing begin to cause the German High Command and Government real concern, and why?

A. The first heavy attack on Hamburg in August 1943 made an extraordinary impression. We were of the opinion that a rapid repetition of this type of attack upon another six German towns would inevitably cripple the will to sustain armaments manufacture and war production. It was I who first verbally reported to the Fuehrer at that time that a continuation of these attacks might bring about a rapid end to the war. At first, however, the raids were not repeated with the same weight and in the meantime it became possible for the civilian population to adapt themselves to these air attacks both from the point of view of morale and the experience gained, whilst at the same time the armaments industry was able to gather useful experience.

¹ *Authors' note:* The original German document has not been available to us.

² Combined Intelligence Objectives Sub-Committee.

The raids on the ball-bearings industry at Schweinfurt in July 1943 evoked a renewed crisis, the full import of which was likewise made known to the Fuehrer in all its gravity. Here again the delay in development of repetitions of the attack gave us the necessary time to take defensive precautions.

The raids on the aircraft industry and tank engine factories early in 1944 caused a serious renewal of anxiety and doubt, although as it became evident in this case also that our industry was more elastic than had at first been assumed, our anxieties in this connection lessened.

In May and June 1944 the concentrated day and night attacks on the Ruhr transport and communications system first began to cause most serious anxieties about future developments, since supplies to industry in the rest of the Reich of the numerous products of the Ruhr, ranging from coal to single items, were bottled up in the Ruhr owing to transport difficulties and could no longer be conveyed to the intended recipients. That these effects did not immediately manifest themselves was due only to the fact that industry throughout the Reich was in possession of considerable stocks of goods, and that in the case of coal it was possible to make a priority delivery for armaments and war production in the summer months at the expense of household deliveries and of the provision of stocks for the winter. A memorandum was delivered by me to the Fuehrer in June 1944 on the subject of the Ruhr and its problems.

The planned assaults on the chemical industry which began on 12th May 1944 caused the first serious shortages of indispensable basic products and therefore the greatest anxiety for the future conduct of the war. Information on this subject is to be found in the numerous memoranda addressed to the Fuehrer in June 1944, in which the further prosecution of the technical side of the war (*eines technischen Krieges*) is repeatedly shown to be impossible. I had the impression that these attacks were to mark the beginning of the *long expected* and long feared series of *planned attacks upon industrial economy* and moreover upon a sphere which owing to its complicated structure was particularly difficult to restore and impossible to decentralise. In actual fact, this type of attack was the *most decisive in hastening* the end of the war.

The attacks on transport and communications *only* produced serious consequences as their intensity was increased. The communications system *proved itself however extremely resistant*, so that in spite of the attacks an emergency transport system for the needs of armament and war production could be maintained until the late autumn of 1944. In this connection, from autumn 1944 onwards the Reichsbahn on my instigation continuously submitted written reports to the Fuehrer regarding the serious anxieties which future developments must inevitably produce.

2. Q. What measures were taken to deal with the threat, and how effective did they prove? Did the German High Command consider they could stop strategic bombing by these measures?

A. Unfortunately no energetic measures were taken in regard to fighter

production. From the time of the attacks on Hamburg from August 1943 onwards, Milch, Galland and I combined to *press* for priority to be given to the construction of fighters and represented that their operational use within the Reich was more urgent than their deployment at the Front. Nevertheless, the High Command ordered bomber production to be continued as they were of the opinion that it was only by means of retaliatory attacks that the Allied assault on German towns could be halted. This accounts for the fact that even in 1945 the construction of four-engined bombers was ordered once again! Moreover, considerably more importance was attached to the Flak programme in the battle against the bombers. From time to time and particularly from autumn 1944 onwards, the Flak programme was given a higher priority than the fighter programme. The Fuehrer was frequently ordering that aircraft production should be reduced in order that more Flak guns could be built, but these orders were in fact incapable of realisation.

In addition to these active measures, after the attack on the ball bearings plants at Schweinfurt, the first steps were taken to transfer this industry to Lower Silesia and to disperse in various groups in Franconia. The dispersal of important plants following upon attacks upon vital points was undertaken. Furthermore, from early in 1944 onwards underground dispersal was envisaged to a planned extent of 3 million square metres (of which $1\frac{1}{2}$ million square metres had been actually executed by February 1945). (*Note: Other informants have suggested that this programme for the occupation of 3 million square metres of underground floor-space referred only to the aircraft industry.*)

I was not of the opinion that the effects of planned air operations against industrial targets could be avoided by measures of this nature. The choice of when to deliver attacks on industrial objectives and of sustaining these raids as consistently as might be required lay exclusively with the enemy bomber. One cannot meet air attack with the slogan 'Concrete versus Bombs'. The opponent in the air is able to choose his objectives and *in so doing he can plan to concentrate on any vital target such a weight of attack as hitherto has never been possible in the whole history of war. There was consequently no means of defence.*

In spite of all this, however, the Allied air attacks remained without decisive success until early 1944. This failure, which is reflected in the armaments output figures for 1943 and 1944, is to be attributed principally to the tenacious efforts of the German workers and factory managers and also to the haphazard and too scattered form of attack of the enemy *who until the attacks on the synthetic oil plants based his raids on no clearly recognisable economic planning.*

3. Q. What effect did the taking of these measures have upon production and allocation of manpower?

A. Up to the year 1944 neither the air attacks nor the defence measures taken to meet them disturbed armaments production for until that time it was still possible to utilise for armament production considerable

reserves drawn from the whole field of industry; in this connection the machine tool industry was in a position to make a valuable contribution.

The restoration of industry was, moreover, made possible by the contracts and extensions which were already in course of execution with the aim of increasing current output. The chemical industry in particular succeeded for a considerable time in satisfying its requirements of materials for rebuilding purposes by using materials earmarked for projected extensions of plant which had been abandoned.

Until the autumn of 1944, the diversion of manpower to A.R.P. construction work and the clearance of air-raid damage had a disturbing effect on production, for up to that time there was a shortage of manpower in industry. From the autumn of 1944 onwards the effects of air attack were so considerable that a rapidly increasing surplus of manpower became available. The total manpower engaged on work arising from air-raid damage can be estimated at between 1,000,000 and 1,500,000 persons.

The total damage suffered by the armament programmes as a result of air attack during the year 1943 was not considerable. With regard to the year 1944, on the other hand, it may be assumed that on the average there was a fall in production amounting to 30/40%, for had it not been for the air attacks the projected output programme would certainly have been achieved; the gap between the production programmes and the actual output attained corresponds to this percentage (see the Rechen-schaftsbericht for 1944).

4. Q. Did the effects of strategic bombing at any time cause any of the three branches of the German High Command to modify, postpone or abandon planned operations?

A. I am not aware that any material alteration had to be made in the timing of a planned operation, or that any operation was abandoned on account of air attack. The reason for this was not that the air raids had not caused material damage before such an operation began, but rather that our supreme command refused to see and to admit the consequences of such attacks.

As an example of this I can quote the beginning of the Ardennes offensive. The attack was ordered to begin although the units had only one or two fuel supply units (Versorgungssatze an Treibstoff); the entire supplies of bridge-building equipment still lay in the rear areas, whilst the rest of the supply organisation for the units was insufficient for the distant goal in view. Feldmarschall Model and Oberstgruppenfuehrer Dietrich called attention to this state of affairs but the time table for the attack was persisted in. *Without any doubt the lack of supplies was due to the transport difficulties caused by air attack.*

5. Q. Which forms of attack at various periods of the war were most effective in weakening the German war effort?

A. Only the mass attacks by day, because these were based upon economic considerations and inflicted heavy damage on precise targets.

Some 'Oboe' night attacks with Mosquitoes upon the Goldenberg power station and the August Thyssen Huette were disturbing on account of the precision with which they were carried out. The last night attack upon the Krupp works, which was carried out by a large number of four-engined bombers, caused surprise on account of the accuracy of the bomb pattern. We assumed that this attack was the first large-scale operation based on 'Oboe' or some other new navigational system.

The last series of night attacks on Poelitz, Bruex and Leuna were more effective in their results than the day attacks by reason of the fact that the superheavy bombs caused shattering damage to these plants. On the other hand, the previous night attacks on towns had no decisive effect upon armaments output.

6. Q. What was the relative importance of: (a) Attack on cities? (b) Attack on specific types of production? (c) Attack on communications? (d) Use of heavy bombers for the bombardment of front line positions? (e) Attack of naval installations and shipping including the effects of mining? (f) Attack of airfields and air parks?

A. From the point of view of armaments the relative importance of the various forms of attack was as follows:

- (a) Attacks on key points in the basic industries or supplies.
- (b) Attacks on transport and communications, but the effect of these was long delayed on account of the density of the transport network.
- (c) Attacks on front line positions, also because of the psychological effect upon the troops.
- (d) Attacks on final stages of manufacture in industry.
- (e) Attacks on towns.
- (f) Attacks on naval installations, shipping activity and airfields.

7. Q. Which of the above forms of attack were most difficult to counteract and for what reasons?

A. The attacks on the chemical industry were the most difficult to deal with, since chemical works form an extraordinarily complex organism. Before activity can be recommenced at a chemical factory, the entire plant must be restored in at least one phase of manufacture in order that the chemical process, which forms a self-contained unit, can pass through all its stages.

On the other hand, in the final stages of all other industrial manufacturing processes work can be recommenced shortly after an attack with the remaining undamaged machine tools, and in this way the factory concerned can take up production again in successive stages.

The highly rationalised automobile industry was also extraordinarily

difficult to restore owing to the multi-storey buildings in use in the trade, the destruction of which brought to a standstill whole sections of the continuous belt production system. These breakdowns could not be offset by emergency improvisations as in the case of other industries. In any event these attacks had exceptionally serious effects.

8. Q. Which, at various periods of the war, caused most concern; British or American heavy bomber attacks, day or night attacks; and why?

A. The American attacks, which followed a definite system of assault on industrial targets, *were by far the most dangerous. It was in fact these attacks which caused the breakdown of the German armaments industry.* The night attacks did not succeed in breaking the will to work of the civilian population. Two mistakes were made in this connection:

(1) The weight of the attack was *gradually stepped up* and consequently it was possible to improve defensive measures and the civilian population was able to accustom itself to the raids. In every case in which the R.A.F. *suddenly* increased the weight of its attacks, as for example the first attack on Cologne and Hamburg and the attacks on Dresden, the effect not only upon the population of the town attacked but upon the whole of the rest of the Reich was terrifying, even if only temporarily so.

(2) The powers of resistance of the German people were underestimated and no account was taken of the fatalistic frame of mind which a civil population finally acquires after numerous air raids. Other peoples, as perhaps the Italians, would have certainly collapsed under a similar series of night attacks and would have been unable to undertake further war production.

9. Q. To what extent did the diversion of forces and equipment to counter the strategic bomber offensive detract from the fighting power of the Wehrmacht?

A. The continuous bomber offensive kept a considerable amount of the German armament production inside Germany, thus withholding it from the Front.

Some 30% of the total output of guns in 1944 consisted of Flak guns, while some 20% of that year's output of the heavier calibres of ammunition (from 7 cm. upwards) consisted of A.A. shells.

Between 50% and 55% of the armaments production capacity of the electro-technical industry was engaged on the manufacture of radar and signals equipment for defence against bomber attacks.

33% of the optical industry was engaged on the production of aiming devices for A.A. guns and for other anti-aircraft equipment.

The fighting power of the Wehrmacht was considerably weakened by reason of the above, since the production of valuable Flak guns would have supplied us with excellent anti-tank weapons and the use of Flak ammunition at the Front, in addition to other types would have provided

a very substantial increase in stocks. Both were used only to a small extent in the final battles.

I cannot say to what extent the fighting capacity of the Luftwaffe was weakened by the use of fighters and night-fighters in Germany itself. One may assume, however, that the small number of fighters retained for Reich defence would have done little to improve the position if they had been used at the Front instead.

The shortage of signals equipment, such as W/T pack-sets, artillery ranging equipment, (sound-ranging devices) and, in fact, the whole supply situation of every type of signals equipment in the Army was particularly serious. This shortage, which made the task of command extraordinarily difficult, was caused by the employment of the electrical industry on priority defence measures against the bombing offensive.

In addition, for the same reason, the radar equipment industry was unable to keep up with the requirements of the Army and Navy, either from the point of view of development or production.

The position was made even more grave by the fact that 50% of the valves produced for G.A.F. purposes were diverted for home defence.

10. **Q.** Do you believe strategic bombing alone could have brought about the surrender of Germany? What scale and form of attack would have been required to achieve this?

A. The answer to the first part of the question is *yes*. *The attacks on the chemical industry would have sufficed, without the impact of purely military events, to render Germany defenceless.* Further targets of the same kind were to be found in the ball bearings industry and in power stations.

11. **Q.** What effect did the bombing of the Homeland have upon the morale of the three fighting forces?

A. The morale of the fighting troops at the Front was considerably influenced by the bombing of the Homeland. In this connection the attacks on the towns undoubtedly had some effect. The stories recounted by soldiers returning from leave in a town which had been destroyed made a big impression on the front line troops. Such stories became very numerous after soldiers were granted the right to home leave following the total destruction of their dwelling. Owing to the poor channels of communication, the troops were very disturbed regarding the fate of their relatives whenever they learned from the Wehrmacht communiqué that their home town had been bombed.

12. **Q.** What effect did strategic bombing have upon the willingness and ability of the civilian population to sustain the war effort? Was German morale more affected by the destruction of cities or by knowledge of the damage caused to essential industries?

A. We drew distinction between morale and conduct. *The morale following attacks upon towns was bad, the conduct of the civil population on the other hand was admirable.* In the armament and war production industries the conduct of the workers could be measured in terms of output which right up to the end of the war did not diminish despite all the raids, as production figures prove. Moreover, the will to rebuild the factories remained unimpaired right up to the end. Neither of these results could be achieved by means of compulsion but only by virtue of the voluntary response of the German workers.

OIL

13. Q. (a) At what stage did the attack of the oil industry affect fuel supplies to the three branches of the armed forces?

(b) On what consumers, including industry and transportation did the cuts first fall, and with what effect on subsequent fighting efficiency?

(c) To what extent was the maintenance of the attack of oil production right up to the end of the war justified?

How far did it succeed in nullifying plans to retrieve the position?

(d) For how long was it possible to maintain minimum essential production. What was the policy observed in the use of reserves?

(e) How far did the attack of oil storage installations increase the difficulties of the fuel situation?

A. (a) The shortage of liquid fuel first made itself felt in the aviation categories. The stocks of Roumanian natural oil in Germany enabled the manufacture of both motor spirit and diesel fuels to be continued for several months further.

In considering this question account must be taken of the O.K.W. reserve and at the same time of the reduction in the quantities in circulation.

In the Luftwaffe the shortage of liquid fuel became insupportable as from September 1944 onwards, since as from that date the allocation was cut down to 30,000 tons a month, whereas the monthly requirements amounted to between 160,000 and 180,000 tons. So far as the Army was concerned, the shortage of liquid fuel, which in this case was also due to supply difficulties, first became catastrophic at the time of the winter offensive of 16th December 1944 and this was substantially responsible for the rapid collapse of the German defensive front against the Russian break-out from the Baranovo bridgehead. There were approximately 1,500 tanks ready for action but these had only one or two fuel supply units (*Versorgungsaetze*) and were consequently immobilised.

(b) An unwelcome factor was the falling off in this output of producer gas (*Treibgas*) as a by-product of hydrogenation. This production sank to about 10% of the previous level(?) (more exact information will be found in one of the memoranda on the synthetic oil plants). On the other hand, the reduction in the production of motor spirit and diesel fuel for industrial purposes remained within tolerable limits, since up to the end

of the war the total requirements could be covered, on an emergency basis, by an allocation of 60,000 tons per month of each type.

The rationing of fuel did not produce serious losses of output in industry; from October 1944 onwards production sank in any case owing to difficulties in rail transport, and consequently the demands on motor transport doubtless diminished also.

(c) It was essential to continue the attacks on synthetic oil plants up to the end of the war. At first it was possible to start a plant up again within six or eight weeks after an attack, thanks to our repair measures. Several attacks on the same plant considerably weakened its structure (gas and water mains) and consequently towards the end of the war an equal weight of attack lengthened the period which was required to restore production. Owing to their greater effectiveness, night attacks caused considerably more damage than day raids. Nevertheless, repair measures were executed at most of the synthetic plants until the end of the war, although towards the end the bombers succeeded in timing their attacks either shortly before or shortly after the resumption of production so that it was no longer possible to attain any output worthy of the name.

Moreover, as a consequence of the latest attacks it was impossible to restore the production of aviation spirit, as the chemical plant required for the conversion of normal fuel to aircraft fuel (DHD plant) could not be repaired in time for the resumption of manufacture. In consequence, even at the time when the synthetic plants were in production, only motor spirit was manufactured.

(d) It proved possible to maintain a minimum production of motor spirit and diesel oil right up to the end of the war because the supply of crude, including that from the Hungarian oil fields was sufficient to produce 60,000 tons of each type of fuel per month.

On the other hand, from June onwards aviation spirit was produced in such small quantities that it was not possible to meet the demands of the Luftwaffe.

The existence of considerable stocks, together with a diminution of the quantities of fuel in circulation, which was partly due to the shrinking of the area to be supplied, enabled the minimum emergency requirements of the Luftwaffe to be met up until September or October 1944.

(e) Storage capacity at the synthetic oil plants and refineries became inadequate owing to the loss of tankage facilities so that when transport was disorganised production had to be reduced owing to the impossibility of disposing of the normal output.

For this reason the production of natural crude at Zistersdorf was stepped down at Zistersdorf in February/March 1945, and similar steps were taken at the same time regarding Hungarian crude.

Reduction of production was also doubtless attributable to the shortage of tank wagons arising from the extended turn-round times on the railways, though this was naturally due to transport conditions rather than to attacks on storage installations.

COMMUNICATIONS

14. Q. (a) When did the German High Command first feel concern at the effects of air attack on communications?

(b) When and where did these attacks begin seriously to affect:

(1) Central and regional administration?

(2) War industry?

(3) Military supply traffic?

(c) Which form of damage to the communication system gave most trouble and was most difficult to overcome?

(d) To what extent did the attacks on oil aggravate the effects of the attacks on communications?

(e) What was the economic and military effect of the repeated breaching of the Dortmund-Ems and Mittelland canal system?

(f) How far, and for what reasons, did the attack of rail communications in France and Belgium contribute to the success of the Allies in the Battle of France?

(g) How far, and in what way, did the attack of communications contribute to the defeat of the Ardennes offensive?

(h) At what point, and for what reasons, did the attack of communications begin seriously to affect industrial production in the Ruhr. When, and to what extent did this react upon industrial production in the rest of Germany?

A. (a) As regards industrial production, concern was first felt following attacks on communications in the Ruhr in May 1944; this threat grew from month to month and gave rise to a most serious crisis from the autumn of 1944 onwards and to final catastrophe from January 1945 onwards.

(b) (1) From the autumn of 1944 onwards it was impossible to maintain communications between central and regional authorities, owing to the breakdown of the postal services. An attempt was made to overcome the situation by means of a motorised courier service but this enjoyed only a limited success.

As a result, the centralisation of the control of armaments production threatened to entail serious consequences, but these were kept within comparatively moderate limits thanks to the initiative of the intermediate administrative bodies and frequent journeys by responsible persons from the central authority.

(2) War industry was affected by the insufficiency of winter stocks of coal for power plants and gasworks from November 1944 onwards and by the lack of transport space for the July deliveries (e.g. in the case of munitions from October 1944 onwards). Despite the greatly reduced raw steel production, the stocks actually held by the steel plants increased from month to month from the summer of 1944 onwards. This is the best demonstration of the extent to which deliveries to industrial producers were limited by transport difficulties.

(3) So far as I am aware, the attacks began to exercise far-reaching effects on military supply traffic at the time of the invasion of France by

S.A.O.—IV—CC

the Allies. The preparations for the Ardennes offensive were brought to a standstill on this account; the transport hold-up in the area on the right bank of the Rhine caused a shortage of supplies in the forward areas.

The period elapsing between the despatch of finished weapons from the factories and their reception by units was substantially raised by the increased times taken by transport from the factory to the ordnance depot and thence successively to the firing range, the modifications depot and the front, and in consequence the supply of weapons to the fighting units was diminished.

(c) First in order of importance was the loss of railroad marshalling facilities, which delayed the passage of single wagons to the factory rail sidings. The second most troublesome factor was the collapse of the railway signals (i.e. telegraph and telephone) system which, in addition to causing a general deterioration of traffic conditions, made it impossible to trace important consignments.

(d) In the Reich itself the possibility of using lorries to help out with the general shortage of transport was limited. Only in the case of minor bottlenecks could sufficient M/T to cover requirements be made available to make good the loss of railway wagon space. For this reason the shortage of liquid fuel could not be said to have aggravated the situation to any substantial extent.

At the Front the effects of the shortage of fuel must have been very far-reaching, as the distances which supplies had to cover were insupportably great. Supplies for Bastogne had to travel a distance of 200 km. by lorry, and as neither lorries nor petrol were available the supplies themselves proved insufficient.

(e) After the transport of coal by rail had fallen off, owing to traffic difficulties, its transportation by canal became decisive in the maintenance of industry in central Germany. The output from Salzgitter and Peine would have come to a complete standstill had the canals been put out of action, and at the same time the gas supply of Berlin would have been considerably reduced. It was possible to maintain industrial production in central Germany on an emergency basis thanks to the fact that we always succeeded in pushing through emergency traffic for one or two days before the next attack. All the same, the attacks on the canals from the late autumn of 1944 onwards were of extraordinary importance.

(f) As far as I know, they were decisive. Tanks, for example, had to be unloaded at Rheims and from there moved by road to Normandy. This resulted in a considerable loss of M/T and substantial wastage before ever the tanks went into action, quite apart from the great expenditure of fuel.

(g) *Transport difficulties were decisive in causing the swift breakdown of the Ardennes offensive.* Even before the offensive began, the supply organisation was blocked and disorganised by the bad traffic conditions on the right bank of the Rhine, so that it proved impossible, for example, to trace the most vital fuel trains quickly and get them up to the troops. While the offensive was in progress it was not possible for the railway to keep pace with the advance. On the contrary, the most advanced railheads of the Reichsbahn were withdrawn further and further back during the offensive

owing to the continuous air attacks. Although, for example, at the beginning of the offensive rail traffic could still reach towns like Stadtkyll, Bitburg and other locations in the Eifel, by the end of December the whole of the supplies had to be fetched from the right bank of the Rhine.

A properly organised railway supply system, however, was a cardinal condition for the success of the offensive because the M/T capacity available was limited and made up of worn-out types. In addition, due to the activity of day and night fighters, transport was reduced to travelling by night and without lights. In consequence the lorry-space available could be utilised only to the extent of some 30% of capacity.

(h) In May/June 1944 steel production fell (see the memorandum presented to the Fuehrer in June 1944), but this, as far as the Ruhr area was concerned, was rather to be ascribed to the direct effects of air attacks. Coal from the Ruhr was moved at a rate of only 12,000 trucks daily instead of at the normal rate of 22,000 trucks. Later in February or March 1945 only some 3,000-4,000 trucks were dispatched every day.

Until the late autumn of 1944 the effect of this drop in coal production could be cushioned as it *was balanced by reduced deliveries for winter stocking* to power stations and gasworks and to industry. With the sharp deterioration of the transport position and the advent of winter, the coal situation became so catastrophic that already from November 1944 onwards it became impossible to avoid the most serious dislocations in the whole of the armaments industry. The final collapse of armaments and war production became inevitable following the loss of the major part of the Upper Silesian coal resources towards the end of January 1945.

BALL BEARINGS

15. Q. (a) How far did the attack of ball bearings affect the production of essential military equipment for the three services?

(b) How far were the effects of these attacks overcome, and by what means?

(c) Could decisive effects have been achieved from the attack of this industry, and if so how?

A. (a) The attacks on ball bearings did not materially affect the production of essential military equipment, as the output necessary for armaments production was maintained despite the attacks.

(b) Four means were employed:

(1) A reduction of the transit time between factory and consumer from 6-8 months to 14 days and in extreme cases from 3 months to a matter of a few days.

(2) The utilisation of machine tools already ordered for projected new ball bearings plants.

(3) A 50%-60% economy in the use of ball bearings in different kinds of equipment and the use of substitute types of bearings.

(4) Speedy dispersal and the restoration of the industry by a special plenipotentiary (Kessler).

(c) Armaments production would have been materially weakened over

a period of two months and would have been brought to a complete standstill at the end of about four months if:

- (1) *All ball bearings plants had been attacked at one and the same time.*
- (2) *The attacks had been repeated three or four times at intervals of fourteen days each, without regard to the bomb-plots.*
- (3) *Each attempt at reconstruction had been attacked every eight weeks by two consecutive heavy raids, and if the execution of this total bombing policy had been continued for six months.*

Even bomb-plots are deceptive, and consequently too great an interval is left between the attacks. It is therefore better to time attacks on the basis of experience.

MILITARY EQUIPMENT

16. Q. (a) How far did the attack of tank assembly plants affect the fighting strength of German armoured units?

(b) How far did the attack of ordnance depots deprive armies in the field of essential military equipment?

A. (a) The attacks were particularly effective upon Tiger tank production at the Henschel factory. As, however, hulls, suspensions, torsion bars and drives were in short supply at the time as a result of raids on other factories, the output of the assembly plants was not directly affected by the attacks. Even had these attacks not taken place no greater output could have been achieved.

During 1944 the output was on the average some 30% below schedule, the decisive factor being the shortage of supplies of materials and components.

(b) So far as I am aware supplies of weapons and equipment were not substantially affected thanks to the decentralised organisation of the subsidiary ordnance depots. I cannot speak for the effect upon food and clothing stores.

U-BOAT OFFENSIVE

17. Q. (a) How far did the bombing of shipyards affect the U-boat construction programme?

(b) In what other ways was the U-boat construction programme affected by bombing?

A. (a) Output at the shipyards was conditioned by the delivery of electric motors and batteries, so that the attacks on the shipyards themselves did nothing to reduce the output of U-boats. Moreover, U-boats which had been sunk could be raised and repaired within a short time. The reduction in output, due to damage inflicted on the yards, would be about 10%.

(b) By the bombing of the electrical industry, which was responsible for manufacturing the electric motors, and of the factories manufacturing batteries. Both types of product constituted particular bottlenecks because the new U-boats required triple the quantity of equipment per boat.

The factories in Hagen and Vienna manufacturing accumulator batteries were destroyed, and Posen was lost to us, *but the largest accumulator factory, ('Aafa') at Hanover remained intact. If the last-named factory had been destroyed, the construction of U-boats would have had to be abandoned four weeks later.*

OTHER INDUSTRIES

18. Q. (a) Were grave difficulties caused to the German war effort by damage to any other particular industry?

(b) Can you suggest any other class of target in the German war industry the attack of which would have been more effective in reducing Germany's war potential than the attacks which were actually carried out?

A. (a) Considered as already answered in the replies to previous questions.

(b) *Yes, by means of a more logical form of attack on industrial targets. No dispersal of effort on final manufacturing processes or upon transport for both of these require too great a number of attacks and after a certain time it is possible to provide alternative facilities.*

It is only by producing a bombing plan aimed at certain vital targets resulting in the elimination of a horizontal section (Querschnittsfactor) of industry that more rapid success may be obtained. In this connection the sequence of attacks must be speeded up in order to render reconstruction impossible.

The destruction of the ball bearings industry, at the cost of a small expenditure of effort, would have caused a complete standstill of armaments and war production within a period of four months, and in certain important spheres even within from 14 days to eight weeks.

Attacks on the electric power stations would have had to include a comparatively large number of plants as our grid system like that of England, is unique in the world and we possess many small and medium power stations. Despite this, however, according to the estimate of the Reich electricity controller (Reichsverteiler) the failure of 60% of the total electric power production would have sufficed to cause the complete collapse of the entire electrical network. In countries where the number of power stations is smaller and in the absence of an extensive grid system the average capacity of each station is somewhat greater, the *destruction of power stations is the most effective means of bringing the whole of industry and public life immediately to a standstill. This and the gas industry are the only spheres where it is impossible to create reserves and build up stocks between the producer and the consumer which can postpone the effects of bombing for several months.*

Another industry which falls within the scope of the question is the chemical industry including the synthetic oil plants. In this connection, however, the nitrogen plants must also be attacked in order to bring about a standstill in powder and explosives manufacture. In this connection it has emerged that the processing of crude oil by means of the comparatively primitive process used by the refineries can be continued despite attack.

AREA ATTACK

19. Q. (a) To what extent did the attack of cities cause direct damage to plant and equipment of vital war factories?

(b) How far was the production of vital war factories affected by damage to essential services (power, gas, water, transport etc.)?

(c) How far was war production in bombed cities affected by the effects of area attack on the productivity of labour? To what extent did conditions change in this respect as the war proceeded?

(d) To what extent did the loss of records affect the efficiency of production and public administration?

(e) To what extent and when did the attack of cities cause the dispersal of industry, and what was the nett effect of this dispersal on the overall level of production?

(f) How far did general administration and accommodation difficulties caused by the attack of cities affect the German war effort as a whole? What would have been the position if both bomber forces had thrown their effort continuously into the attack of cities?

(g) What was the effect of Mosquito raids on Berlin and other cities? How could these have been made more effective?

(h) What diversion of manpower and resources was necessary to meet the threat and results of area attack, including A.R.P. and essential repair work, and how far did this affect the resources available for war products and the armed forces?

A. (a) It often occurred naturally that attacks on cities caused damage to plants and equipment of vital war industries, but this was mostly of a temporary nature, as it was due to the failure of electricity and gas supplies.

The best gauge of the effects of night attacks upon production was provided by the demands on power supplies following the attacks; these frequently dropped to between 30% and 40% although after a week they usually rose again rapidly to their original level. Such graphs showing the demand for current were prepared in respect of all major night attacks and are to be found in the records of the Reichslastverteiler. They give the *best overall impression* of the effects of the various night attacks upon production.

(b) A particularly difficult situation was caused by the failure of transport facilities in all areas where employees had to cover large distances on the way to work. Thus in the case of the attacks on Berlin, on every occasion individual groups of factories remained idle for several days, although their buildings were intact.

Heavy damage was caused by the destruction of the gas grid in the Ruhr, which resulted in a serious and continuous reduction in the processing of products. In this connection the graphs kept by the 'Ruhrgas' organisation (Director Wunsch), showing the rise and fall in gas supplies, present an exact picture of the situation.

As a result of the breaching of the Mohne Dam, the Ruhr valley was flooded and the fresh-water pumping station in the Ruhr was put out of action by mud and silt; despite this, however, adequate supplies of water

were restored after a lapse of a week. The simultaneous destruction of the other Ruhr valley dams would have resulted in a considerable drop in output in the Ruhr.

Works lying idle owing to shortages of electric power could always be restored to activity within a comparatively short space of time.

(c) Up to the end of the war the productivity of labour remained as high as ever.

(d) On the contrary, the loss of records led to a temporary loosening of the ties of bureaucracy. We very often received the message 'Administrative building burnt out, production continues at full pressure'. I do not know how far the loss of records affected the difficulties of local administrative authorities.

(e) The dispersal of important industries from west and north-west Germany to central and eastern Germany was carried out in 1942 and 1943. From 1944 onwards vital key industries were transferred to caves and other underground installations.

These dispersals did not at first affect production as it was possible to execute them within a short space of time. Production was hindered by dispersal and decentralisation only after transport and communications facilities had been shattered.

(f) The accommodation available for the workers was of course entirely insufficient but this state of affairs was willingly borne right up to the end of the war. Even if all the raids had been concentrated upon the towns and cities this would still not have had any decisive effect if the old system of attacks with long intervals between each, had been continued. The effects would, however, have been more important *if the raids had been based on a different system*. After the first raid it was generally the case that the water mains were heavily damaged and that consequently the water pressure in the town was considerably reduced. A renewal of these attacks on the next two or three nights *would have had a considerably greater effect, since damage caused by the night raids was in the main due to fire*.

A pre-requisite for attaining such results is that the town attacked should be reduced by a succession of raids separated only by short intervals. If intervals of considerable length elapsed between the attacks which raised the first fires, the danger of new conflagrations was considerably reduced by the restoration of the water mains and the creation of natural fire-breaks. Day attacks made in addition to night raids would only have had some effect if in the main they, like the night raids, had taken the form of incendiary attacks.

Such a system of attack was employed on Dresden and, despite all previous raids throughout the Reich during the three preceding years, it caused a considerable shock effect. Nevertheless, the industrial life of Dresden recovered with comparative rapidity.

Consequently it can be said in conclusion *that a bomb load is more effective if it is dropped upon economic targets than if it is expended upon towns and cities*.

(g) The Mosquito attacks on Berlin and other towns with the exception of the 'Oboe' attacks had no considerable effect. They were felt as purely nuisance raids and it would have been more effective if they had been

continued over a longer period of time, because their most disturbing aspect was the loss of sleep which they caused. Moreover, the regular time-table of the attacks enabled people to make their own arrangements to correspond. *Irregular attacks, spread as widely as possible would have been more effective.*

(h) I do not know the detailed figures of personnel engaged in A.R.P. and in bomb damage repair organisations, but in the year 1943-1944 the figure may be reckoned at some 1,000,000-1,500,000. Needless to say, this was one reason why industry was unable to make good its shortages of manpower. It is not, however, to be assumed that a materially greater output of armaments would have been attained even had the necessary manpower been available, since the bottlenecks in materials (raw steel, etc.) would still have persisted.

There is no doubt that, in the absence of air raids, it would have been possible to withdraw several hundred thousand more soldiers from the armaments industry at the end of 1943. A large proportion of German skilled labour was required at the factories for bomb damage clearance, where their specialised knowledge and keenness to restore the plants made their presence indispensable after air attacks. If no air raids had taken place, we should have been able to increase the proportion of foreign and unskilled labour.

Furthermore, during 1944 Army training units were increasingly employed on bomb damage clearance work, leading to a reduction in the standard of training and to a lengthening of training schedules.

20. Q. In attacks on German cities what was the relative effect of H.E. and I.B. respectively on:

- (1) The production of industries associated with the city.
- (2) Absenteeism among workers in those industries.
- (3) The morale of the population?

A. (1) In so far as concentrated area attacks are concerned, the effect of incendiary bombs was greater than that of high-explosive bombs owing to the wide area affected. The effect of high-explosive bombs was merely to render the incendiaries more effective. On the other hand, the effects caused by the heaviest type of mines were fearful.

The difference between the effects of high-explosive and incendiary bomb attacks was to be seen in Berlin. Here the American Air Force carried out several attacks on the centre of the city, exclusively with H.E., but considering the number of aircraft engaged, these did not have the effect of a comparable night attack.

The damage caused to industrial plants by concentrated high-explosive attacks was of varying character. The best and most effective attacks were the last raids by the R.A.F. on Poelitz and Bruex, which, *thanks to the mixed bomb loads had excellent results.*

(2) Fire was also much more effective in destroying workers' dwellings than high explosive, which often left a part of a house still habitable.

Consequently the worker was kept from his place of employment for a longer period by conflagrations than by high-explosive attacks.

(3) Fires made the greatest impression on the general morale of the population which after events in Hamburg and elsewhere was extremely afraid of the outbreak of large area conflagrations.

SECTION VI

**Bomber Command Operational
Statistics and Schedules**

INTRODUCTION

THIS section provides information about the composition, strength, effort and casualties of Bomber Command. In the latter connection an important paper by the Director of Bomber Operations is also reproduced.¹ By showing that a casualty rate of seven per cent of the despatched sorties resulted in the survival of only ten from each hundred crews which started a tour of thirty operations, this serves to underline the meaning of the missing rates so often mentioned in the main volumes of this work. Also included are a number of detailed statistics relating to particular phases of the campaign. For comparative purposes the bomb tonnages dropped by the United States Eighth Air Force have been included.

These statistics, as is indicated in several of the authors' notes, should be read with caution, and it should also be realised that the performance figures given in Appendix 43 are theoretical and provide an accurate basis only for comparing the various aircraft with each other.

We are indebted to the Air Ministry Manning Statistics Branch for supplying us with the best available figures of Bomber Command air and ground crew casualties.

¹ See below, Ap. 42.

APPENDIX 38

Bomber Command Orders of Battle 1939, 1943 and 1945

(a) *Bomber Command—Order of Battle at 27th September, 1939¹*

Headquarters, Advanced Air Striking Force

<i>Wing</i>	<i>Squadrons</i>	<i>Equipment</i>
71	15 (O) 40 (O)	} Battles
72	105 (O) 226 (O)	
74	103 (O) 150 (O)	
75	88 (O) 218 (O)	
76	12 (O) 142 (O)	

No. 1 Group. Forming at Benson

No. 2 Group. Wyton

<i>Station</i>	<i>Wing</i>	<i>Squadrons</i>	<i>Equipment</i>
Wyton	82	114 (O) 139 (O)	} Blenheims
Wattisham	83	107 (O) 110 (O)	
Watton	79	21 (O) 82 (O)	
West Raynham		101	

¹ (O) immediately following the number of a squadron indicates that it is an operational squadron.

(GP) similarly indicates that the squadron concerned is a Group Pool squadron.

No. 3 Group. Mildenhall

<i>Station</i>	<i>Squadrons</i>	<i>Equipment</i>
Feltwell	37 (O) 214	} Wellingtons
Marham	38 (O) 115 (O)	
Mildenhall	99 (O) 149 (O)	
Honington	9 (O)	
Bassingbourn	215	
Stradishall (Care and Maintenance basis)	—	

No. 4 Group. Linton-on-Ouse

<i>Station</i>	<i>Squadrons</i>	<i>Equipment</i>
Dishforth	10 (O) 78	} Whitleys
Driffield	77 (O) 102 (O)	
Linton-on-Ouse	51 (O) 58 (O)	
Leconfield (Care and Maintenance basis)	—	

No. 5 Group. Grantham

<i>Station</i>	<i>Squadrons</i>	<i>Equipment</i>
Cottesmore	106 185	} Hampdens
Hemswell	61 (O) 144 (O)	
Scampton	49 (O) 83 (O)	
Waddington	44 (O) 50 (O)	
Finningley (Care and Maintenance basis)	—	

No. 6 Group. Abingdon

<i>Station</i>	<i>Squadrons</i>	<i>Equipment</i>
Abingdon	97 (GP)	Whitleys
	166 (GP)	
Bicester	104 (GP)	Blenheims
	108 (GP)	
Upwood	90 (GP)	Blenheims
Benson	52 (GP)	Battles
	63 (GP)	
Cranfield	35 (GP)	Battles
	207 (GP)	
(Hucknall) (in Fighter Command)	98	Battles
Harwell	75 (GP)	Wellingtons
	148 (GP)	
Upper Heyford	7 (GP)	Hampdens
	76 (GP)	

Authors' note: The total operational squadrons amounted to 33 but of these 10 were Battles and six were Blenheims. Neither the Battles nor the Blenheims had the range or carrying capacity to make any effective contribution to the strategic air offensive. The ten Battle squadrons, moreover, were in France in the Advanced Air Striking Force which, though administratively part of Bomber Command, was devoted to the purposes of the support of the Army in the field. There were, therefore, in fact only 17 operational squadrons in Bomber Command which could contribute to the strategic air offensive.

All squadrons were established at a strength of 16 I.E.: I.E. stood for Initial Equipment and represented the number of aircraft the squadrons was supposed to have available for operations. However, since some squadrons were below established strength and all squadrons had some unserviceable aircraft, these figures did not, of course, represent the actual strength available. Moreover, true strength is only represented by the number of serviceable aircraft available with operational crews. The availability of operational aircraft in the squadrons with operational crews is, therefore, shown in a separate table. (See below, Appendix 39.)

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943

Unit		Location	Aircraft			Remarks
Operational	Non-Operational		I.E. + I.R.	Type	On Unit Charge	
<i>No. 1 Group</i>		<i>Beaury</i>				
12		Wickenby	16 + 2	Lancaster	21	
101		Holme	16 + 2	Wellington II Lancaster	1 18	
103		Elsham Wolds	16 + 2	Wellington III Lancaster	1 19	
460 (R.A.A.F.)		Brighton	16 + 2	Halifax Lancaster	1 17	
166		Kirmington	16 + 2	Wellington IV	1	
199		Ingham	16 + 2	Wellington III	21	
399 (Pol.)		Henswell	16 + 2	Wellington III	20	
301 (Pol.)		Henswell	16 + 2	Wellington III	8	The three Polish Sqdns. are operating to 10 + 2 establishment Forming
305 (Pol.)		Henswell	16 + 2	Wellington IV	12	
		Grimsby	16 + 2	Wellington IV	10	
	100		16 + 2	Lancaster	20	
<i>No. 2 Group</i>		<i>Huntingdon</i>				
88 ¹		Oulton	16 + 2	Boston III (A.20)	15	
107 ²		Gt. Masingham	16 + 2	Boston III (A.20)	19	
226 ²		Swanton Morley	16 + 2	Boston III (A.20)	14	
105		Marham	16 + 2	Mosquito	18	
139		Marham	16 + 2	Mosquito	10	
21		Methwold	16 + 2	Blenheim V	13	
464 (R.A.A.F.)		Feltwell	16 + 2	Ventura (B.34) Ventura (B.34)	16 20	

¹ Trained in use of gas spray and earmarked for reinforcement of Northern Ireland on Alert No. 1 or at the request of the War Office.
² Squadrons trained in use of gas spray.

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

Unit		Location	Aircraft			Remarks
Operational	Non-Operational		I.E. + I.R.	Type	On Unit Charge	
No. 2 Group— <i>contd.</i> 487 (R.N.Z.A.F.) 98 180		Feltwell Foulsham Foulsham	16 + 2 16 + 2 16 + 2	Ventura (B.34) Mitchell (B.25) Mitchell (B.25)	21 20 19	
No. 3 Group 15 ^a 75 (N.Z.) 90 149 ^a 214 ^a 218 115		<i>Exmg</i> Bourn Newmarket Ridgewell Lakenheath Chedburgh Downham Market East Wretham	16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2	Stirling Stirling Stirling Stirling Stirling Stirling Wellington Halifax	20 15 15 17 15 16 — 17 15	To re-equip Operational on Wellington These Sqdns. are under the control of A.C.A.S. (1)
198 (Special) 161 (Special)		Tempsford Tempsford	13 + 2 7 + 0 5 + 0 1 + 0 2 + 0	Lysander Halifax Hudson Havoc	8 5 1 2	
192 (Special)		Gransden Lodge	2 + 0 1 + 0 8 + 3 3 + 0	Albermarle/Hudson Halifax Wellington X Mosquito Wellington IC	2 2 12 3 2	Det. on loan to Coastal Command at St. Eval

<i>No. 4 Group</i>	<i>York</i>	Melbourne Snaith Linton-on-Ouse Elvington Linton-on-Ouse Pocklington Rufforth Leconfield East Moor Leconfield Burn	16 + 2 24 + 3 16 + 2 16 + 2 16 + 2 16 + 2 24 + 3 16 + 2 16 + 2 16 + 2 16 + 2	Halifax Halifax Whitley Halifax Halifax Whitley Halifax Halifax Halifax Wellington II Wellington X Wellington III Wellington X Wellington X Wellington X	31 25 2 18 19 1 18 17 27 1 20 16 2 16 19										
						<i>No. 5 Group</i>	<i>Grantham</i>	9 44 (Rhod.) 49 50 57 61 97 106 207 467 (R.A.A.F.)	Waddington Waddington Fiskerton Skellingthorpe Scampton Syerston Woodhall Spa Syerston Langar Bottesford	16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2 16 + 2	Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster	19 16 16 19 17 19 16 17 22 24			
													431 (R.C.A.F.)	Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster Lancaster	19 16 16 19 17 19 16 17 22 24

* Squadrons trained for gas bombing.

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

Unit		Location	Aircraft			Remarks
Operational	Non-Operational		I.E. + I.R.	Type	On Unit Charge	
<i>No. 6 Group R.C.A.F.</i>		<i>Allerton</i>				
405		Beauieu	16 + 2	Halifax	18	Temporarily detached to Coasta Command
408		Leeming	16 + 2	Halifax	15	
419		Middleton St. George	16 + 2	Halifax	16	
420		Middleton St. George	16 + 2	Wellington III	18	
424		Topcliffe	16 + 2	Wellington III	19	
425		Dishforth	16 + 2	Wellington III	18	
426		Dishforth	16 + 2	Wellington III	18	
427		Croft	16 + 2	Wellington III	19	
428		Dalton	16 + 2	Wellington III	10	
				Wellington X	5	
<i>No. 8 Group</i>		<i>Wyton</i>				
7 (P.F.F.)		Oakington	24 + 3	Stirling	21	Lodger Unit on 3 Group Station
35 "		Gravely	24 + 3	Halifax	23	
83 "		Wyton	16 + 2	Lancaster	19	
109 "		Wyton	16 + 2	Mosquito	19	
156(†) "		Warboys	16 + 2	Wellington IC	2	
				Lancaster	17	Re-equipping
				Wellington III	8	

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

SUMMARY OF SQUADRONS

No.	Squadrons Established		Type of Aircraft	No.	Squadrons Operational		Squadrons Non-Operational	
	Total I.E. + I.R.	Total Strength			On Type I.E. + I.R.	A/C on Unit Charge	No.	On Type I.E. + I.R.
—	—	13	Blenheim	—	—	—	—	13
3	48 + 6	48	Boston	3	48 + 6	48	—	—
3	48 + 6	47	Mosquito	3	48 + 6	47	—	—
6	96 + 12	108	TOTAL LIGHT BOMBERS	6	96 + 12	95	—	13
—	—	2	Wellington IC	—	—	—	—	2
—	—	2	Wellington II	—	—	—	—	2
8	128 + 16	193	Wellington III	9 ¹	144 + 18	193	—	—
5	80 + 10	62	Wellington X (or III)	4	64 + 8	43	16 + 2	19
2	32 + 4	23	Wellington IV	2	32 + 4	22	—	1
3	48 + 6	57	Ventura	3	48 + 6	57	—	—
2	32 + 4	39	Mitchell	2	32 + 4	39	—	—
20	320 + 40	378	TOTAL MEDIUM BOMBERS	20	320 + 40	354	16 + 2	24
11	200 + 25	228	Halifax	11	200 + 25	228	—	—
17	272 + 34	315	Lancaster	15 ¹	248 + 31	295	14 + 3	20
81	136 + 17	119	Stirling	7	120 + 15	119	—	—
36	608 + 76	662	TOTAL HEAVY BOMBERS	33 ¹	568 + 71	642	24 + 3	20
62	1024 + 128	1148	TOTAL ALL CLASSES	59 ¹	984 + 123	1091	40 + 5	57
3	42 + 6	52	SPECIAL DUTY SQUADRONS (Various)	3	42 + 6	52	—	—

¹ 115 Squadron established Stirling, operational on Wellington III.

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

TRAINING UNITS

Unit	Location	Aircraft			Remarks
		I.E. + I.R.	Type	On Unit Charge	
<i>No. 1 Group</i> 1520 B.A.T. Flight 1481 (Bomber) G.F.	<i>Bawtry</i> Holme Lindholme	6 + 2	Oxford	8	
		6 + 0	Whitley Lysander	6 8	
		6 + 0	Defiant	4	
	Lindholme Lindholme	1 + 0	Tiger Moth	1	
		7 + 3	Martinet	2	
		4 + 1	Oxford	5	
		12 + 0	Lancaster Manchester	15 6	
	Lindholme Blyton	20 + 0	Halifax	23	
		6 + 2	Oxford	8	
		12 + 0	Lancaster	—	
20 + 0		Halifax/Manchester	—		
<i>No. 2 Group</i> 1508 B.A.T. Flight 1315 B.A.T. Flight 1519 B.A.T. Flight 1482 (Bomber) G.F.	<i>Huntingdon</i> Horsham St. Faith Swanton Morley Feltwell	4 + 1	Oxford	7	
		6 + 2	Oxford	8	
		6 + 2	Oxford	9	
	West Raynham	2 + 1	Mitchell Defiant	— 4	
			Blenheim	3	
			Lysander	6	

No. 2 Group— <i>contd.</i>	Marham	1655 Training Unit			
1 0	Tiger Moth	1 + 0		1	
6 + 2	Martinet	6 + 2		3	
3 + 1	Ventura	3 + 1		4	
4 + 2	Blenheim	4 + 2		6	
6 + 3	Mosquito	6 + 3		9	
4 + 1	Oxford	4 + 1	Exning Exning	5	Detachments attached to No. 3 Group Sqdns.
6 + 2	Oxford	6 + 2	Stradishall Marham	8	
2 + 0	Lysander	2 + 0		5	
1 + 0	Defiant	1 + 0		3	
8 + 0	Tiger Moth	8 + 0		11	Lodger Units on a No. 2 Group Station
7 + 3	Wellington	7 + 3		5	
6 + 2	Martinet	6 + 2	Marham	7	
32 + 0	Oxford	32 + 0	Stradishall	26	
32 + 0	Stirling	32 + 0	Waterbeach	32	
6 + 0	Wellington	6 + 0	Gransden Lodge	6	
4 + 1	Halifax	4 + 1		4	
1 + 0	Lancaster	1 + 0		1	
1 + 0	Stirling	1 + 0		1	
1 + 0	Proctor	1 + 0		1	
4 + 1	Oxford	4 + 1	York Driffield	5	
5 + 0	Whitley	5 + 0	Driffield	5	
8 + 0	Defiant	8 + 0		12	
1 + 0	Lysander	1 + 0		4	
7 + 3	Tiger Moth	7 + 3		1	
	Martinet			9	

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

Unit	Location	Aircraft			Remarks
		I.E. + I.R.	Type	On Unit Charge	
<i>No. 4 Group—contd.</i> Air Bomber Training Flight 1652 Conversion Unit 1658 Conversion Unit 1663 Conversion Unit	Driffield	6 + 2	Oxford	9	Forming
	Marston Moor	32 + 0	Halifax	34	
	Ricall	32 + 0	Halifax	29	
	Rufforth	32 + 0	Halifax	—	
<i>No. 5 Group</i> 1506 B.A.T. Flight 1514 B.A.T. Flight 1518 B.A.T. Flight 1485 (Bomber) G.F.	<i>Grantham</i> Waddington	6 + 2	Oxford	8	
	Coningsby	6 + 2	Oxford	9	
	Dunholme Lodge	6 + 2	Oxford	8	
	Fulbeck	4 + 0	Lysander	4	
		8 + 0	Defiant	4	
		1 + 0	Manchester	8	
		6 + 2	Tiger Moth	1	
		6 + 2	Martinet	5	
	Fulbeck	6 + 2	Oxford	8	
	Wigsley	12 + 0	Lancaster	18	
Swinderby		20 + 0	Manchester/ Halifax	18	
		12 + 0	Lancaster	14	
1660 Conversion Unit		20 + 0	Manchester/ Halifax	18	
		12 + 0	Lancaster	9	
1661 Conversion Unit	Winthorpe	12 + 0	Lancaster	14	
		20 + 0	Manchester/ Halifax	14	

<p><i>No. 6 Group</i> 1512 B.A.T. Flight 1535 B.A.T. Flight 1659 Conversion Unit</p>	<p><i>Allerton</i> Diahforth Middleton St. George Leeming</p>	<p>6 + 2 6 + 2 32 + 0</p>	<p>Oxford Oxford Halifax</p>	<p>9 8 21</p>
<p><i>No. 91 Group</i> 10 O.T.U.</p>	<p><i>Abingdon</i> Abingdon</p>	<p>8 + 2 40 + 14 1 + 0 4 + 1 20 + 6 1 + 0 40 + 14 1 + 0 4 + 0 40 + 14 8 + 2 1 + 0 4 + 1 40 + 14 1 + 0 4 + 1</p>	<p>Anson Whitley Defiant Lysander Whitley Leopard Moth Wellington Defiant Lysander Whitley Anson Defiant Lysander Wellington Defiant Lysander Anson Anson Wellington Defiant Lysander Wellington Defiant Lysander</p>	<p>11 55 1 3 33 1 48 — 3 50 15 1 2 52 1 2 4 17 54 1 3 60 1 3 57 1 2</p>
<p>Special Flight</p>	<p>Abingdon</p>	<p>4 + 1</p>	<p>Whitley</p>	<p>3</p>
<p>15 O.T.U.</p>	<p>Harwell</p>	<p>1 + 0</p>	<p>Leopard Moth</p>	<p>1</p>
<p>19 O.T.U.</p>	<p>Kinloss</p>	<p>4 + 0</p>	<p>Wellington</p>	<p>—</p>
<p>20 O.T.U.</p>	<p>Lossiemouth</p>	<p>1 + 0</p>	<p>Defiant</p>	<p>3</p>
<p>21 O.T.U.</p>	<p>Moreton-in-the-Marsh</p>	<p>4 + 1</p>	<p>Lysander</p>	<p>15</p>
<p>22 O.T.U.</p>	<p>Wellesbourne-Mountford</p>	<p>12 + 4 40 + 14 1 + 0 4 + 1 50 + 16 1 + 0 4 + 1 40 + 14 1 + 0 4</p>	<p>Anson Anson Wellington Defiant Lysander Wellington Defiant Lysander Wellington Defiant Lysander</p>	<p>2 3 52 1 2 4 17 54 1 3 60 1 3 57 1 2</p>
<p>23 O.T.U.</p>	<p>Pershore</p>	<p>4 + 1</p>	<p>Wellington</p>	<p>2</p>

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

Unit	Location	Aircraft			Remarks
		I.E. + I.R.	Type	On Unit Charge	
No. 91 Group—contd. 24 O.T.U.	Honeybourne	40	Whitley	55	
		8	Anson	11	
		1	Defiant	1	
		4	Lysander	2	
		4	Oxford	6	
		6	Oxford	8	
1501 B.A.T. Flight 1516 B.A.T. Flight 1443 B.A.T. Flight 1446 F.T. Flight	Abingdon Hampstead Norris Harwell Moreton-in-the-Marsh	2	Wellington	1	
		2	Anson	2	
		2	Wellington	12	
		2	Wellington	2	
No. 92 Group 11 O.T.U.	Winslow Hall Westcott	40	Wellington	52	
		1	Defiant	2	
		4	Lysander	2	
		4	Anson	1	
		40	Wellington	51	
12 O.T.U.	Chipping Warden	1	Defiant	1	
		4	Lysander	2	
		36	Blenheim	46	
		1	Defiant	1	
13 O.T.U.	Bicester	4	Lysander	—	
		8	Anson	9	
		8	Albermarle	1	
		40	Wellington	52	
14 O.T.U.	Cottesmore	1	Defiant	1	
		4	Lysander	2	
		4	Anson	4	

No. <i>gr</i> Group— <i>contd.</i> 16 O.T.U.	Upper Heyford	40	+	14	Wellington	57
		1	+	0	Defiant	1
17 O.T.U.	Upwood	4	+	1	Lysander	2
					Anson	6
		18	+	6	Blenheim	33
		4	+	1	Anson	5
		1	+	0	Defiant	1
26 O.T.U.	Wing	4	+	1	Lysander	2
		40	+	14	Wellington	58
		1	+	0	Defiant	1
		4	+	1	Lysander	3
					Anson	6
29 O.T.U.	North Luffenham	40	+	14	Wellington	49
		1	+	0	Defiant	1
		4	+	1	Lysander	2
					Anson	3
					Blenheim	7
307 F.T.U.	Bicester	7	+	0	Oxford	5
		6	+	2	Oxford	8
		6	+	2	Oxford	8
		1	+	0	Leopard Moth	1
		3	+	1	Wellington	4
1551 Flight	Bicester	6	+	2	Anson	6
					Whitley	1
		4	+	0	Anson	4
		2	+	0	Master	2
		3	+	0	Oxford	3
E.C.D.U.	Wescott	3	+	0	Wellington	4

To be disbanded

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

Unit	Location	Aircraft			Remarks
		I.E. + I.R.	Type	On Unit Charge	
No. 93 Group 18 O.T.U.	Egginton Hall Bramcote	20 + 7	Wellington	39	Det. at Finningley
		1 + 0	Defiant	—	
		4 + 1	Lysander	3	
25 O.T.U.	Finningley		Wellington	1	Disbanded
			Lysander	1	
27 O.T.U.	Lichfield	40 + 14	Wellington	49	
		4 + 1	Lysander	3	
		1 + 0	Defiant	1	
28 O.T.U.	Wymeswold		Anson	2	
			Albermarle	2	
		40 + 14	Wellington	55	
30 O.T.U.	Hixon	1 + 0	Wellington	1	
		4 + 1	Defiant	2	
		40 + 14	Lysander	69	
81 O.T.U.	Whitchurch Heath	1 + 0	Wellington	1	
		4 + 1	Defiant	3	
		30 + 10	Lysander	41	
1507 B.A.T. Flight 1513 B.A.T. Flight	Finningley Bramcote	1 + 0	Whitley	—	
		6 + 2	Defiant	8	
		4 + 1	Anson	3	
		4 + 1	Lysander	5	
		6 + 2	Oxford	8	

(b) Bomber Command Order of Battle as at 1800 hours 4 February 1943—Continued

Type	O.T.U.		Conversion Units		Miscellaneous Units		Total	
	U.E. (I.E. + I.R.)	On Charge	U.E. (I.E. + I.R.)	On Charge	U.E. (I.E. + I.R.)	On Charge	U.E.	On Charge
Halifax	—	—	168	116	5	4	173	120
Stirling	—	—	64	58	1	1	65	59
Lancaster	—	—	48	61	1	1	49	62
Total	—	—	280	235	7	6	287	241
Albermarle	—	3	—	—	—	—	—	3
Anson	69	102	—	—	12	12	81	114
Blenheim	72	79	6	6	7	10	85	95
Defiant	21	20	—	—	20	27	41	47
Leopard Moth	1	1	—	—	1	1	2	2
Lysander	105	50	—	—	—	27	105	77
Manchester	—	—	60	57	8	8	68	65
Martinet	—	—	—	—	46	24	46	24
Master	—	—	—	—	2	2	2	2
Mitchell	—	—	—	—	3	—	3	—
Mosquito	—	—	9	9	—	—	9	9
Oxford	—	—	—	—	166	180	166	180
Proctor	—	—	—	—	1	1	1	1
Tiger Moth	—	—	—	—	5	5	5	5
Ventura	—	—	—	—	4	4	4	4
Wellington	795	803	—	—	25	38	820	841
Whitley	228	234	—	—	11	12	239	246
Total	1,291	1,292	75	72	311	351	1,677	1,715
Grand Total	1,291	1,292	355	307	318	357	1,964	1,956

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945

Unit		Location	Aircraft		Remarks
Operational	Non-Operational		U.E.	Type	
<i>Bowby</i>					
No. 1 Group					
12		Wickenby	20	Lancaster I, III	20
100		Grimsby	20	Lancaster I, III	19
101		Ludford Magna	30	Lancaster I, III	32
103		Elham Wolds	20	Lancaster I, III	19
150		Henswell	20	Lancaster I, III	16
153		Scampton	20	Lancaster I, III	21
166		Kirmington	30	Lancaster I, III	27
170		Henswell	20	Lancaster I, III	18
900 (Pol.)		Faldingworth	20	Lancaster I, III	20
460 (R.A.A.F.)		Bimbrook	30	Lancaster I, III	27
550		N. Killingholme	30	Lancaster I, III	27
576		Fiskerton	20	Lancaster I, III	19
625		Kelstern	30	Lancaster I, III	29
626		Wickenby	20	Lancaster I, III	21
<i>Evening</i>					
No. 3 Group					
15		Mildenhall	20	Lancaster I, III	22
75		Mepal	30	Lancaster I, III	26
90		Tuddenham	20	Lancaster I, III	21
115		Witchford	30	Lancaster I, III	32
	138	Tuddenham	20	Lancaster I, III	20
		Methwold	30	Lancaster I, III	30
149		Stradbhall	30	Lancaster I, III	31
186(†)	186(†)	Wrattling Common	30	Lancaster I, III	30
195		Chedburgh	30	Lancaster I, III	29
218		Waterbeach	30	Lancaster I, III	32
514		Mildenhall	20	Lancaster I, III	22
622					
					2 Flights operational

No. 4 Group	York	30	Halifax III	25	Operational Hal. III
10	Melbourne	30	Halifax III	31	
51	Snaith	30	Halifax VI	11	
76	Holme	30	Halifax III	29	
78	Brighton	30	Halifax III	29	
158	Lissett	30	Halifax III	29	
346 (F.A.F.)	Elvington	20	Halifax VI	8	Operational Hal. III
347 (F.A.F.)	Elvington	20	Halifax III	18	To re-equip
466 (R.A.A.F.)	Driffild	20	Halifax VI	18	Hal. VI, 30.3.45
640	Leconfield	20	Halifax III	5	
77	Full Sutton	30	Halifax VI	19	Operational Hal. III
102	Pocklington	20	Halifax III	10	
				15	
				28	
				19	
				19	
				1	
No. 5 Group	Swinderby	20	Lancaster I, III	22	
9	Bardney	20	Lancaster I, III	16	
44 (Rhod.)	Spilsby	20	Lancaster I, III	19	
49	Fulbeck	20	Lancaster I, III	17	
50	Shellingthorpe	20	Lancaster I, III	16	
57	East Kirkby	20	Lancaster I, III	16	
61	Shellingthorpe	20	Lancaster I, III	19	
106	Metheringham	20	Lancaster I, III	16	
189	Fulbeck	20	Lancaster I, III	17	
207	Spilsby	20	Lancaster I, III	21	
227	Balderton	20	Lancaster I, III	18	
463 (R.A.A.F.)	Waddington	20	Lancaster I, III	21	
467 (R.A.A.F.)	Waddington	20	Lancaster I, III	19	
619	Strubby	20	Lancaster I, III	17	
630	East Kirkby	20	Lancaster I, III	21	
617	Woodhall Spa	30	Lancaster I, III Mosquito VI	41	Special tasks
				1	

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945—Continued

Unit	Location	Aircraft			Remarks
		U.E.	Type	On Unit Charge	
No. 5 Group— <i>contd.</i> 83 (P.F.F.) 97 (P.F.F.) 627 (P.F.F.)	Coningsby	20	Lancaster I, III	} 22 19 29	On loan from 8 Group Includes 4 ML. IX, XVI
	Coningsby	20	Lancaster I, III		
	Woodhall Spa	20	Mosquito IV, XX, 25		
No. 6 Group (R.C.A.F.)	<i>Allerton</i>				
	East Moor	20	Halifax III	18	
			Halifax VII	6	
	Tholthorpe	20	Halifax III	24	
	Tholthorpe	20	Halifax III	22	
	Linton	20	Halifax VII	24	
	Linton	20	Halifax VII	25	
	East Moor	20	Halifax VII	24	
	Skipton-on-Swale	20	Lancaster I, III	20	
	Leeming	20	Lancaster I, III	20	
			Halifax III	8	
	Leeming	20	Lancaster I, III	19	
			Halifax III	5	
	Skipton-on-Swale	20	Lancaster I, III	20	
			Halifax III	1	
433	Middleton St. George	20	Lancaster X	23	
	Middleton St. George	20	Lancaster X	25	
	Croft	20	Lancaster X	20	
	Croft	20	Lancaster X	19	
	Croft	20	Lancaster I, III	5	

No. 8 Group (P.F.F.)					
S.A.O. — IV — EE	<p><i>Huntingdon</i> Oakington Graveley</p> <p>Upwood Gransden Lodge Little Staughton Downham Market Bourn Little Staughton Wyton Upwood</p> <p>Gransden Lodge Bourn Wyton Oakington Graveley</p> <p>Downham Market Graveley</p>	<p>20 20</p> <p>20 20 20 20 20 30 30 20 20</p> <p>20 20 20 20 20 20 20</p>	<p>Lancaster I, III Lancaster I, III Lancaster I, III } Lancaster I, III } Lancaster I, III Lancaster I, III Lancaster I, III Mosquito IX, XVI Mosquito IX, XVI Mosquito XVI Mosquito IX, XVI Mosquito XX, 25 Mosquito 25 Mosquito XX, 25 Mosquito 25 Mosquito XX, 25 Mosquito XVI Mosquito XX, 25 Mosquito XVI Mosquito XX, 25 Mosquito IV, XX Mosquito XVI</p>	<p>19 19</p> <p>19 18 21 19 34 36 24 14 14 19 18 17 29 2 9 20 25</p>	<p>Detached to 5 Grp. (q.v.)</p> <p>Inc. 1 Mk. 25 Operating Moeq. XX, 25</p> <p>Re-equipping</p> <p>Detached to 5 Grp.</p>
No. 100 Group	<p><i>Bylaugh Hall</i> Little Snoring Swannington West Raynham Swannington Great Massingham</p>	<p>18 18 18 18 18 18</p>	<p>Mosquito VI Mosquito 30 Mosquito 30 Mosquito VI Mosquito XIX Mosquito 30 Mosquito XIX Mosquito VI</p>	<p>28 18 11 6 10 12 15 4</p>	<p>Incl. 1 Mk. VI</p> <p>Incl. 2 Mk. VI</p>

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945—Continued

Unit		Location	Aircraft			Remarks
Operational	Non-Operational		U.E.	Type	On Unit Charge	
<i>No. 100 Group—contd.</i>						
239 (B.S.)		West Raynham	18	Mosquito 30	19	Incl. 1 Mk. VI
515 (B.S.)		Little Snoring	18	Mosquito VI	23	
171 (B.S.)		North Creak	20	Halifax III	19	
192 (B.S.)		Foulsham	17	Halifax III	15	
			7	Mosquito XVI	8	
			1	Anson	—	
				Mosquito IV	6	
199 (B.S.)		North Creak	20	Halifax III	17	
				Stirling III	2	
		Foulsham	20	Halifax III	22	
462 (R.A.A.F.)				Fortress III	18	Not included in Summary
(B.S.)		Oulton	20	Liberator	14	
214 (B.S.)		Oulton	16	Mosquito VI	6	
223 (B.S.)		Swanton Morley	4	Mosquito XIX	2	
B.S.D.U.			2	Mosquito 30	3	
			3	Mosquito II	1	
					1	

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945—Continued

SUMMARY OF SQUADRONS

No.	U.E.	Total Strength	Type of Aircraft	Squadrons Operational on Type			Squadrons Non-Operational on Type		
				No.	U.E.	A/C on Unit Charge	No.	U.E.	A/C on Unit Charge
				5	120	176	—	—	—
6	120	115	6	120	113	1	20	2	
12	260	291	TOTAL LIGHT BOMBERS	11	240	289	1	20	2
9	220	299	Halifax III	12	290	278	—	—	21
5	120	81	Halifax VI	2	50	47	—	—	34
3	60	79	Halifax VII	3	60	73	—	—	6
52	1,170	1,150	Lancaster I, III	49 $\frac{1}{2}$	1,110	1,106	2 $\frac{1}{2}$	50	44
4	80	87	Lancaster X	4	80	87	—	—	—
73	1,650	1,696	TOTAL HEAVY BOMBERS	70 $\frac{1}{2}$	1,600	1,591	2 $\frac{1}{2}$	50	105
85	1,910	1,987	TOTAL ALL CLASSES	81 $\frac{1}{2}$	1,840	1,880	3 $\frac{1}{2}$	70	107
1	25	29	(B.S.) Halifax/Mosquito	1	25	29	—	—	—
3	54	58	(B.S.) Mosquito 30	3	54	58	—	—	—
2	36	23	(B.S.) Mosquito XIX	2	36	23	—	—	—
2	36	65	(B.S.) Mosquito VI	2	36	65	—	—	—
1	20	18	(B.S.) Fortress	1	20	18	—	—	—
—	—	2	(B.S.) Stirling	—	—	—	—	—	2
3	60	58	(B.S.) Halifax	3	60	58	—	—	—
1	16	14	(B.S.) Liberator	1	16	14	—	—	—
13	247	267	TOTAL BOMBER SUPPORT	13	247	265	—	—	2

¹ Includes 1 Mark VI.

Note. The aircraft in Squadrons partly operational are included in the operational total.

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945—Continued

TRAINING UNITS

Unit	Location	Aircraft			Remarks
		Est.	Serv.	Type	
No. 1 Group 15 Base 1687 B.D.T. Flt.	<i>Bawtry</i>				
	Hemswell				
No. 3 Group 1688 B.D.T. Flt. B.D.U. (Bombing Development Unit)	<i>Exning</i>	8	3	Halifax III	
	Feltwell	—	1	Halifax VI	
	Feltwell	5	9	Lancaster I, III	
		1	—	{ Mosquito XVI	
		1	1	{ Mosquito XX	
		2	1	Spitfire V	
No. 4 Group 1689 B.D.T. Flt.	<i>Tork</i> Holme	1	1	Beaufighter I	
		1	1	Proctor	
		—	1	Anson	
		—	—	Mosquito IX	
No. 5 Group 1690 B.D.T. Flt. No. 6 Group (R.C.A.F.) 1695 B.D.T. Flt.	<i>Swinderby</i> Metheringham Allerton Park Dishforth				

<p><i>No. 8 Group</i> 1696 B.D.T. Flt. P.N.T.U. (Pathfinder Navigation Trg. Unit)</p> <p>1323 Flt. A.G.L.(T) Trg.</p>	<p><i>Huntingdon</i> Bourn Warboys</p> <p>Warboys Fulbeck</p>	<p>14</p> <p>14</p> <p>15</p> <p>—</p> <p>10</p> <p>4</p>	<p>9</p> <p>1</p> <p>2</p> <p>—</p> <p>10</p> <p>7</p> <p>8</p> <p>7</p> <p>—</p>	<p>Lancaster I, III Mosquito XXV Mosquito XX Mosquito XVI Mosquito IV Oxford I Oxford II Lancaster I, III Lancaster I, III</p>
<p><i>No. 100 Group</i> 1694 B.D.T. Flt. 1692 (B.S.) T.U.</p> <p>1699 Fortress Trg. Flt. B.S.D.U. (Bomber Support Development Unit)</p>	<p><i>Bylaugh Hall</i> Great Massingham Great Massingham</p> <p>Oulton</p> <p>Swanton Morley</p>	<p>16</p> <p>6</p> <p>2</p> <p>1</p> <p>4</p> <p>3</p> <p>8</p> <p>—</p> <p>5</p> <p>1</p> <p>1</p> <p>2</p> <p>1</p> <p>—</p>	<p>13</p> <p>7</p> <p>—</p> <p>1</p> <p>3</p> <p>1</p> <p>3</p> <p>1</p> <p>9</p> <p>—</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>—</p>	<p>Mosquito VI Anson Wellington XVIII Oxford II Fortress III Fortress II Halifax III Halifax XI Lancaster I, III Mosquito XVI Mosquito XX Spitfire V Beaufighter I Proctor Anson Mosquito IX</p>

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945—Continued

TRAINING UNITS

Unit	Location	Aircraft			Remarks
		Est.	Serv.	Type	
No. 7 Group 1651 Conversion Unit	Grantham Woolfox Lodge	32	13	Lancaster I, III	
		2	—	Spitfire V	
1652 Conversion Unit	Marston Moor	2	2	Beaufighter VI	
		—	2	Hurricane II	
		35	11	Halifax III	
		2	2	Spitfire V	
1653 Conversion Unit	N. Luffenham	2	1	Hurricane II	
		—	1	Hurricane IV	
		32	15	Lancaster I, III	
		2	1	Spitfire V	
1654 Conversion Unit	Wigsley	—	—	Beaufighter VI	
		32	15	Hurricane II	
		2	2	Lancaster I, III	
		2	2	Spitfire V	
1656 Conversion Unit	Lindholme	32	24	Hurricane II	
		2	2	Lancaster I, III	
		2	2	Spitfire V	
		2	2	Hurricane II	
1659 Conversion Unit (R.C.A.F.)	Topcliffe	32	27	Halifax III	
		2	1	Spitfire V	
		2	2	Hurricane II	
		2	2	Lancaster I, III	
1660 Conversion Unit	Swinderby	32	23	Spitfire V	
		2	2	Lancaster I, III	
		2	2	Hurricane II	

<p><i>No. 7 Group—contd.</i> 1661 Conversion Unit</p> <p>1663 Conversion Unit</p> <p>1666 Conversion Unit (R.C.A.F.)</p> <p>1667 Conversion Unit</p> <p>1668 Conversion Unit</p> <p>Bomber Command Instructors School</p>	Winthorpe	32	16	Lancaster I, III Spitfire V	
	Rufforth	3	3	Hurricane II Halifax III	
	Wombledon	32	12	1	Spitfire V
		2	2	2	Hurricane II
		32	26	1	Lancaster I, III
		—	3	2	Lancaster X Spitfire V
	Sandtoft	2	2	1	Hurricane II
		32	28	2	Lancaster I, III Spitfire V
	Bottesford	2	2	1	Hurricane II
		32	19	2	Lancaster I, III
2		2	1	Spitfire V	
Finningley	2	2	2	Beaufighter VI Hurricane II	
	—	—	2	Wellington X	
	22	16	10	Lancaster I, III	
	15	2	2	Hurricane II	
	2	1	1	Master II	
	3	2	1	Spitfire V Oxford Halifax III	
<p><i>No. 91 Group</i> 10 O.T.U.</p> <p>19 O.T.U. (‡)</p>	Abingdon Abingdon	54 6	47	Wellington I Hurricane II	
	Kinloss	2 40 5 2	3 36 3 1	Master II Wellington X Hurricane II Master II	

(c) Bomber Command Order of Battle as at 1800 hours 22nd March 1945—Continued

Unit	Location	Aircraft			Remarks
		Est.	Serv.	Type	
<i>No. 91 Group—contd.</i> 20 O.T.U.	Lossiemouth	54	44	Wellington X	Disbanding
		6	5	Hurricane II	
21 O.T.U.	Moreton-in-the-Marsh	2	1	Master II	
		54	38	Wellington X	
		6	4	Wellington III	
22 O.T.U.	Wellesbourne Mountford	2	1	Hurricane II	
		54	42	Master II	
		6	4	Wellington X	
24 O.T.U.	Honeybourne	2	—	Hurricane II	
		54	45	Master II	
27 O.T.U.	Lichfield	6	3	Wellington X	
		2	2	Hurricane II	
		54	44	Master II	
30 O.T.U. (‡)	Gamston	4	4	Wellington X	
		—	2	Hurricane II	
		40	29	Master II	
		5	1	Wellington X	
		2	3	Wellington III	
			2	Hurricane II	
				Master II	

No. 99 Group 11 O.T.U.	Windsor Westcott	54 6	46	Wellington X
				Hurricane II
12 O.T.U.	Chipping Warden	54 6	39	Master II
				Wellington X
				Hurricane II
14 O.T.U. (‡)	Market Harborough	40 5	30	Master II
				Hurricane II
16 O.T.U. (Mosq.)	Upper Heyford	—	11	Master II
				Mosquito XXV
				Mosquito XX
				Mosquito XVI
				Mosquito IV
				Mosquito VI
17 O.T.U.	Silverstone	40	—	Mosquito III
				Oxford II
				Oxford I
				Wellington X
				Hurricane II
				Master II
29 O.T.U. (‡)	Bruntingthorpe	40 5	31	Wellington X
				Hurricane II
84 O.T.U. (‡)	Desborough	40 5	36	Master II
				Wellington X
				Hurricane II
85 O.T.U. (‡)	Husbands Bosworth	40 5	34	Master II
				Wellington
				Hurricane II
				Master II
				Martinet

APPENDIX 39

Average Daily availability in Bomber Command of aircraft and aircraft with crews at selected dates 1939-1945

	Wells.	Whits.	Hamps.	Blens.	Stirs.	Hals.	Manchs.	Lancs.	Mosqs.	Forts.	Vents.	Bosts.	Mitchells	Aircraft with crews
Sept. 39 ¹	77	61	71	140	—	—	—	—	—	—	—	—	—	280
Nov. 41	250	62	150	79	18	17	31	—	—	3	—	—	—	506
May 42	214	15 ²	27	29	45	62	15	29	—	—	—	44	—	417
Jan. 43	128	—	—	—	56	104	—	178	17	—	45	37	17 ³	515
March 44	—	—	—	—	63	328	—	594	58	—	—	—	—	974
April 45	—	—	—	—	—	353	—	1,087	203	—	—	—	—	1,609

¹ The Advanced Air Striking Force is not included.

² There were no Whitleys after 5th May 1942.

³ There were no Mitchells until 21st January 1943.

APPENDIX 40

Monthly Annual and Grand Totals of Bomber Command Aircraft despatched, missing and damaged on operations September 1939 to May 1945

Authors' note: These tables are divided into Night and Day Raids.

Night Raids cover aircraft from Bomber Command despatched on bombing and leaflet operations, and, from December 1943, the associated activities of 100 Group.¹ The latter are also shown separately. The following have been excluded: sorties of the Advanced Air Striking Force, intruder activities of Fighter Command and the Air Defence of Great Britain, aircraft of Bomber Command engaged on minelaying, sea and flying bomb patrols, reconnaissance and Special Operations Executive operations.

The source from which these figures have been compiled is, from 1939 to February 1942, the Bomber Command Operations Record Book. The figures given in this record for despatched and missing are fairly reliable, but no consistent attempt was made to cover damaged aircraft. Figures are regularly given for 'Crashed' aircraft, but whether these were total wrecks or merely damaged it is impossible to say. It is, however, clear that many more aircraft were damaged than are shown under 'Crashed'.

From February 1942 to May 1945 the Operational Research Section of Bomber Command made much more detailed reports on every Night Raid. These reports have been used as the source for the figures after February 1942. The form of the table, therefore, changes at this date. Full statistics of damaged aircraft are included in these reports which show the extent of the damage and the estimated cause. The columns headed 1 in these tables refer to aircraft which were total wrecks and those headed 2 refer to aircraft which were repairable.

The Operational Research Section did not attempt to analyse the cause for which aircraft were missing until July 1942.² As only strong evidence was accepted in assessing the cause of loss the figures in these columns will very rarely be found to add up to the total missing.

Day Raids cover aircraft from the operational squadrons of Bomber Command despatched on bombing and leaflet operations, and, from June 1944, the activities of 100 Group, which are also shown separately. A great number of the aircraft despatched by day (especially before 1942) were engaged on searching for enemy warships. Many of these sorties were fruitless and they have only been included in the number despatched when the aircraft found and attacked a target. The following have been excluded: sorties of the Advanced Air Striking Force, Bomber Command

¹ When O.T.U. squadrons operated as part of the main force, e.g. on the night of the Thousand attack on Cologne, they have been counted as operational squadrons.

² From February 1942 for Day Raids.

anti-submarine patrols, convoy escort duties, minelaying, supply carrying,¹ reconnaissance, anti-invasion exercises and the repatriation of prisoners of war.

The source used for these figures from 1939 to February 1942 is the Bomber Command Operations Record Book, and the same observations apply to the statistics of 'Crashed' aircraft as in the Night Raids.

From February 1942 to May 1943 the Operational Research Section of Bomber Command made detailed reports on every day raid. These reports have been used as the source for the figures between these dates, and the table alters accordingly. There were no day operations (except reconnaissance) after May 1943 until February 1944. Unfortunately, the Operational Research Section did not restart its Day Raid Reports until March 1945. The source, therefore, used for February 1944 to March 1945 is the Operations Record Book. The same difficulty again arises over damaged aircraft. These are rarely mentioned and it should not be assumed that, because the table shows no figure for damaged aircraft, that none was, in fact, damaged. No attempt is made in the Operations Record Book or in the later series of Day Raid Reports to assess the cause of loss. From March 1945 to the end of the war the sources used are the Operational Research Section Day Raid Reports.

¹ Sorties to drop supplies on occupied countries have, however, been included.

Night Raids

Month and Year	Total Despatched	Missing	Crashed	Month and Year	Total Despatched	Missing	Crashed
1939				1941			
September	83	2	3	January	1,030	12	12
October	32	2	2	February	1,617	16	32
November	15	-	1	March	1,728	35	36
December	40	-	-	April	2,249	56	12
				May	2,416	39	14
1940				June	3,228	76	15
January	38	-	-	July	3,243	91	28
February	54	1	2	August	3,344	121	45
March	239	5	6	September	2,621	76	62
April	489	18	8	October	2,501	68	40
May	1,617	21	3	November	1,713	83	21
June	2,484	26	7	December	1,411	28	16
July	1,722	40	3				
August	2,188	52	11	1942			
September	3,141	65	21	January	2,216	56	32
October	2,242	27	32				
November	1,894	50	34				
December	1,385	37	23				

Night Raids

Month and Year	Despatched		Missing				Damaged						
	Total	100 Group (included in total)	Estimated Cause of Loss			Total Damaged	By Fighters		By Flak		Not by Enemy Action		
			Fighters	Flak	Not Enemy Action		1	2	1	2	1	2	
													1
1943													
October	4,638	-	83	32	2	4	75	2	151	15	71		
November	5,208	-	72	32	2	2	43	9	380	37	85		
December	4,123	11	95	30	6	4	54	1	239	42	56		
1944													
January	6,278	41	136	79	4	8	87	3	176	27	115		
February	4,263	82	70	50	8	-	44	-	120	24	76		
March	9,031	102	115	50	6	6	100	-	163	33	100		
April	9,873	217	75	57	6	7	51	2	189	16	113		
May	11,353	330	137	50	4	10	85	2	194	17	97		
June	13,592	719	128	55	2	8	65	6	160	16	59		
July	11,500	927	92	40	6	5	74	4	288	20	67		
August	10,013	855	65	39	2	4	44	1	318	17	79		
September	6,428	207	27	14	8	1	21	2	165	12	46		
October	10,193	1,210	9	24	2	1	8	3	354	22	98		
November	9,589	1,336	47	17	5	9	31	1	216	24	50		
December	11,239	1,115	39	14	-	1	15	5	212	37	76		
1945													
January	9,603	1,890	48	28	10	2	18	2	204	53	67		
February	13,715	1,228	74	27	6	12	39	8	156	40	115		
March	11,585	1,578	73	29	10	29	47	5	157	42	86		
April	8,822	1,386	10	5	-	7	7	3	72	22	29		
May 1/2 to 6/7	349	161	-	-	-	-	-	-	6	-	1		

Day Raids

Month and Year	Total Despatched	Missing	Crashed	Month and Year	Total Despatched	Missing	Crashed
1939				1941			
September	40	12	-	January	96	3	1
October	-	-	-	February	124	2	2
November	4	-	-	March	162	4	-
December	119	17	2	April	676	23	7
				May	273	20	3
1940				June	531	22	3
January	6	-	-	July	582	66	3
February	4	-	-	August	468	35	5
March	53	1	-	September	263	14	1
April	167	15	-	October	138	17	1
May	802	49	3	November	43	-	-
June	812	31	1	December	151	7	-
July	616	32	4				
August	417	18	-	1942			
September	98	1	-	January	24	-	-
October	172	1	-				
November	113	2	-				
December	56	2	-				

Day Raids

Month and Year	Total Despatched	Missing			Damaged															
		Total	Estimated Cause of Loss		Total	By Fighter		By Flak		Not by Enemy Action										
			Fighter	Flak		Not Enemy Action	1	2	1	2	1	2								
1942																				
February	252	15	-	-	-	2	-	-	4	1	17	-	-	3	1					
March	131	2	-	-	-	2	-	-	4	-	26	-	-	1	1					
April	246	13	6½	6½	6½	6½	6½	6½	13	2	45	-	-	-	-					
May	105	1	-	1	1	-	-	-	-	-	34	-	-	-	-					
June	196	2	-	-	-	1	-	-	1	1	42	-	-	-	-					
July	313	19	2	2	2	5	-	-	7	-	37	-	-	11	1					
August	186	10	3	3	3	3	-	-	5	3	30	-	-	1	1					
September	127	6	2	2	2	-	-	-	3	-	6	-	-	5	5					
October	406	14	-	-	-	-	-	-	4	-	23	-	-	18	18					
November	127	11	-	-	-	-	-	-	2	-	16	-	-	5	5					
December	200	16	1	1	1	1	-	-	3	1	35	-	-	24	24					
1943																				
January	406	15	2	2	2	3	-	-	2	2	32	-	-	9	9					
February	426	6	1	1	1	2	-	-	3	-	46	-	-	2	2					
March	284	7	2	2	2	-	-	-	1	-	30	-	-	1	1					
April	316	12	10	10	10	-	-	-	2	-	40	-	-	4	4					
May	360	19	11	11	11	4	-	-	5	3	50	-	-	3	3					

There were no more day raids until February 1944.

Day Raids

Month and Year	Total Despatched	100 Group Sorties ¹	Missing	Crashed	Month and Year	Total Despatched	Missing	Damaged													
								Total	By Fighters		By Flak		Not by Enemy Action								
									1	2	1	2	1	2							
1944																					
February	45	-	-	-	1945	9,606	47	-	4	5	4	949	6	51	-	-	-	-	-	-	
March	18	-	-	-	March	5,001 ²	22	-	1	2	1	250	5	10	-	-	-	-	-	-	
April	10	-	-	-	April	1,068	-	-	-	-	-	-	1	1	-	-	-	-	-	-	
May	16	-	-	-	May		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
June	2,371	17	12	-	(to 8th		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
July	6,298	39	12	4	May		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
August	10,271	105	35	1	only)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
September	9,643	161	41	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	
October	6,713	150	52	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	
November	5,055	49	41	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	
December	3,656	1	31	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1945																					
January	1,304	1	12	-																	
February	3,685	12	9	-																	

¹ The 100 Group sorties are also included in the total despatched.

² One of these aircraft came from 100 Group.

Annual Totals

	<i>Total Despatched</i>		<i>Total Missing</i>	
	<i>By Night</i>	<i>By Day</i>	<i>By Night</i>	<i>By Day</i>
1939	170	163	4	29
1940	17,493	3,316	342	152
1941	27,101	3,507	701	213
1942	32,737	2,313	1,291	109
1943	62,736	1,792	2,355	59
1944	113,352	35,096	2,349	224
1945	44,074	20,664	507	90

Estimated Cause of Loss

	<i>By Fighters</i>		<i>By Flak</i>		<i>Not by Enemy Action</i>		<i>Unknown Causes</i>	
	<i>Night (July-Dec. only)</i>	<i>Day 14½ (Feb.-Dec.)</i>	<i>Night 193 (July-Dec.)</i>	<i>Day 18½ (Feb.-Dec.)</i>	<i>Night 7 (July-Dec.)</i>	<i>Day 2 (Feb.-Dec.)</i>	<i>Night 327 (July-Dec.)</i>	<i>Day 74 (Feb.-Dec.)</i>
1942	169	14½	193	18½	7	2	327	74
1943	964	26 (to May only)	574	9 (to May only)	26	6	691	18 (to May only)
1944	940	—	489	—	53	—	867	—
1945	205	—	89	—	26	—	187	—

<i>Total Damaged</i>	
<i>Night</i>	<i>Day</i>
1942 (Feb.-Dec.)	2,839
1943	5,177
1944	4,520
1945	1,242
	(Unrecorded)
	1,265
	(March-May only)

Estimated Cause of Damage

	By Fighters		By Flak		Not by Enemy Action		Unknown Causes						
	Day		Day		Day		Day						
	Night	Day	Night	Day	Night	Day	Night	Day					
1942 (Feb.-Dec.)	23	277	1	2	43	1,958	1	2	10	3	2	1	2
	37	552	2	61	61	3,589	2	69	-	-	2	3	8
1943													
1944	60	625	-	29	29	2,555	-	265	8	2	2	-	-
	43	111	-	18	18	595	5	157	19	12	1	-	-
1945													

Grand Totals of Sorties

Total Despatched 1939-1945:	Night, 297,663
	Day, 66,851
Total Missing 1939-1945:	Night, 7,449
	Day, 876
Total Damaged February 1942-May 1945	Night, 13,778
Estimated Cause of Loss, July 1942 to May 1945	Night, 2,278 by fighters
	1,345 by flak
	112 not by enemy action (mainly collisions)
	2,072 from unknown causes
Estimated Cause of Damage, February 1942-May 1945:	Night, 1,728 fighters (163 wrecked, 1,565 repairable)
	8,848 by flak (151 wrecked, 8,697 repairable)
	3,159 not by enemy action (876 wrecked, 2,283 repairable)
	43 from unknown causes (37 wrecked, 6 re- pairable)

APPENDIX 41

Bomber Command Casualties, 3rd September 1939–8th May 1945

R.A.F., W.A.A.F., Dominion and Allied personnel at R.A.F. posting disposal

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed	216	659	727	820	1,550	1,610	5,582
(b) Presumed dead	1,159	2,786	5,819	11,302	14,933	5,549	41,548
(c) Died P.O.W.	6	15	31	31	43	12	138
(d) Missing now safe	43	38	186	496	1,178	927	2,868
(e) P.O.W. now safe	419	906	1,437	2,466	3,596	960	9,784
(f) Wounded	269	600	786	871	1,030	644	4,200
2. Non-Operational							
(g) Killed	383	774	1,382	1,933	2,413	1,205	8,090
(h) Wounded	217	535	786	1,112	1,070	483	4,203
(j) Died other causes	15	26	39	36	58	41	215
(k) Missing now safe	8	12	14	21	19	9	83
(l) P.O.W. now safe	4	20	12	8	6	4	54
GROUND STAFF							
(m) Killed	157	111	90	108	52	12	530
(n) Wounded	96	162	121	156	150	74	759
(o) Died other causes	93	176	188	211	204	168	1,040
(p) Missing now safe	15	2	7	2			26
(q) P.O.W. now safe	30	7	2	11	2		52

Notes. Item (a) includes died of wounds. Items (g) and (m) include deaths from flying accident, ground battle and air raid casualties. Items (j) and (o) include accidents not attributable to enemy action.

¹ These figures were supplied to the authors by the Air Ministry Directorate of Manning (Manning Statistics).

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R.A.F. and W.A.A.F.

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed	216	565	478	536	1,031	900	3,726
(b) Presumed dead	1,128	2,487	3,958	7,970	10,343	3,278	29,164
(c) Died P.O.W.	6	12	22	19	25	6	90
(d) Missing now safe	43	32	113	343	652	463	1,646
(e) P.O.W. now safe	418	767	957	1,718	2,397	504	6,761
(f) Wounded	269	531	501	589	669	376	2,935
2. Non-Operational							
(g) Killed	378	633	915	1,294	1,400	705	5,325
(h) Wounded	216	442	520	763	654	317	2,912
(j) Died other causes	15	26	28	23	37	28	157
(k) Missing now safe	8	12	13	21	16	9	79
(l) P.O.W. now safe	4	14	5	5	4		32
GROUND STAFF							
(m) Killed	156	109	77	83	43	9	477
(n) Wounded	94	158	108	137	116	58	671
(o) Died other causes	90	171	160	178	156	131	886
(p) Missing now safe	14	2	6	1			23
(q) P.O.W. now safe	30	7	1	4	1		43

R.C.A.F.

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed		24	124	164	270	392	974
(b) Presumed dead		99	888	2,091	2,752	1,405	7,235
(c) Died P.O.W.			3	10	13	5	31
(d) Missing now safe		2	17	97	375	297	788
(e) P.O.W. now safe		39	201	515	819	269	1,843
(f) Wounded		22	122	164	219	146	673
2. Non-Operational							
(g) Killed		66	254	359	675	293	1,647
(h) Wounded		39	126	176	227	91	659
(j) Died other causes			4	9	13	6	32
(k) Missing now safe			1		2		3
(l) P.O.W. now safe		4	1		1		6
GROUND STAFF							
(m) Killed			10	14	2		26
(n) Wounded		1		6	11	7	25
(o) Died other causes			4	4	12	15	35
(p) Missing now safe				1			1
(q) P.O.W. now safe							-

R.N.Z.A.F.

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed		16	36	37	20	37	146
(b) Presumed dead	5	87	300	439	352	104	1,287
(c) Died P.O.W.		1	2	1	2		6
(d) Missing now safe			3	19	23	28	73
(e) P.O.W. now safe		31	90	92	69	17	299
(f) Wounded		12	43	40	19	18	132
2. Non-Operational							
(g) Killed	3	13	59	63	56	41	235
(h) Wounded	1	9	38	41	40	16	145
(j) Died other causes				2	1	2	5
(k) Missing now safe							-
(l) P.O.W. now safe			4		1		5
GROUND STAFF							
(m) Killed		1		1			2
(n) Wounded				1	1		2
(o) Died other causes	1	1					3
(p) Missing now safe							-
(q) P.O.W. now safe				6			6

R.A.A.F.

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed		6	41	66	194	218	525
(b) Presumed dead		28	394	580	1,305	580	2,887
(c) Died P.O.W.			1		3	1	5
(d) Missing now safe		1	22	18	112	115	268
(e) P.O.W. now safe		8	72	105	285	114	584
(f) Wounded		6	36	41	96	67	246
2. Non-Operational							
(g) Killed		11	103	146	225	132	617
(h) Wounded		13	53	98	111	43	318
(j) Died other causes			5	1	6	4	16
(k) Missing now safe					1		1
(l) P.O.W. now safe		1	1	3			5
GROUND STAFF							
(m) Killed			1	2			3
(n) Wounded		1	1	1	3		6
(o) Died other causes	1			2	2	1	6
(p) Missing now safe			1				1
(q) P.O.W. now safe			1	1	1		3

S.A.A.F.

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed						4	4
(b) Presumed dead				1	5	9	15
(c) Died P.O.W.		1					1
(d) Missing now safe					2	2	4
(e) P.O.W. now safe		1			1	8	10
(f) Wounded				1	1	3	5
2. Non-Operational							
(g) Killed					6	1	7
(h) Wounded					2		2
(j) Died other causes							-
(k) Missing now safe							-
(l) P.O.W. now safe							-
GROUND STAFF							
(m) Killed							-
(n) Wounded							-
(o) Died other causes							-
(p) Missing now safe	1						1
(q) P.O.W. now safe							-

Other Dominions

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed					1	2	3
(b) Presumed dead			4	1	11	10	26
(c) Died P.O.W.							-
(d) Missing now safe					2	3	5
(e) P.O.W. now safe				2	1		3
(f) Wounded			1		2		3
2. Non-Operational							
(g) Killed		2	1			2	5
(h) Wounded		1			1		2
(j) Died other causes							-
(k) Missing now safe							-
(l) P.O.W. now safe		1					1
GROUND STAFF							
(m) Killed							-
(n) Wounded							-
(o) Died other causes							-
(p) Missing now safe							-
(q) P.O.W. now safe							-

Poles

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed		32	37	16	10	18	113
(b) Presumed dead	26	52	219	197	103	39	636
(c) Died P.O.W.			3	1			4
(d) Missing now safe		2	25	14	5	7	53
(e) P.O.W. now safe		42	101	31	12	11	197
(f) Wounded		22	72	24	15	2	135
2. Non-Operational							
(g) Killed	1	38	40	42	33	17	171
(h) Wounded		21	39	24	22		106
(j) Died other causes			2	1	1	1	5
(k) Missing now safe							-
(l) P.O.W. now safe			1			4	5
GROUND STAFF							
(m) Killed			1	2	1		4
(n) Wounded		1		1			2
(o) Died other causes		1	7	4	2	1	15
(p) Missing now safe							-
(q) P.O.W. now safe							-

Allies (other than Poles)

	3-9-39 to 2-9-40	3-9-40 to 2-9-41	3-9-41 to 2-9-42	3-9-42 to 2-9-43	3-9-43 to 2-9-44	3-9-44 to 8-5-45	Total 3-9-39 to 8-5-45
AIRCREW							
1. Operational							
(a) Killed		11	16	1	24	39	91
(b) Presumed dead		33	56	23	62	124	298
(c) Died P.O.W.		1					1
(d) Missing now safe		1	6	5	7	12	31
(e) P.O.W. now safe	1	18	16	3	12	37	87
(f) Wounded		7	11	12	9	32	71
2. Non-Operational							
(g) Killed	1	11	10	29	18	14	83
(h) Wounded		10	10	10	13	16	59
(j) Died other causes							-
(k) Missing now safe							-
(l) P.O.W. now safe							-
GROUND STAFF							
(m) Killed		1		6		1	8
(n) Wounded	1					3	4
(o) Died other causes			2	1	2	9	14
(p) Missing now safe							-
(q) P.O.W. now safe							-

APPENDIX 42

What is the highest percentage of losses that the Royal Air Force could stand over a period of 3 months of intensive operations?
(Paper by the Director of Bomber Operations,
16th March 1945)

Aircraft in Bomber Command missing on operations during the five years 1940/44 have fluctuated between 1·8% and 4·4% of sorties despatched. There were occasions when losses rose considerably higher in certain units for short periods with the result that the units concerned were suspended from operations to enable them to rehabilitate themselves or to re-equip to an improved type of aircraft.

2. The following figures show what happened on three such occasions, inherent faults in the aircraft being a strong contributory cause in each case:

(i) *Halifaxes—No. 4 Group—1942*

<i>1942</i>	<i>Sorties</i>	<i>% Missing</i>
March	80	8·8
April	131	9·2
May	291	4·8
June	654	6·0
July	472	4·9
August	142	10·1

Halifax squadrons of No. 4 Group were suspended from operations for three or four weeks to rest and train crews.

(ii) *Stirlings—No. 3 Group—1943*

<i>1943</i>	<i>Sorties</i>	<i>% Missing Against German Targets</i>	<i>Sorties</i>	<i>% Missing Against all Targets</i>
August	709	7·8	1,076	5·8
September	474	6·3	991	3·4
October	278	3·6	505	2·4
November	250	5·6	418	4·8

Stirlings were permanently suspended from bombing operations against targets in GERMANY.

(iii) *Halifax II's and V's—No. 4 Group—1943/44*

<i>1943/44</i>	<i>Sorties</i>	<i>% Missing Against German Targets</i>	<i>Sorties</i>	<i>% Missing Against all Targets</i>
November	1,191	3·8	1,301	3·8
December	713	8·1	746	6·4
January	544	11·4	613	10·1
February	269	10·8	644	5·1

Permanently suspended from bombing operations against targets in GERMANY.

3. The figures for the operations of the Halifax II's and V's against targets in GERMANY are perhaps most instructive. The following table shows the proportion of crews which would be expected to survive a tour of 30 operations at the loss rates actually sustained by the Halifaxes in the Winter of 1943/44:

<i>% Missing</i>	<i>Crews surviving 30 operations</i>
8·1	8%
10·8	3·2%
11·4	2·6%

4. If the total wastage rate including crashes and postings is 7% the proportion of crews who would survive a tour of 30 operations is only 10% which means that most of the experienced Squadron and Flight Commanders with their best crews would rapidly be lost. Thereafter, operational losses would rise rapidly by reason of the unduly high percentage of inexperienced crews. This is borne out by the figures in paragraph 2 (iii) above.

5. Two main factors limit the loss rate which can be sustained—operational efficiency and morale. The first is dependent upon the average level of experience amongst the crews in the Squadrons. The higher the loss rate the lower the level of experience and the lower the operational effectiveness. This factor is largely independent of the intensity of operations. Morale, which is to some extent governed by the standard of operational efficiency, is closely related to the intensity of operations to which, for a given loss rate, the actual losses over a period are proportional. Experience suggests that the factor of operational efficiency will impose an earlier limitation upon the acceptable loss rate than that of morale.

Conclusion

6. Operational experience in this war, therefore, indicates that a strategic bomber force would become relatively ineffective if it suffered operational losses in the region of 7% over a period of 3 months' intensive operations, and that its operational effectiveness may become unacceptably low if losses of 5% were sustained over this period.

APPENDIX 43

Principal Aircraft in Bomber Command 1939-1945

Type and Mark	Engine(s)	Number of Crew	Wing Span ft.	Gross Wing-Area sq. ft.	Length ft.	Height (Tail Down) ft.	Maximum Weight lb.	Mean Weight lb.	Light Weight ¹ lb.	Tare Weight lb.
Wellington 1A and 1C	2 Pegasus XVIII	6	86	830	60-8	18-75	30,000	25,800	20,800	18,800
Wellington II	2 Merlin X	6	86	830	60-8	18-75	32,000	27,600	22,500	20,050
Wellington III	2 Hercules XI	6	86	830	60-8	18-75	34,500	29,950	25,125	21,950
Wellington IV	2 Twin Wasp S3C4-G	6	86	830	60-8	18-75	31,600	27,500	23,200	20,150
Wellington V	2 Hercules VIII	3	86-2	840	62-6	17-4	32,000	27,050	21,547	20,225
Wellington VI	2 Merlin 60	3	86-2	840	62-6	17-4	31,600	26,650	20,931	19,617
Wellington X	2 Hercules VI	6	86	830	60-8	18-75	36,500	31,500	26,325	22,486
Whitley V	2 Merlin X	5	84	1,232	69-3	12-75	33,500	28,200	21,986	19,330
Hampden	2 Pegasus XVIII	4	69-3	737	53-3	14-9	22,500	19,150	15,000	12,794
Blenheim IV	2 Mercury XV	3	56	469	40	9-2	15,800	13,500	11,700	9,790
Stirling I	4 Hercules XI	7	99	1,460	87	22-75	70,000	59,400	46,900	44,000
Stirling III	4 Hercules VI	7	99	1,460	87	22-75	70,000	59,400	46,900	44,000
Halifax I	4 Merlin X	7	98	1,250	70-1	20-75	59,000	49,000	38,000	34,500
Halifax II and V	4 Merlin XX	6	98	1,250	70-1	20-75	60,000	50,000	Mk. II	Mk. II
Halifax III	4 Hercules XVI	7	104	1,275	70-1	20-75	65,000	54,600	40,420	36,177
Manchester	2 Vulture II	5	90-1	1,130	68-8	19-5	50,000	41,315	31,970	29,432
Lancaster I and III	4 Merlin 22, 28 or 38	7	102	1,297	68-9	19-5	68,000	55,000	41,000	36,900
Mosquito IV	Merlin 21	2	54-17	454	40-5	12-5	21,462	18,390	15,318	13,400
Mosquito IX	Merlin 23	2	54-17	454	40-5	12-5	21,462	18,390	15,318	13,400
Mosquito XVI*	Merlin 72	2	54-17	454	44-5	12-5	22,475	18,893	15,310	14,435
Mosquito XX	Packard Merlin 31 or 33	2	54-17	454	44-5	12-5	23,000	19,093	15,510	14,695
		2	54-17	454	40-5	12-5	21,462	18,390	15,318	13,400

Other Aircraft in Bomber Command

Fortress I	4 Cyclone R. 1820-73	6	104	1,420	66	15-5	53,200	43,500	34,560	30,670
Ventura I	2 Double Wasp S1A4-G	4	65-5	551	52-6	14-2	26,000	23,000	21,000	17,250
Boston III	2 Cyclone G.R.2600-23	4	61-33	465	48-0	15-8	23,000	20,500	17,120	15,650

* No fuel, oil or bombs. * Pressure cabin.

Principal Aircraft in Bomber Command 1939-1945—Continued

	Take Off over 50 ft. (Max. weight) yds.	Landing over 50 ft. (a) light weight (b) at 55,000 lb. (c) at 45,000 lb. yds.	Service Ceiling (Max. weight) ft.	Maximum Speed at Associated Height		Most Economical Cruising Speed at Associated Height	
				Max. Speed (m.p.h.)	Height ft.	Height ft.	Cruising Speed (m.p.h.)
Wellington 1A and 1C cont.	1,300	(a) 800	15,000	(a) M.225	M. 4,700	10,000	165
Wellington II cont.	1,350	(a) 850	20,000	S. 235	S. 15,500	15,000	175
Wellington III cont.	1,050	(a) 900	19,500	(a) M.245	M. 7,000	15,000	180
Wellington IV cont.	1,000	(a) 850	18,000	S. 247	S. 17,000	15,000	175
Wellington V cont.	1,070	(a) 490	35,000	M. 242	M. 1,000	35,000	233
Wellington VI cont.	1,026	(a) 480	36,700	S. 261	S. 12,500	35,000	265
Wellington X cont.	1,200	(a) 950	18,250	(a) M.222	M. 7,500	15,000	180
Whitley V cont.	1,000	(a) 650	17,600	S. 229	S. 13,000	15,000	165
Hampden cont.	1,150	(a) 650	20,000	(a) M.264	M. 6,500	15,000	155
Blenheim IV cont.	940	(a) 850	22,000	S. 292	S. 32,000	15,000	180
Stirling I cont.	1,400	(a) 1,100	16,500	(a) M.246	M.12,000	15,000	200
				S. 300	S. 32,000		
				M.250	M. 6,000		
				S. 255	S. 14,500		
				(a) M.202	M. 6,500		
				S. 222	S. 17,000		
				(a) M.243	M. 4,000		
				S. 254	S. 13,800		
				(a) M.266	M.11,000		
				S. —	S. —		
				(a) M.245	M. S.L.	15,000	
				S. 200	S. 10,500		

Stirling III cont.	1,400	(a) 1,100	17,000	(a) M.270 S. 270	M. 7,000 S. 14,500	15,000	200
Halifax I cont.	1,400	(a) 850	18,000	(a) M.255 S. 262	M. 7,000 S. 18,000	15,000	195
Halifax II and V cont.	1,200	(a) 850	21,000	M.250 ¹ S. 253 ¹	M.13,000 S. 19,000	20,000 ²	205
Halifax III cont.	1,150	(b) 1,100	20,000	(b) M.277 S. 281	M. 6,000 S. 13,500	20,000	225
Manchester cont.	1,300	(a) 1,050	19,200	(a) M.258 S. 273	M. 7,000 S. 17,000	15,000	185
Lancaster I and III cont.	1,500 ¹ 1,200 ²	(c) 1,000	20,000	(c) M.266 ¹ M.271 ² S. 270 ¹ S. 281 ²	M.12,500 ¹ M. 6,250 ² S. 20,000 ¹ S. 11,000 ²	20,000	216 ⁴
Mosquito IV Merlin 21 cont.	840	(a) 860	33,000	(a) M.362 S. 380	M. 9,000 S. 14,000	15,000	265
Merlin 23 cont.	795	(a) 863	33,000	(a) M.362 S. 380	M. 9,000 S. 14,000	15,000	265
Mosquito IX cont.	890	(a) 865	36,000	(a) M.375 S. 397	M.13,000 S. 26,000	15,000	245
Mosquito XVI cont.	890	(a) 865	36,000	(a) M.376 S. 397	M.13,000 S. 26,000	15,000	245
Mosquito XX cont.	795	(a) 860	33,000	(a) M. 362 S. 380	M. 9,000 S. 14,000	15,000	265
Fortress I cont.	1,150	(a) 650	33,300	(a) S. 325	S. 28,000 to 30,000	30,000	230
Ventura I cont.	900	(a) 1,050	25,000	(a) M.264 S. 274	M. 6,800 S. 14,000	16,000	175
Boston III cont.	1,100	(a) 1,200	25,500	(a) M.308 S. 318	M. 3,000 S. 10,500	15,000	200

¹ At 9 lb. boost.
² At max. combat power.
³ The aircraft will not cruise at this height until the weight is reduced to approx. 56,000 lb.
⁴ At mean weight.

Principal Aircraft in Bomber Command 1939-1945—Continued

	Rate of Climb at Max. Weight to Min. ft.	Range with Fuel carried and Associated Bombload at Most Economical Cruising Speed		Maximum Alternative Bombload			Armament					
		(a) With maximum bombload	(b) With permanent tank(s) full	(c) With auxiliary tank(s) full ¹	Fuelage lb.	Wings lb.	Total lb.	Front Turret	Mid-upper Turret	Tail Turret	Fixed or Free	Under Turret
Wellington IA and IC cont.	10,000 : 25	(a) 1,200	4,500	520	9 X 500		4,500	2 X .303	—	2 X .303	2 X .303	
		(b) 1,805	2,750	750	18 X 250		4,500					
		(c) 2,550	1,000	1,030	2 X 2,000		4,500					
Wellington II cont.	15,000 : 28.5	(a) 1,400	4,500	616	9 X 500		4,500	2 X .303	—	2 X .303	2 X .303	
		(b) 1,750	3,500	750	18 X 250		4,500					
		(c) 2,450	1,250	1,030	2 X 2,000		4,000					
Wellington III cont.	15,000 : 25	(a) 1,200	4,500	638	9 X 500		4,500	2 X .303	—	2 X .303	2 X .303	
		(b) 1,440	3,500	750	18 X 250		4,500					
		(c) 2,040	1,500	1,030	2 X 2,000		4,000					
Wellington IV cont.	15,000 : 31.5	(a) 980	4,500	500	9 X 500		4,500	2 X .303	—	2 X .303	2 X .303	
		(b) 1,510	2,700	750	18 X 250		4,500					
		(c) 2,180	500	1,030	2 X 2,000		4,000					
Wellington V cont.	35,000 : 70	(a) 1,560	4,500	750	2 X 2,000		4,000	—	—	4 X .303	—	
		(c) 2,250	1,500	1,030	4 X 1,000		4,000					
					18 X 250		4,500					

Wellington VI cont.	35,000 : 65	(a) 1,510	4,500	750	2 X 2,000	4,000	—	—	—	4 X '303	—
		(c) 2,180	1,500	1,030	4 X 1,000 9 X 500	4,000 4,500	—	—	—	—	—
Wellington X cont.	15,000 : 27.7	(b) 1,325	4,500	750	9 X 500	4,500	2 X '303	—	—	4 X '303	—
		(c) 1,885	1,500	1,030	16 X 250	4,000	—	—	—	—	—
		(a) 630	8,000	370	2 X 2,000 + 2 X 500	12 X 250	8,000	1 X '303	—	—	4 X '303
Whitley V cont.	15,000 : 36.5	(b) 1,370	5,500	705	2 X 500	—	—	—	—	—	—
		(c) 1,930	3,500	969	—	—	—	—	—	—	—
Hampden cont.	15,000 : 26.5	(a) 1,200	4,000	438	2 X 2,000	4,000	2 X '303	—	—	4 X '303	—
		(b) 1,885	2,000	654	4 X 500	2,000	(Rose mounting)	—	—	—	—
Blenheim IV cont.	15,000 : 17	(a) 1,460	1,000	466	4 X 250	1,000	2 X '303	—	—	3 X '303	—
		(b) 1,460	1,000	466	—	—	—	—	—	—	—
		(a) 740	14,000	980	7 X 2,000	14,000	2 X '303	2 X '303	2 X '303	4 X '303	4 X '303
Stirling I cont.	15,000 : 42	(b) 1,930	5,000	2,254	18 X 500	12,000	—	—	—	—	—
		(c) 2,330	1,500	2,694 ²	7 X 2,000	14,000	2 X '303	—	—	—	—
		(a) 590	14,000	850	18 X 500	6 X 500	12,000	2 X '303	2 X '303	4 X '303	2 X '303
Stirling III cont.	15,000 : 30	(b) 2,010	3,575	2,254	7 X 2,000	14,000	—	—	—	—	—
		(c) 2,440	Nil	2,694 ²	18 X 500	6 X 500	12,000	—	—	—	—
		(a) 1,000	13,000	955	2 X 2,000 +	—	—	—	—	—	—
Halifax I cont.	15,000 : 29.5	(a) 1,740 ³	8,500 ³	1,552 ²	6 X 1,000	13,000	2 X '303	—	—	4 X '303	6 X '303
		(b) 1,840 ⁴	7,750 ⁴	1,640 ⁴	—	—	—	—	—	—	—
		(c) 2,720	1,500	2,330	4 X 2,000 (Mine) + 6,500	6 X 500	11,000	—	—	—	—
				9 X 500	6 X 500	9,000	—	—	—	—	—
					6 X 500	7,500	—	—	—	—	—

¹ This figure represents the highest fuel and range capacity of the aircraft with the smallest bombload given in the M.A.P. forms.
² With wing auxiliary tanks. ³ With Hampden tanks 160 gals. ⁴ With additional wing tank fitted.

Principal Aircraft in Bomber Command 1939-1945—Continued

	Rate of Climb at Max. Weight to Mins. ft.	Range with Fuel Carried and Associated Bombload at Most Economical Cruising Speed			Maximum Alternative Bombload			Armament			
		Range miles	Bombs Carried lb.	Fuel Carried gals.	Fuselage lb.	Wings lb.	Total lb.	Front Turret	Mid-upper Turret	Tail Turret	Fixed or Free
Halifax II and V cont.	20,000 : 43.5	(a) 650 ^a	13,000	830 ^a	2 X 2,000	6 X 500	13,000	1 X .303	4 X .303	4 X .303	
		(a) 580 ^a		760 ^a	+ 6 X 1,000						
		(b) 1,660	{ 5,250 ^b	1,882	4 X 2,000	6 X 500	11,000				
		(c) 2,320	{ 4,750 ^c	2,572 ^c	2 X 4,000	6 X 500	11,000				
Halifax III cont.					1 X 8,000	6 X 500	11,000				
					2 X 1,500 (Mines) +	6 X 500	9,000				
					6 X 500	6 X 500	7,500				
	20,000 : 45	(a) 980	13,000	1,077	2 X 2,000 +	6 X 500	13,000	1 X .303	4 X .303	4 X .303	
		(b) 2,005	6,250	1,998	6 X 1,000	6 X 500	11,000				
		(c) 2,785	500	2,688	4 X 2,000	6 X 500	11,000				
Manchester cont.					2 X 4,000	6 X 500	11,000				
					1 X 8,000	6 X 500	11,000				
					2 X 1,500 (Mines) +	6 X 500	9,000				
	15,000 : 25	(a) 1,200	10,350	882	6 X 500	6 X 500	7,500				
Lancaster I and III cont.		(b) 1,630	8,100	1,160	9 X 500						
					4 X 1,900 +						
		(a) 1,660	14,000	1,625	2 X 1,000		10,350	2 X .303	2 X .303	4 X .303	4 X .303
		(b) 2,250	10,000	2,150	+ 3 X 250						
				15 X 500		7,500					
				14 X 1,000 (Special)		14,000 ^b	2 X .303	2 X .303	4 X .303	4 X .303	
				6 X 2,000 +		12,750					
				3 X 250							

Mosquito IV cont.	15,000 : 9	(c) 3,150	—	2,950	6 X 1,500 (Mines) 1 X 8,000 1 X 4,000 +	9,000	—	—	—	—
Mosquito IX cont.	15,000 : 7 ^a	(b) 1,620 (c) 2,040 (a) 1,370	2,000 ^b — 5,000	536 657 500	4 X 500 1 X 4,000 4 X 500	2,000 5,000 3,000	—	—	—	—
Mosquito XVI cont.	15,000 : 7.75	(b) 1,485 (c) 1,870 (a) 1,370 (b) 1,485 (c) 1,795	3,000 1,000 5,000 3,000 2,000	536 500 536 657	4 X 500 1 X 4,000 1 X 4,000 4 X 500 4 X 500	3,000 3,000 4,000 5,000 2,000	—	—	—	—
Mosquito XX cont.	15,000 : 9	(b) 1,620 (c) 2,040	3,000 1,000	536 657	4 X 500 — 2 X 500 2 X 500	2,000 1,000 3,000 4,000	—	—	—	1 X '30 5 X '50
Fortress I cont.	30,000 : 37.5	(a) 1,850 (b) 1,850 (c) 2,860	7,400 7,400 —	1,415 1,415 2,075	4 X 500 2 X 2,000 4 X 1,100 8 X 600 2 X 2,000 + 2 X 1,100 +	4,000 4,400 4,800 7,400	—	—	—	—
Ventura I cont.	15,000 : 11	(a) 925 (b) 925 (c) 1,400	2,500 2,500 1,000	470 470 674	3 X 500 + 4 X 250	2,500 2,500	—	—	{ 2 X '303 or 2 X '50	2 or 4 X '303 + 2 X '50
Boston III cont.	15,000 : 11	(a) 1,240 (b) 1,240 (c) 2,035	2,000 2,000 —	447 447 689	4 X 500 4 X 250 2 X 500 + 2 X 250	2,000 1,000 1,500	—	—	—	7 X '303 ¹⁰

^a Halifax II. ^b Halifax V. ^c With this fuel, approximately 500 lb. for Halifax II and 1,000 lb. for Halifax V of normal service load must be deleted for a take off weight of 60,000 lb. ^d Some Lancasters were modified to carry the Grand Slam, 22,000 lb. ^e About thirty Mosquito IV's were modified to carry the 4,000 lb. bomb, which reduced their capacity. ^f In some Boston III's the armament was not so heavy.

APPENDIX 44

Tonnages of Bombs Dropped by the R.A.F. Bomber Command and the U.S. Eighth Air Force 1939-1945

Authors' Note: The precise weight of bombs dropped by the strategic air forces will never be known. No one knows what happened to the great tonnages carried by aircraft which did not return, and in the various sources which survive it is by no means always clear whether these bombs are included or excluded in the reckoning. Confusion is also liable to occur as to whether the tonnages related to bombs claimed to have found targets or merely to bombs expended. For these and other reasons no two sources bear each other out exactly about the same events.

In the case of the R.A.F. Bomber Command three leading sources have been considered. These are the records of the War Room, of the Operational Research Section, Bomber Command, and the findings of the British Bombing Survey Unit.

Probably the most accurate figures are to be found in the Final Night and Day Raid Reports of the Operational Research Section, but unfortunately these records do not cover the whole period of the war. The British Bombing Survey Unit figures are inadequately explained and in any case indicate only annual and not monthly totals. The War Room figures on the other hand do give monthly totals for the whole period of the war. The War Room figures have, therefore, been adopted for this table. The War Room figures do approximately correspond with those in other sources. For instance, in January 1943, Bomber Command dropped, according to the War Room, 4,345 long tons and according to the Operational Research Section 4,385 long tons. In March 1945 it dropped, according to the War Room, 67,637 long tons, and according to the Operational Research Section 69,518 long tons. In the whole of 1942, Bomber Command dropped, according to the War Room, 51,700 short tons and according to the British Bombing Survey Unit 51,028 short tons. In 1944, according to the War Room, it dropped 589,100 short tons and according to the British Bombing Survey Unit 571,057 short tons.

In the case of the U.S. Eighth Air Force, the figures given in the Statistical Summary of the force have been adopted as being the nearest possible parallel to the British War Room record. These figures do bear reasonable comparison with those given by the British Bombing Survey Unit. In 1943, for instance, the Eighth Air Force dropped, according to the Eighth Air Force Statistical Summary, 49,495 short tons of bombs and, according to the British Bombing Survey Unit, 47,340 short tons. In 1944 the respective figures are 434,001 and 445,603.

It is reasonable to assume that the following table presents a broadly correct indication of the effort expended in the Combined Bomber Offensive. While these tonnages relate only to the strategic air forces and

exclude bombs dropped by tactical forces, it does not, of course, follow that all these bombs were aimed at strategic objectives. A large proportion of them did not fall on Germany, and no attempt has been made to distinguish the amounts which fell upon individual target systems. Such an attempt over the whole period of the war would be liable to very large errors. The figures are all expressed in terms of long tons.

*Monthly Tonnages of Bombs Dropped by Bomber Command
and the United States Eighth Air Force, 1939-1945*

	<i>Tons dropped by Bomber Command</i>	<i>Tons dropped by U.S. Eighth Air Force</i>
1939		
September	6	—
October	—	—
November	—	—
December	25	—
1940		
January	1	—
February	1	—
March	31	—
April	112	—
May	1,668	—
June	2,300	—
July	1,257	—
August	1,365	—
September	2,339	—
October	1,651	—
November	1,316	—
December	992	—
1941		
January	777	—
February	1,431	—
March	1,744	—
April	2,396	—
May	2,846	—
June	4,310	—
July	4,384	—
August	4,242	—
September	2,889	—
October	2,984	—
November	1,907	—
December	1,794	—

*Monthly Tonnages of Bombs Dropped by Bomber Command and
the United States Eighth Air Force, 1939-1945—Continued*

	<i>Tons dropped by Bomber Command</i>	<i>Tons dropped by U.S. Eighth Air Force</i>
1942		
January	2,292	—
February	1,011	—
March	2,675	—
April	4,433	—
May	3,234	—
June	6,845	—
July	6,368	—
August	4,162	151
September	5,595	188
October	3,809	278
November	2,423	604
December	2,714	340
1943		
January	4,345	594
February	10,959	568
March	10,591	1,483
April	11,467	858
May	12,920	2,555
June	15,271	2,330
July	16,830	3,475
August	20,149	3,999
September	14,855	7,369
October	13,773	4,548
November	14,495	5,751
December	11,802	10,655
1944		
January	18,428	10,532
February	12,054	16,480
March	27,698	19,892
April	33,496	22,447
May	37,252	32,450
June	57,267	54,204
July	57,615	40,784
August	65,855	44,120
September	52,587	36,332
October	61,204	38,961
November	53,022	36,091
December	49,040	36,826

Monthly Tonnages of Bombs Dropped by Bomber Command and the United States Eighth Air Force, 1939-1945—Continued

	<i>Tons dropped by Bomber Command</i>	<i>Tons dropped by U.S. Eighth Air Force</i>
1945		
January	32,923	34,891
February	45,889	46,088
March	67,637	65,962
April	34,954	41,632
May (to 0001 hours 9th May)	337	—

APPENDIX 45

Extract from a paper of the Directorate of Bomber Operations (1) on the Review of the Present Strategical Air Offensive Indicating the Limitations of Night Bombing, 5th April 1941

BOMBING OF SCHARNHORST AND GNEISENAU AT BREST

2870 bombs have been dropped on the 2 warships at Brest between 30th March and 21st April. 2 hits at least are claimed, i.e., one on each.

Laws of Probability indicate that

<i>Aiming Error Yards</i>	<i>P.</i>	<i>No. of Bombs to give 2 direct hits</i>
1000	0·00092	2200
1500	0·00401	5000

This assumes that target can be seen and aimed at. Area bombing will increase the requirement of bombs to some extent.

OIL PLANTS

For the purpose of this study the standard 200,000 tons/annum oil target (detailed data concerning which is not repeated here) has been taken. The gross site area of this is 740 yards × 740 yards and the vulnerable portion of the target is 485 yards × 125 yards. Two cases are considered thus:

Case I

It is assumed that the Pilots are able to find the target area, pick out the specific target and use the bomb sights. Assuming that they drop four hundred 500 lb. bombs, then the damage which will result will, according to the laws of probabilities, vary generally as follows for various aiming errors:

If the aiming error is	300 yds.	600 yds.	1000 yds.
No. of direct hits	30·8	13·6	5·96
Effective H.P. hours lost (millions)	297	141	44
Percentage of annual output lost	34%	16·1%	5%

Thus by increasing the aiming error 100% from 300 to 600 yards the extent of the damage is reduced by 52·7% (from 34% to 16·1%). Also, to achieve the same damage (34% of annual output) with 600 yard as with 300 yard aiming error the number of bombs required to be dropped

is 2.32 times as great (from 400 to 930 bombs), and to achieve the same damage with 1000 yard as with 300 yard aiming error the number of bombs required to be dropped is 5.1 times as great (from 400 to 2060 bombs).

Case II

In this case it is assumed that the Pilots estimate that they are over the area by D.R. or nearness to sighted water, or particularly heavy A.A. concentration, or very heavy artificial smoke screen, etc., the vulnerable portion of the target being anywhere within an area 1, 2 or 3 miles square. Assuming that they drop four hundred 500 lb. bombs then the damage which will result will, according to the laws of probabilities, vary generally as follows for various areas of recognition:

Recognition Area	740 × 740 yds.	1.0 × 1.0 Mile	2.0 × 2.0 Miles	3.0 × 3.0 Miles
No. of direct hits	27.6	6.84	1.96	0.87
Effective H.P. hours lost (millions)	266	54	10.7	3.48
Percentage of annual output lost	30.4	6.1	1.22	0.4

It follows that to accomplish the same damage, the same number of direct hits are required and thus the number of bombs to be dropped with the larger recognition areas compared with the nett gross target area of 740 × 740 yards, for which four hundred bombs are required, would be as follows:

1 mile × 1 mile 1610 bombs = 4 times the number
 2 miles × 2 miles 5630 „ = 14 „ „ „
 3 miles × 3 miles 12680 „ = 32 „ „ „

APPENDIX 46

Most Important Figures used to calculate the Success of Bombing Operations, December 1941 to February 1942, as shown by Night Photographs

*Compiled by the Operational Research Section, Bomber Command,
22nd April 1942*

No. of sorties despatched (excluding mining and intruder operations on which cameras were not carried)	4,061
No. of aircraft claiming attack	2,444
No. of photographs taken with bombing which showed enough ground detail to be plotted	431
No. of photographs showing target area	194

Table 1. Weather variations and the Target Area (Within 5 miles)

Weather	Moon	Sorties Despatched	Claiming Attack	Successful Photos	Photos of Targ. Area ¹	%	% June-Nov. 1941
No or slight cloud or haze	Bright	484	347	154	105	68	50
	Mod.	49	37	25	14	56	33
	Dark	163	120	90	46	51	39
Moderate haze or cloud	Bright	442	321	22	8	36	36
	Mod.	205	152	17	2	12	23
	Dark	761	500	45	9	20	14
Thick haze or cloud	Bright	1,252	672	30	5	17	8
	Mod.	172	73	11	3	27	10
	Dark	533	222	37	2	5	5

¹ i.e. photos showing enough ground detail to be plotted.

Table 2. Weather variations and Built-up Areas

Weather	Moon	Useful Targets	Outskirts or Villages	Open Country
No or slight haze or cloud	Bright	49	12	39
	Mod.	37	10	53
	Dark	41	16	43
Moderate Haze or cloud	Bright	19	0	81
	Mod.	8	38	54
	Dark	7	17	76
Thick haze or cloud	Bright	7	4	89
	Mod.	(40)	(0)	(60)
	Dark	9	18	73

The limitations and usefulness of the calculation will now be readily apparent.

APPENDIX 47

Bomber Command Operations Against French Marshalling Yards, 6/7 March-10/11 April 1944

Target	Date 1944	Despatched					Missing	Average Bombing		Visibility
		Hals.	Lancs.	Stirs.	Mos.	Total		Height ft.		
Trappes	6/7 March	261	—	—	6	267	—	13,000	Good	
Le Mans	7/8 "	242	56	—	6	304	—	12,000	Bad	
Amiens	13/14 "	213	—	—	9	222	1	13,000	Good	
	15/16 "	94	—	38	8	140	3	12,600	Moderate	
Laon	16/17 "	81	—	41	8	130	—	12,500	Moderate	
	23/24 "	83	—	48	11	143	2	12,500	Good	
Aulnoye	10/11 April	—	148	—	—	148	1	12,000	Good	
	25/26 March	92	47	37	16	192	—	8,700	Moderate	
Courtrai	26/27 "	70	—	32	7	109	—	11,500	Moderate	
Vaires	29/30 "	76	—	—	8	84	1	13,000	Good	
Villeneuve	9/10 April	147	68	—	10	225	—	15,000	Moderate	
	9/10 "	166	40	22	11	239	1	15,000	Good	
Tergnier	10/11 "	157	—	—	—	157	10	10,000	Moderate	
Ghent	10/11 "	122	—	—	—	122	—	14,000	Moderate	

APPENDIX 48

Small Targets in Occupied Territory, March–September 1944

*Mean bombing densities in terms of bombs dropped
and bombs despatched*

Technique	No. of raids analysed	Measured density Hits/acre/ 1000 bombs dropped	Variability ¹ Coefficient of mean density	Estimated density per 1000 bombs despatched
<i>Oboe</i> Ground-marking	40	2.17	84.9%	2.00
Controlled <i>Oboe</i>	18	1.79	65.1%	1.66
8 Group Visual	11	1.41	78.5%	1.35
5 Group Visual (March–April)	12	2.50	68.9%	2.03
5 Group Visual (May–June)	14	5.43	57.7%	4.40
1 Group Visual	4	1.62	130.6%	1.50
Total—Night	99	2.496	91.0%	2.26

¹ Defined as $\frac{100\delta}{m}$ where δ = standard deviation
 m = mean density.

Technique	No. of raids analysed	Measured density Hits/acre/ 1000 bombs dropped	Variability ¹ Coefficient of mean density	Estimated density per 1000 bombs despatched
Controlled <i>Oboe</i>	41	2.80	94.6%	2.37
<i>Oboe</i> Ground-marking	4	2.16	75.6%	1.99
Formation <i>Oboe</i>	15	7.44	71.6%	6.09
Formation <i>G.H.</i>	4	1.73	57.7%	1.60
Visual with prox. T.I.'s (incl. 5 Gp.)	13	3.31	53.0%	3.12
Visual without T.I.'s	15	4.18	131.2%	3.65
<i>Gee</i> —D.R.	6	0.27	65.9%	0.24
Total—Day	98²	3.566	114.3%	3.13
Total—Day + Night	197	3.030	107.0%	2.70

¹ Defined as $\frac{100\delta}{m}$ where δ = standard deviation
 m = mean density.

² 10 attacks on airfields have been omitted because:

- (a) The crater spacing (40 yards) was about 3 times that used against the remaining targets.
- (b) There was a planned extra scatter of bombs to cover the whole target.

SECTION VII

Statistics of German Production
and Loss

INTRODUCTION

THESE statistical tables have been selected from the large number printed in the British and United States post-war surveys. Most of them are due to the energy and industry of the United States investigators. They are, of course, only a very small proportion of the whole number but they include some of the most important. Some consideration of their provenance is given in Annex 5. A few other statistical tables have been added which show the calculations made in Britain during the course of the war concerning the effects of the area offensive and the attack on the oil plants and refineries. Finally two, numbers (xv) and (xxxix), have been taken from the German documents themselves, because they give some additional information of importance which, so far as has been ascertained, has not been utilised elsewhere.

APPENDIX 49

(i)

Indices of German Finished Munitions Output, Total and Main Categories, Monthly, 1942-45¹
(January-February 1942 = 100)

Munition category	Year	Annual average	January	February	March	April	May	June	July	August	September	October	November	December
Total	1942	142	103	97	129	133	135	144	153	153	155	154	165	181
	1943	222	182	207	216	215	232	226	229	224	234	242	231	222
	1944	277	241	231	270	274	285	297	322	297	301	273	268	263
	1945	—	227	175	145	—	‡	—	—	—	—	—	—	—
	1942	133	112	88	151	135	133	131	145	140	142	133	134	155
Aircraft	1943	216	172	227	205	216	211	233	236	228	222	237	216	186
	1944	277	232	186	262	285	295	321	367	308	310	255	274	224
	1945	—	231	168	139	—	‡	—	—	—	—	—	—	—
	1942	166	98	102	115	124	144	173	177	201	202	209	222	229
	1943	247	215	230	239	229	245	230	238	245	259	265	282	288
Ammunition	1944	306	281	303	314	302	301	310	319	323	335	321	307	263
	1945	—	224	191	154	—	‡	—	—	—	—	—	—	—
	1942	137	98	106	111	122	150	125	148	135	149	150	155	195
	1943	234	169	185	216	212	235	238	238	240	260	269	264	280
	1944	348	274	284	301	320	337	361	384	382	377	372	375	408
1945	—	284	216	208	—	‡	—	—	—	—	—	—	—	

¹ U.S.S.B.S. *The Effects of Strategic Bombing on the German War Economy* (No. 3), Table 100, p. 275. Source: *Indizes der Deutschen Rüstungsanfertigung, Planungsamt, Ministry for Armament and War Production*. Based on constant unit prices.
‡ Not available.

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Indices of German Finished Munitions Output, Total and Main Categories, Monthly, 1942-45—Continued
(January-February 1942 = 100)

Munition category	Year	Annual average	January	February	March	April	May	June	July	August	September	October	November	December
Panzer	1942	130	93	107	80	129	152	122	122	134	131	144	146	199
	1943	330	154	169	210	289	465	340	367	328	405	454	364	415
	1944	536	438	460	498	547	567	580	589	558	527	516	571	598
	1945	—	557	385	273	3	3	—	—	—	—	—	—	—
Naval vessels	1942	142	90	111	109	162	113	165	163	136	133	134	202	187
	1943	181	190	164	233	185	207	208	163	158	191	171	168	140
	1944	166	140	170	153	127	152	107	139	141	184	217	124	333
	1945	—	164	143	99	3	3	—	—	—	—	—	—	—
Motor vehicles	1942	120	108	93	129	123	125	137	131	123	105	116	109	135
	1943	138	128	132	168	145	144	161	146	129	128	133	122	116
	1944	104	142	122	133	121	126	133	117	116	84	79	78	63
	1945	—	60	44	37	3	3	—	—	—	—	—	—	—
Powder	1942	129	103	97	111	108	116	129	132	134	160	151	148	153
	1943	199	168	184	184	194	205	200	214	200	201	216	219	208
	1944	212	204	219	226	230	242	223	209	224	219	205	173	166
	1945	—	162	140	125	3	3	—	—	—	—	—	—	—
Half-tracks	1942	124	96	105	118	121	126	138	102	123	133	128	151	153
	1943	210	101	177	205	211	223	213	206	219	241	223	208	236
	1944	228	201	234	266	213	242	269	263	281	243	197	153	170
1945	—	147	129	162	3	3	—	—	—	—	—	—	—	

* Not available.

(ii)

Quarterly Indices of German Actual and Potential Armaments Production (January-February, 1942 = 100)¹

Quarter Year	Tanks		Weapons		Ammunition		Aircraft		Naval Construction		Motor Vehicles		Half-tracks		Powder		Explosives		Total Armaments		
	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	Actual	Poten-tial	
1942.	1st	92	105	—	105	—	117	—	103	—	115	—	106	—	104	—	108	—	110	—	
	2nd	134	132	147	—	133	—	147	—	144	—	128	—	118	—	138	—	138	—	138	—
	3rd	129	144	193	—	142	—	144	—	144	—	151	—	119	—	142	—	130	—	154	—
	4th	163	167	220	—	141	—	174	—	174	—	151	—	144	—	151	—	150	—	168	—
1943.	1st	178	190	228	—	201	—	196	—	170	—	161	—	179	—	182	—	202	—	202	—
	2nd	345	228	235	—	220	—	200	202	179	—	216	—	200	—	186	—	224	—	224	—
	3rd	367	246	247	—	229	233	171	186	166	175	222	—	205	—	192	—	230	—	235	—
	4th	411	271	278	—	213	255	156	176	159	170	222	—	214	—	205	—	233	—	256	—
1944.	1st	465	286	299	310	227	280	154	177	173	185	—	234	—	214	—	235	—	248	281	
	2nd	558	339	304	330	300	320	129	141	167	195	—	241	—	232	—	269	—	287	307	
	3rd	558	381	326	350	328	363	155	194	195	205	—	262	—	218	260	208	295	308	345	
	4th	562	385	297	360	251	405	225	308	81	212	174	280	275	181	275	195	300	270	381	
1945.	1st	405	236	190	360	184	445	135	350	59	212	146	300	142	275	100	300	182	406	406	
1945.	Jan.	557	284	224	360	231	435	164	345	87	212	147	295	162	275	128	300	228	400	400	
	Feb.	385	216	191	360	168	445	143	350	49	212	129	300	140	275	102	300	175	406	406	
	Mar.	273	208	154	360	154	455	99	355	41	212	162	305	125	275	70	300	150	411	411	

¹ B.B.S.U. Potential and Actual Output of German Armaments in Relation to the Combined Bomber Offensive, Table 1, p. 21.

(iii)

(a) Comparison of Actual Output of Particular Classes of Armaments in Germany and the United Kingdom, 1940-44¹

	1940		1941		1942		1943		1944	
	Germany	U.K.	Germany	U.K.	Germany	U.K.	Germany	U.K.	Germany	U.K.
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469										
<i>Military aircraft</i>										
Total (numbers)	10,200	15,000	11,000	20,100	14,200	23,600	25,200	26,200	39,600	26,500
Total structural weight (million lb.)	59 ²	59	64	87	92	133	138	185	174	208
<i>Bombs (filled weight in 1,000 tons)</i>	3	48	245	143	262	241	273	309	231	370
<i>Armoured vehicles</i>										
Tanks ⁴	1,600	1,400	3,800	4,800	6,300	8,600	12,100	7,500	19,000	4,600
Others ⁵	500	6,000	1,300	10,500	3,100	19,300	7,800	24,200	9,900	22,600
<i>Wheeled vehicles (thousands)</i>										
Heavy type	3	112	62	110	81	109	109	104	89	91
Light cars and vans	3	21	3	17	29	16	36	17	26	13
Motor cycles	3	68	3	71	3	75	38	79	33	75
<i>Heavy guns (75 mm. and over)</i>										
Field, medium and heavy	4,400	1,000	4,700	3,800	5,100	4,000	11,700	3,000	24,900	2,800
Tank	470	—	650	—	2,200	2	9,500	4,600	20,400	7,500
Anti-tank	—	—	—	—	2,100	500	9,900	3,300	13,800	1,900
Anti-aircraft	1,400	900	2,400	1,500	4,200	2,100	6,900	1,300	8,200	200
Total	6,300	1,900	7,800	5,300	13,600	6,600	38,000	12,200	62,300	12,400
<i>Light guns (under 75 mm., excluding 20 mm.)</i>										
Tank	—	240	100	6,000	3,000	22,000	900	10,400	700	1,700
Anti-tank	430	1,500	2,100	2,700	4,500	9,100	2,600	9,800	—	1,100
Anti-aircraft	3	1,100	1,200	2,700	2,100	5,300	4,600	5,600	7,700	800
Total	3	2,800	3,400	11,400	9,600	36,400	8,100	25,800	8,400	3,600

(a) Comparison of Actual Output of Particular Classes of Armaments in Germany and the United Kingdom, 1940-44—Continued

	1940		1941		1942		1943		1944	
	Germany	U.K.	Germany	U.K.	Germany	U.K.	Germany	U.K.	Germany	U.K.
<i>Small arms</i>										
Infantry rifles (1,000's)	1,350	81	1,358	78	1,370	594	2,244	910	2,585	547
Infantry machine guns (1,000's)	170	30	320	46	320	1,510	440	1,650	790	730
<i>Ammunition (million rounds)</i> ⁶										
Heavy gun (75 mm. and over)	27	7	27	14	57	25	93	14	108	12
Light gun (under 75 mm., excluding 20 mm.)	•	3	8	9	42	25	15	23	25	10
Small arms (20 mm. and under)	2,950	540	1,340	1,120	1,340	2,190	3,170	3,010	5,370	2,460
<i>Naval armaments</i>										
Major war vessels (1,000 tons standard displacement) ⁷	•	222	162	346	193	300	221	292	234	270
Heavy guns (75 mm. and over)	•	620	300	740	1,020	1,060	960	990	980	550
Light guns (excluding 20 mm.)	•	860	380	1,730	1,070	2,740	1,210	2,170	2,050	400
Torpedoes	•	940	14,200	1,900	11,000	3,900	11,600	7,000	15,800	6,200
Heavy gun ammunition (1,000's)	•	840	2,450	1,150	12,640	1,510	1,680	990	1,170	800
Light gun ammunition (1,000's, excluding 20 mm.)	•	3,100	4,100	5,400	35,200	8,700	3,700	7,800	7,100	4,100

¹ B.B.S.U. *The Strategic Air War Against Germany 1939-45*, Table 16, pp. 72-73. Sources: United Kingdom. Statistics relating to the war effort of the United Kingdom (Cmd. 6564); Statistical Digest Series D, No. 53, issued by Central Statistical Office, August 1945; Anglo-American consolidated statement of Munition and War-like Stores; Analysis of United Kingdom Output January 1942 to December 1946, issued by Central Statistical Office, July 1945; Germany. *Statistische Schnellberichte zur Rüstungsproduktion*, February 1945, issued by Speer Ministry; Speer's Report to Hitler on Armaments Production dated 27th January 1945; J.I.C. Draft Report, 8th Oct. 1945; U.S.S.B.S. *Effects of Strategic Bombing and Overall Economic Effects Division*. United Kingdom figures refer to United Kingdom production only, German figures include all deliveries to the Wehrmacht.

² Estimated.

³ Not available.

⁴ Tanks and self-propelled guns.

⁵ For Germany includes armoured reconnaissance cars, armoured half-tracks, armoured infantry and gun carriers. For United Kingdom includes cars, scout cars and carriers.

⁶ Excluding Naval ammunition.

⁷ For Germany includes submarine production only. For United Kingdom includes completion of all major war vessels.

(b) *Comparison of Output of Particular Classes of Armaments During First and Second Halves of 1944 in Germany and the United Kingdom¹*

	January-June, 1944		July-December, 1944	
	Germany	U.K.	Germany	U.K.
<i>Military aircraft</i>				
Number	16,900	14,600	22,600	11,860
Tare weight (million lb.)	83	112	91	96
<i>Bombs (filled weight in 1,000 tons)</i>	149	228	82	142
<i>Armoured Vehicles</i>				
Tanks	8,900	2,500	10,100	2,100
Others	5,100	13,900	4,800	8,700
<i>Wheeled vehicles (1,000's)</i>				
Heavy type	55	47	34	44
Light vans and cars	16	8	10	5
Motor cycles	19	39	14	36
<i>Heavy guns (75 mm. and over)</i>				
Field, medium and heavy	10,500	1,860	14,400	990
Tank	8,700	2,740	11,700	4,800
Anti-tank	6,700	1,340	7,100	520
Anti-aircraft	4,100	190	4,100	50
Total	30,000	6,130	37,300	6,360
<i>Light guns (under 75 mm., excluding 20 mm.)</i>				
Tank	480	1,700	230	25
Anti-tank	—	510	—	540
Anti-aircraft	2,590	700	5,120	140
Total	3,070	2,910	5,350	700
<i>Small arms</i>				
Infantry rifles (1,000's)	1,276	319	1,310	228
Infantry machine guns (1,000's)	251	430	536	300
<i>Ammunition (million rounds)</i>				
Heavy gun (75 mm. and over)	56.5	3.6	51.5	8.7
Light gun (excluding 20 mm.)	9.3	5.5	15.7	4.7
Small arms (20 mm. and under)	2,390	1,370	2,980	1,090
<i>Naval Armaments</i>				
Major war vessels	98	150	136	120
Heavy guns	510	300	470	250
Light guns	940	340	1,120	60
Torpedoes	7,000	3,500	8,800	2,700
Heavy gun ammunition (1,000's)	590	370	580	430
Light gun ammunition (excluding 20 mm., 1,000's)	3,100	2,200	4,000	1,900

¹ B.B.S.U. *The Strategic Air War*, Table 17, p. 74

(iv)
Mobilisation of Manpower in Germany, 1939-44¹
 (Pre-war Reich, including Austria, Sudetenland, Memel)
 (In millions)

Date	Civilian Labour Force			Armed Forces			Total Germans Mobilised (3) + (5)	Total Civilian Labour Force (3) + (4)	Total Active Labour Force (7) + (9)
	Germans		Total (3)	Total Mobilised (5)	Armed Forces				
	Men (1)	Women (2)			Forcigners and Prisoners of War (4)	Cumulative Losses (6)			
31 May, 1939	24.5	14.6	39.1	1.4	—	1.4	40.5	39.4	40.8
31 May, 1940	20.4	14.4	34.8	5.7	.1	5.6	40.5	36.0	41.6
31 May, 1941	19.0	14.1	33.1	7.4	.2	7.2	40.5	36.1	43.3
31 May, 1942	16.9	14.4	31.3	9.4	.8	8.6	40.7	35.6	44.2
31 May, 1943	15.5	14.8	30.3	11.2	1.7	9.5	41.5	36.6	46.1
31 May, 1944	14.2	14.8	29.0	12.4	3.3	9.1	41.4	36.1	45.2
30 September, 1944	13.5	14.9	28.4	13.0	3.9	9.1	41.4	35.9	45.0

¹ B.B.S.U. *The Strategic Air War*, Table 21, p. 80. Sources: *Kriegswirtschaftliche Kraeftebilanz* (latest edition), *Statistisches Reichsamt Abt. VI*; O.K.W. *Zusammenstellung ueber die personelle und materielle Ruestungslage der Wehrmacht, Heerespersonalampt.*

Column (2) includes 'helping family members' (mainly in agriculture) who numbered 5.8 millions in 1939, and who would not be counted as employed in British or U.S. statistics. Thus the number of women employed, on a basis comparable to that adopted in British statistics, was only 8.8 millions.

Column (5) is the cumulative figure of the total numbers called up to the armed forces, without any deduction for discharges, losses etc. It does not include those called up from outside the area of the pre-war Reich, e.g. Alsace-Lorraine, Poland or the Protectorate.

Column (6) is the cumulative figure of losses due to deaths, of personnel taken prisoners of war and missing, and of discharges but not desertions as reported by German official sources.

(v)
Mobilisation of Manpower in Great Britain and Germany, 1939-43¹
(In thousands)

	Great Britain			Germany		
	June, 1939	June, 1943	Index No. (1939 = 100)	31 May, 1939	31 May, 1943	Index No. (1939 = 100)
Group I						
Metal, Chemical and allied industries ²	3,106	5,233	168.5	5,778	6,863	118.8
Group II						
Agriculture ³	5,530	5,632	101.8	18,419	19,227	104.4
Mining	1,113	1,118	100.4	11,224	11,301	100.7
Government Services ⁴	873	818	93.7	766	903	117.9
Gas, water, electricity	1,385	1,786	129.0	2,894	3,879	134.0
Transport ⁵	232	200	86.2	231	206	89.2
Food, drink, tobacco	1,273	1,191	93.6	1,624	1,799	110.8
Group III						
Building, civil engineering	654	519	79.4	1,680	1,139	67.8
Textiles, clothing, boots, shoes	10,477	6,679	63.7	14,969	10,757	71.9
Other manufactures ⁶	1,310	726	55.4	2,534	1,256	49.6
Distribution trades	1,754	1,154	65.8	2,769	2,111	76.2
Other services	1,444	968	67.0	2,475	1,833	74.1
Domestic service	2,887	2,009	69.6	3,428	2,156	62.9
Armed Forces	1,882	1,422	75.6	2,181	1,959	89.8
	557	400	33.3	1,582	1,442	91.2
Grand total	19,670	22,612	115.0	40,566	46,447	114.5
Total, excluding Armed Forces and agriculture	18,000	16,426	91.3	27,942	25,546	91.4

¹ B.B.S.U. *The Strategic Air War*, Table 22, p. 81. Source: Great Britain—Statistics relating to the war effort of the United Kingdom, Cmd. 6564, November 1944—for all categories except domestic service, which is an independent estimate.

² German agricultural employment includes 'helping family members' who numbered 5.8 millions in 1939.

³ Government Services include Post Office employees.

⁴ Excluding Post Office employees.

⁵ Lumber and steel and their products, non-ferrous metals and their products, machinery, transportation, equipment, aircraft, bombs, ships, vehicles, electrical products, instruments, optical goods, chemicals and petroleum.

⁶ Lumber and steel and their products, non-ferrous metals and their products, machinery, transportation, equipment, aircraft, bombs, ships, vehicles, electrical products, instruments, optical goods, chemicals and petroleum. The British figures include leather and leather products other than boots and shoes.

(vi)
Female Labor Force by Industry Division and Nationality, selected dates 1925-44¹
 (In thousands)

Year and month	All divisions		Agriculture		Industry, hand-work and power		Trade, banking, insurance and transport		Administration and services		Domestic service		Home work	
	Total ^a	German ^a	Total	German	Total	German	Total	German	Total	German	Total	German	Total	German
1925	11,478	*	4,970	*	2,988	*	1,566	*	598	*	1,357	*	*	*
1933	11,479	*	4,649	*	2,758	*	1,965	*	858	*	1,249	*	*	*
1939	12,701	*	4,880	*	3,310	*	2,084	*	1,094	*	1,332	*	*	*
1939, May	14,686	14,626	6,073	6,049	3,858	3,836	2,230	2,227	958	954	1,567	1,560	*	*
1940, May	14,348	14,190	5,796	5,689	3,676	3,650	2,187	2,183	1,162	1,157	1,526	1,511	*	*
1941, May	14,341	13,971	5,608	5,369	3,758	3,677	2,176	2,107	1,293	1,284	1,506	1,473	*	*
1942, May	15,011	(14,315)	6,085	5,673	3,727	3,537	2,247	2,225	1,486	1,471	1,466	1,410	*	*
1943, May	16,259	(15,123)	6,311	5,665	4,385	3,740	2,373	2,320	1,756	1,719	1,434	1,362	*	*
1944, May	16,490	14,806	6,447	5,694	4,308	3,592	2,313	2,219	1,794	1,746	1,372	1,301	256	256
1944, Sept.	16,728	14,897	6,562	5,756	4,447	3,636	2,300	2,193	1,799	1,748	1,343	1,287	277	277

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 2, p. 203. Sources: 1925-39, *Statistisches Jahrbuch*, 1941-42, Table 20, p. 33; 1939-44, *Kriegswirtschaftliche Kräftebilanz* prepared by *Statistisches Reichsamts, Abt. VI* (adjusted to 1925-39 classification by combining transport with trade, banking and insurance, and combining categories III and IV of the *Kräftebilanz*). Data for 1925 and 1933 and the first line of 1939 figures cover Old Germany; the second line of 1939 figures and data for 1940-44 cover prewar Germany (including the Saar, Austria and the Sudetenland).
 * Figures in parentheses are adjusted on the basis of revisions indicated by the 1944 edition of the *Kräftebilanz*.
 * Not available.

(vii)
Civilian Labor Force by Nationality and Industry Division, May 31, 1939-44¹
(In thousands)

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Industry division	1939				1940				1941	
	Germans	Foreigners ²		Germans	Foreigners ²		Germans	Foreigners ²		
		Number	Per cent ³		Number	Per cent ³		Number	Per cent ³	
I. Agriculture ⁴	11,103	120	1.1	10,006	681	6.4	9,262	1,459	13.6	
II. Industry and transport	18,482	155	.8	15,857	402	2.5	15,206	1,379	8.3	
(a) Industry	10,836	110	1.0	9,551	256	2.6	9,200	965	9.5	
(b) Handwork	5,307	29	.5	4,122	108	2.6	3,730	310	7.7	
(c) Transport	2,109	16	.7	1,982	35	1.8	2,073	97	4.5	
(d) Power	231	1	.4	202	2	1.0	204	7	3.3	
III. Trade, banking and insurance	4,595	8	.2	3,719	20	.5	3,358	58	1.7	
IV. Administration and services ⁵	2,670	7	.3	2,605	21	.8	2,626	51	1.9	
V. Armed forces administration ⁶	689	2	.3	710	11	1.5	804	39	4.7	
VI. Domestic service ⁷	1,575	7	.4	1,511	15	1.0	1,473	33	2.2	
VII. Home work	3	3	.4	3	3	.8	3	3	.8	
Total ⁸	39,114	301	.8	34,409 (34,829)	1,148 (1,154)	3.2	32,729 (33,144)	3,020 (3,033)	8.4	

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 5, p. 206. Sources: 1939, 1943 and 1944 data, *Kriegswirtschaftliche Kräftebilanz* for 1944; 1940 and 1941 data, *Kriegswirtschaftliche Kräftebilanz* for 1942; 1942 data, *Kriegswirtschaftliche Kräftebilanz* for 1943.

² Including Jews, both German and foreign, and prisoners of war. Foreigners as per cent of total civilian labor force in each industry division.

⁴ Including forestry and fishing.

⁵ Government administration excepting police and the Armaments Ministry, and public and private services, arts and sports.

⁶ Including police and the Armaments Ministry.

⁷ Data incorporate the following additions to the *Kräftebilanz* figures to make the series comparable for all years: 440,000 in 1940, 420,000 in 1941, and 400,000 in 1942.

⁸ Not available.

⁹ Figures in parentheses are adjusted on the basis of revisions indicated by the 1944 edition of the *Kräftebilanz*.

Civilian Labor Force by Nationality and Industry Division, May 31, 1939-44—Continued
(In thousands)

Industry division	1942		1943		1944			
	Foreigners ¹		Germans	Foreigners ²		Germans	Foreigners ³	
	Number	Per cent ⁴		Number	Per cent ⁵		Number	Per cent ⁶
I. Agriculture ⁴	1,978	17.6	9,008	2,293	20.3	8,708	2,478	22.1
II. Industry and transport	1,879	12.0	13,324	3,566	21.1	12,489	4,132	24.9
(a) Industry	1,401	14.3	8,170	2,829	25.7	7,640	3,163	29.3
(b) Handwork	296	8.5	2,957	430	12.7	2,745	537	16.4
(c) Transport	171	7.7	2,010	289	12.6	1,927	407	17.4
(d) Power	10	4.9	187	19	9.3	177	26	12.7
III. Trade, banking and insurance	95	3.0	2,933	148	4.8	2,679	188	6.5
IV. Administration and services ⁵	48	2.0	2,340	62	2.6	2,228	94	4.1
V. Armed forces administration ⁶	60	4.8	1,292	120	8.5	1,294	163	11.2
VI. Domestic service ⁷	56	3.8	1,370	72	5.0	1,307	72	5.2
VII. Home work	8	8	8	8	8	279	1	4
Total⁸	4,115 (4,224)	11.7	30,269	6,360	17.1	28,984	7,126	19.7

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 5, p. 206. Sources: 1939, 1943 and 1944 data, *Kriegswirtschaftliche Kräftebilanz* for 1944; 1940 and 1941 data, *Kriegswirtschaftliche Kräftebilanz* for 1942; 1942 data, *Kriegswirtschaftliche Kräftebilanz* for 1943.

² Including Jews, both German and foreign, and prisoners of war.

³ Foreigners as per cent of total civilian labor force in each industry division.

⁴ Including forestry and fishing.

⁵ Government administration excepting police and the Armaments Ministry, and public and private services, arts and sports.

⁶ Including police and the Armaments Ministry.

⁷ Data incorporate the following additions to the *Kräftebilanz* figures to make the series comparable for all years: 440,000 in 1940, 420,000 in 1941, and 400,000 in 1942.

⁸ Not available.

⁹ Figures in parentheses are adjusted on the basis of revisions indicated by the 1944 edition of the *Kräftebilanz*.

(viii)

Civilian Labor Force, by Nationality and Sex, and Armed Forces, Active Strength and Losses, selected dates 1939-44
(In thousands)

Date	Civilian labor force ²			Foreigners		Armed forces ³		
	Total labor force	Germans		Males	Females	Active strength	Cumulative losses	Total mobilized
		Total	Males					
1939, May 31	40,781	39,114	24,488		14,626	1,366	—	1,366
1940, May 31	41,593	34,829 ⁴	20,449		14,386	5,600	85	5,685
1941, May 31	43,377	33,144 ⁴	18,990		14,167	7,200	185	7,385
1942, May 31	44,160	31,301	16,864		14,437	8,695	800	9,435
1943, May 31	46,084	30,269	15,462		14,806	9,555	1,680	11,235
1944, May 31	45,210	28,984	14,175		14,808	9,100	3,285	12,385
1944, Sept. 30	45,044	28,432	13,535		14,897	9,125	3,875	13,000

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 6, p. 207. Sources: Civilian labor force data, 1939, 1943 and 1944; *Kriegswirtschaftliche Kräftebilanz* for 1944; 1940 and 1941, do. for 1942; 1942, do. for 1943. Armed forces data, *OKW, Zusammenstellung über die personelle und materielle Rüstungslage der Wehrmacht* (April 1941 with data added through October 1941) and statistics of the *Heerespersonalamt*.

² Civilian labor force data for 1940-42 are adjusted on the basis of revisions indicated by the 1944 edition of the *Kräftebilanz*.

³ Active strength figures for 1939-41 are given in *OKW Zusammenstellung über die personelle und materielle Rüstungslage der Wehrmacht* (April 1941 with data added through October 1941); those for 1942-44 are derived from the total mobilized by deducting losses. Losses of the armed forces, comprising deaths, personnel taken prisoner of war and missing, discharges and net desertions, are reported by the *Heerespersonalamt* as

follows for years ended September 1: 112,000 in 1939-40, 217,000 in 1940-41, 626,000 in 1941-42, 970,000 in 1942-43, and 1,819,000 in 1943-44. Losses from September 1 to the following May 31 are assumed to have been 75 per cent of the foregoing losses for the current 12-month period, except in 1940-41 when they are assumed to have been one-third of losses in the 12 months ended September 1, 1941. Losses in September 1944 are estimated at approximately 136,000. To obtain the total mobilized after 1941, the numbers drafted as reported by the *Kräftebilanz* have been increased by approximately 50,000 annually, representing persons not in the labor force at the time they were drafted into the armed forces.

⁴ Not equal to sum of male and female data because of slight discrepancies in the *Kräftebilanz* figures from which derived.

(ix)
*Average Weekly Hours worked by Wage Earners in Production and Consumption Goods Industries, by Sex and Skill,
 selected periods 1929-44¹*

Year and Month	Production goods				Consumption goods					
	All industries	Male		Female		All wage earners	Male		Female	
		All wage earners	Skilled	Unskilled	Skilled		Unskilled	Skilled	Unskilled	Skilled
1929	46.0	46.3	3	3	3	45.7	3	3	3	3
1933	42.9	43.0	3	3	3	42.9	3	3	3	3
1935	44.4	45.9	3	3	3	42.6	3	3	3	3
1937	46.1	47.3	3	3	3	44.5	3	3	3	3
1938	46.5	47.8	3	3	3	44.9	3	3	3	3
1939, Mar.	47.6	48.2	50.2	49.5	47.2	45.9	48.1	47.9	46.5	46.8
Sept.	47.8	48.8	50.7	50.9	46.2	43.5	46.6	47.9	42.5	43.7
1940, Mar.	47.6	48.5	50.7	49.7	46.7	43.8	46.9	47.5	43.1	44.3
Sept.	49.2	49.9	52.3	52.6	47.9	45.9	49.4	49.2	45.3	45.0
1941, Mar.	49.1	49.9	52.4	51.4	47.2	45.8	49.7	49.2	44.8	44.4
Sept.	49.5	50.3	52.8	52.3	46.1	45.9	50.0	49.4	44.7	44.1
1942, Mar.	48.7	49.6	52.2	50.4	45.1	45.0	49.2	48.8	43.8	43.2
Sept.	49.1	49.9	52.0	51.2	43.8	44.8	49.9	49.2	42.9	42.5
1943, Mar.	47.9	48.9	52.8	51.3	43.8	45.3	50.5	49.4	43.5	42.0
Sept.	47.9	48.9	51.6	50.8	42.3	43.1	49.5	48.6	40.2	39.2
1944, Mar.	48.3	49.2	51.9	50.9	41.5	43.3	49.6	48.7	40.4	39.3

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 14, p. 215. Sources: 1929-38, *Statistisches Jahrbuch*, 1939-40, p. 384; 1939-44, *Ergebnisse der amtlichen Lohnhebungen für März 1944*, *Statistisches Reichsamt, Abteilung Sozialstatistik*. Data for 1929-38 are annual averages. Data for 1939-44 are monthly averages. ² Not available.

(x)

*Civilian Labor Force and Estimated Labor Force in Civilian Goods
Production, Prewar Germany, May 31, 1939-44¹*

(Millions of persons)

	1939	1940	1941
Civilian labor force:			
Agriculture	11.2	10.7	10.7
Industry and power	11.2	10.0	10.4
Handwork	5.3	4.2	4.0
Transport	2.1	2.0	2.2
Trade, banking, and insurance	4.6	3.7	3.4
Administration	2.4	2.4	2.6
Social services	1.0	.9	.9
Domestic service	1.6	1.5	1.5
Total	39.4	35.6	35.7
Index, 1939 = 100	100.0	90.4	90.6
Nonagricultural total	28.2	24.9	25.0
Index, 1939 = 100	100.0	88.3	88.7
Labor force in civilian goods production:²			
Agriculture	9.6	9.0	8.7
Industry and power	3.1	2.4	2.2
Handwork	4.2	3.3	3.0
Transport	1.2	1.1	1.1
Trade, banking, and insurance	4.0	3.1	2.8
Administration	1.4	1.3	1.3
Social services	1.0	.9	.9
Domestic service	1.6	1.5	1.5
Total	26.1	22.6	21.5
Index, 1939 = 100	100.0	86.6	82.4
Nonagricultural total	16.4	13.6	12.8
Index, 1939 = 100	100.0	82.9	78.0
	1942	1943	1944³
Civilian labor force:			
Agriculture	11.2	11.3	11.2
Industry and power	10.0	11.2	11.0
Handwork	3.5	3.4	3.3
Transport	2.2	2.3	2.3
Trade, banking, and insurance	3.2	3.1	2.9
Administration	2.7	2.8	2.8
Social services9	1.0	.9
Domestic service	1.5	1.4	1.4
Total	35.3	36.5	35.8
Index, 1939 = 100	89.6	92.6	90.9
Nonagricultural total	24.1	25.2	24.6
Index, 1939 = 100	85.5	89.4	87.2

(For footnotes, see page 480.)

*Civilian Labor Force and Estimated Labor Force in Civilian Goods
Production, Prewar Germany, May 31, 1939-44—Continued*

(Millions of persons)

	1942	1943	1944 ²
Labor force in civilian goods production: ²			
Agriculture	8.3	8.2	8.1
Industry and power	1.8	1.8	1.6
Handwork	2.5	2.4	2.3
Transport	1.0	1.0	.9
Trade, banking, and insurance	2.5	2.3	2.1
Administration	1.2	1.2	1.0
Social services9	1.0	.9
Domestic services	1.5	1.4	1.4
Total	19.7	19.3	18.3
Index, 1939 = 100	75.5	73.9	70.1
Nonagricultural total	11.4	11.1	10.2
Index, 1939 = 100	69.5	67.7	62.2

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 94, p. 270. Source: *Kriegswirtschaftliche Kräftebilanz, Statistisches Reichsamt, 1939-44*.

² Estimated as follows:

Agriculture.—Forestry workers and persons engaged in the production of technical crops as given in the *Kräftebilanz* were deducted from the agricultural total. The residual figure was then reduced by the proportion of civilian sales to total sales in the food industries.

Industry.—The estimates were based on employment data of the *Statistisches Reichsamt* for *ubrige verarbeitende Industrie*. It was necessary to increase these data to raise them to the employment levels indicated by the *Kräftebilanz*. The figures thus obtained for each year were then reduced by the proportion of civilian sales to total sales of the consumer goods industries.

Handwork.—According to the *Planungsamt* (*Reichsministerium für Rüstungs- und Kriegsproduktion*), the output of metal and construction handwork in 1940 made up about half of total handwork output. It was assumed that the proportion of consumer goods in the production of metal and construction handwork was the same as the ratio of consumers outlay to total national product, and that other handwork production consisted entirely of consumer goods. The *Kräftebilanz* employment figures for each year were broken down in accordance with these assumptions.

Transport and administration.—These estimates were likewise obtained by applying to the employment data the ratio of consumers expenditures to total national product.

Trade, banking, and insurance.—The number of employees given in the *Kräftebilanz* was reduced for each year by the proportions of civilian sales to total sales of the consumer goods industries and of agriculture, equal weight being given to the two proportions.

³ Not including persons engaged in home work, a category first reported in 1944.

(xi)

Indices of Civilian Expenditure on Consumption Goods in Germany and the United Kingdom, 1938-44¹

(Indices based on constant prices, 1938 = 100)

Year	Germany (Pre-war Area)	United Kingdom
1938	100	100
1939	108	100
1940	100	87
1941	97	81
1942	88	79
1943	87	76
1944	79	77

¹ B.B.S.U. *The Strategic Air War*, Table 19, p. 76. Sources: Germany—U.S.S.B.S. Overall Effects Division, Special Paper No. 1; United Kingdom—*The Impact of the War on Civilian Consumption in the United Kingdom, United States and Canada*, H.M.S.O., 1945.

(xii)

The Estimated Percentage Loss attributable to all Town Area Attacks allowing for the lag in Effects on Industry, (a) for all Production, and (b) for War Production. All Percentages are in terms of the corresponding Estimated Potential Production in the absence of Town Raids¹

Industrial Group(s)	1942	1943		1944		1945
	January-December	January-June	July-December	January-June	July-December	January-April ²
11/12 Iron and Metal Processing:						
War Production .	3.0	14.5	46.5	24.2	39.0	54.2
All Production .	2.1	10.3	31.9	16.8	26.4	37.1
13/16 Iron and Metal Wares:						
War Production .	0.5	2.4	7.6	3.8	2.4	10.0
All Production .	0.3	1.4	4.4	2.8	3.6	5.2
17 Machine, Ship, Aircraft and Motor Construction:						
War Production .	1.8	9.0	10.0	2.2	(3.0)	(4.0)
All Production .	1.1	5.0	14.1	8.1	12.0	16.9
18 Electrical Industry:						
War Production .	—	(Average overall gain of about 6 per cent from January, 1943, to June, 1944)			—	—
All Production .	—				—	—
19 Precision and Optical Instruments:						
All Production .	1.2	6.0	17.4	8.8	15.4	19.8
20 Chemical Industry:						
War Production .	2.9	8.6	9.6	3.9	(6.5)	(8.8)
All Production .	7.2	5.6	14.6	7.3	12.7	16.5
7/10, 21/28, 36/38 Building, Textiles, Clothing, etc.:						
All Production .	0.6	2.5	7.8	4.4	6.3	9.3
30/35 Food and Drink:						
All Production .	1.6	6.0	19.6	10.7	16.8	23.0
<i>Total Productive Industry (excluding Mining):</i>						
War Production . .	0.5	3.2	6.9	2.4	(2.6)	(3.7)
All Production . .	0.7	3.5	10.5	5.7	9.0	(12.2)
<i>Total Productive Industry (excluding Mining and Iron and Metal Processing) (Group 11/12):</i>						
War Production . .	0.25	1.8	3.8	1.0	(0.9)	(1.2)
All Production . .	0.56	2.7	8.2	4.4	7.2	9.7

¹ B.B.S.U. Report on the Effects of Strategic Air Attacks on German Towns, Table 24, p. 30.

² Effects calculated as though they took place over a six months' period.

Figures in parenthesis are very conjectural, as they assume that war production could be maintained relative to all production as well as it was in January-June 1944.

(xiii)

Economic Effects of Air Offensive on German Cities¹

City	Index of Intensity	Tons Claimed Dropped	Total Direct and Indirect Loss (in months)	% of City's Contribution to Reich Production	Loss as % of Annual Reich Production
Hamburg	31.2	8,600	3.6	3.36	1.01
Augsburg	29.1	2,850	5.6	.31	.15
Wuppertal	28.6	4,544	4.4	.82	.30
Dusseldorf	21.7	4,138	2.2	1.63	.30
Bochum	14.4	4,490	2.8	.90	.21
Dortmund	12.0	4,281	3.4	.90	.26
Hagen	11.6	1,276	.6	.34	.02
Oberhausen	11.5	725	2.0	.51	.09
Leipzig	10.5	3,355	1.2	1.68	.17
Bremen	7.2	5,680	1.9	1.22	.20
		39,939			2.71

¹ U.S.S.B.S. Area Studies Division Report, Tables P and Q, p. 18.

From these figures a rough estimate may be made that for every 15,000 tons of bombs dropped in area raids a loss of one per cent of annual production was imposed on Germany. On the basis of a one per cent loss for 15,000 tons dropped in area raids, the total losses imposed on Germany may be estimated as follows.

Year	Tonnage Claimed Dropped	Loss as % of Annual Reich Production
1942	37,826	2.5
1943	143,578	9.0
1944	254,666	17.0
1945 (Jan.-Apr.)	97,443	6.5

(xiv)
Schedule of Towns subjected to Area Attack by R.A.F. Bomber Command with Dates, Tonnage Dropped and Resulting Devastation¹

Town	Date of First Main Force Attack	Date of Last Main Force Attack	Total Number of Main Force Attacks	Tonnages (Short) claimed dropped (including Mosquito Attacks) Jan., 1942—May, 1945	Acres 40 per cent or more Built-up (Target) Area	Acres Destroyed in Built-up (Target) Area	Destroyed Percentage of Built-up (Target) Area
Aachen	5/6.10.42	13/14. 7.43	2	3,930	1,030	605	59
Augsburg	25/26. 2.44	—	1	2,076	1,535	445	29
Berlin	16/17. 1.43	24/25. 3.44	24	49,400	19,423	6,427 ^a	33
Bochum	29/30. 3.43	4/5.11.44	6	10,207	640	532	83
Bonn	18.10.44	4/5. 2.45	5	2,317	708	240	34
Bremen	3/4. 6.42	22. 4.45	12	9,709	1,744	1,042	60
Bremerhaven	18/19. 9.44	—	1	968	375	297	79
Brunswick	14/15. 1.44	14/15.10.44	5	6,803	1,400	655	47
Chemnitz	14/15. 2.45	5/6. 3.45	2	4,574	1,452	590	41
Coblenz	6/7.11.44	—	1	896	523	303	58
Cologne	13/14. 3.42	2. 3.45	22	28,599	3,250	1,994	61
Darmstadt	25/26. 8.44	11/12. 9.44	2	1,726	745	516	69
Essau	7/8. 3.45	8/9. 4.45	2	2,017	542	331	61
Dortmund	14/15. 4.42	12. 3.45	9	18,295	1,720	923	54
Dresden	13/14. 2.45	—	1	2,978	2,844	1,681	59
Duisburg	13/14. 7.42	21/22. 2.45	18	29,010	2,955	1,424	48

¹ B.B.S.U. *Air Attacks on German Towns*, Table on p. 43.

Authors' note: These figures should be regarded as only approximate. The tonnage claimed dropped included some tonnage which did not fall on the target area while some tonnage was dropped on it by aircraft which failed to return. It is not known how far those two errors compensate each other. It was also impossible in the later stages of the war to distinguish accurately between the effects of area attacks and those on special industries. Many attacks of the 8th Air Force on special industries in cloudy weather were in effect little different from the area

attacks of Bomber Command. The statistics of destruction are compiled from photographic surveys. Nevertheless the table has been included to show the principal towns attacked and the period through which the attack extended. The statistics of tonnage and destruction give a guide to the extent of the effort made and the destruction that resulted from it. A comparison of the latter with the figures in the previous table shows that the compilation is not misleading.

^a Includes up to 1,000 acres of American damage.

Schedule of Towns subjected to Area Attack by R.A.F. Bomber Command with Dates, Tonnage Dropped and Resulting Devastation—Continued

Town	Date of First Main Force Attack	Date of Last Main Force Attack	Total Number of Main Force Attacks	Tonnages (Short) claimed dropped (including Mosquito Attacks) Jan., 1943—May, 1945	Average 40 per cent or more Built-up (Target) Area	Average Destroyed in Built-up (Target) Area	Destroyed Percentage of Built-up (Target) Area
Dusseldorf	31/1. 8.42	2/3.11.44	10	18,099	3,115	2,003	64
Emden	6/7. 6.42	6. 9.44	5	2,834	485	270	56
Essen	8/9. 3.42	11. 3.45	28	39,997	2,630	1,319	50
Frankfurt A/Main	24/25. 8.42	28/29.12.44	11	23,139	2,200	1,145	52
Freiburg	27/28.11.44	—	1	1,900	694	257	37
Friedrichshafen	27/28. 4.44	—	1	1,234	148	99	67
Gelsenkirchen	25/26. 6.43	22/23. 1.45	4	7,386	757	360	48
Giesse	2/3.12.44	6/7.12.44	2	549	398	130	33
Hagen	1/2.10.43	15/16. 3.45	4	4,515	486	325	67
Hamburg	15/16. 1.42	13/14. 4.45	17	16,089	8,315	6,200	75
Hannu	5.12.44	—	1	514	355	140	39
Hannau	6/7. 1.45	18/19. 3.45	2	3,059	275	190	69
Hannover	22/23. 9.43	25. 3.45	16	15,299	2,519	1,517	60
Harburg	11/12.11.44	—	1	—	286	153	53
Heilbronn	22. 3.45	—	1	1,254	430	351	82
Hildesheim	4/5.12.44	—	1	1,168	378	263	70
Kaiserslautern	27/28. 9.44	—	1	999	369	194	36
Karlsruhe	2/3. 9.42	2/3. 2.45	6	8,178	1,237	398	32
Kassel	27/28. 8.42	8/9. 3.45	6	6,175	905	620	69
Kiel	27/28. 2.42	23/24. 4.45	10	10,875	1,466	725	50
Konigsberg	26/27. 8.44	29/30. 8.44	2	1,053	824	435	53
Krefeld	2/3.10.42	21/22. 6.43	2	2,779	1,529	714	47
Leipzig	20/21.10.43	19/20. 2.44	3	5,714	3,183	625	20
Lubeck	28/29. 3.42	—	1	441	633	190	30
Magdeburg	21/22. 1.44	13/14. 2.45	4	4,166	1,884	774	44
Mainz	11/12. 8.42	27. 2.45	4	3,295	971	593	61
Mannheim-Ludwigshaven	14/15. 2.42	1. 3.45	13	14,319	1,911	1,213	64
Mulheim	22/23. 6.43	—	1	1,848	393	193	64
Munchen-Gladbach and Rheyd	30/31. 8.43	1. 2.45	4	4,115	1,176	633	54

Schedule of Towns subjected to Area Attack by R.A.F. Bomber Command with Dates, Tonnage Dropped and Resulting Devastation—Continued

Town	Date of First Main Force Attack	Date of Last Main Force Attack	Total Number of Main Force Attacks	Tonnages (Short) claimed dropped (including Mosquito Attacks) Jan., 1942—May, 1945	Average 40 per cent or more Built-up (Target) Area	Average Destroyed in Built-up (Target) Area	Destroyed Percentage of Built-up (Target) Area
Munich	19/20. 9.42	7/8. 1.45	9	8,755	3,634	1,547	42
Munster	28/29. 1.42	25. 3.45	6	3,769	997	650	65
Ncus	23/24. 9.44	28/29. 11.44	4	5,744	225	17	8
Nuremberg	28/29. 8.42	16/17. 3.45	11	13,807	2,255	1,146	51
Oberhausen	14/15. 6.43	4. 12.45	3	3,065	100		20
Osabruck	9/10. 8.42	25. 3.45	5	4,437	658	441	67
Pforzheim	23/24. 2.45	—	1	1,825	369	304	83
Plauen	10/11. 4.45	—	1	1,344	712	365	51
Potsdam	14/15. 4.45	—	1	—	559	75	13
Remscheid	30/31. 7.43	—	1	871	339	281	83
Rostock	23/24. 4.42	26/27. 4.42	4	990	634	200	32
Saarbrucken	29/30. 7.42	5/6. 10.44	4	2,986	866	418	48
Schweinfurt	24/25. 2.44	26/27. 4.44	2	3,321	293	126	43
Solingen	4. 11.44	5. 11.44	2	2,048	343	169	49
Stettin	20/21. 4.43	29/30. 8.44	4	5,261	1,386	736	53
Stuttgart	4/5. 5.42	12/13. 2.45	18	21,246	2,514	1,152	46
Trier	21. 12.44	23. 12.44	2	1,436	492	48	10
Ulm	17/18. 12.44	—	1	1,449	562	155	28
Wiesbaden	2/3. 2.45	—	1	2,483	605	90	15
Wilhelmshaven	10/11. 1.42	15/16. 10.44	9	7,354	972	130	13
Witten	18/19. 3.45	—	1	1,081	207	129	62
Worms	21/22. 2.45	—	1	1,116	328	127	39
Wuppertal-Barmen	29/30. 5.43	13. 3.45	2	3,448	1,139	655	58
Wuppertal/Eilberfeld	24/25. 6.43	—	1	1,979	929	870	94
Wurzburg	16/17. 3.45	—	1	1,127	477	422	89

475,363

All area attacks prior to January, 1942

7,074

Total

482,437

(xv)

Towns to be Rebuilt, etc. 1st May 1944¹

Lfd. Nr.	Town	Total Destruction	In percentages of the total number of houses	Heavy damages and total destructions (combined)	In percentages of the total number of homes
1	Köln	129,689	51·35	153,018	60·58
2	Aachen	21,893	46·04	34,087	71·69
3	Hamburg	242,712	44·83	267,470	49·40
4	Kassel	27,209	44·22	34,139	55·48
5	Düsseldorf	67,980	43·94	90,051	58·21
6	Essen	61,430	34·30	97,747	54·57
7	Remscheid	11,295	32·47	17,000	48·85
8	Frankfurt/M.	54,000	31·50	81,000	47·25
9	Emden	2,900	28·86	3,400	33·84
10	Mannheim	23,000	27·85	49,312	59·71
11	Hannover	38,000	26·08	50,000	34·32
12	Augsburg	13,000	24·68	17,200	32·65
13	Frankenthal	1,790	24·03	2,220	29·80
14	Rostock	7,956	23·81	8,543	25·56
15	Wilhelmshaven	6,380	20·10	10,535	33·19
16	Mülheim/Ruhr	7,424	19·45	11,446	29·99
17	Krefeld	10,000	17·72	21,582	38·24
18	Dortmund	25,531	17·52	31,331	21·50
19	Oberhausen	8,300	17·45	14,700	30·90
20	Bochum	14,680	17·43	24,720	29·35
21	Rheydt	3,840	15·95	90,000	37·38
22	Ludwigshafen	6,000	14·65	11,642	28·42
23	Wuppertal	17,404	14·09	39,550	32·01
24	Schweinfurt	1,800	13·86	4,800	36·96
25	Berlin	196,035	13·17	311,419	20·91
26	Mainz	5,500	12·66	6,500	14·96
27	Leipzig	26,462	11·81	57,081	25·81
28	Bremen	14,000	11·75	18,000	15·11
29	Münster	3,550	11·27	5,140	16·31
30	Hagen	4,657	11·04	6,679	15·84
31	München-Gladbach	3,270	9·92	6,240	18·94
32	Duisburg	10,882	9·75	24,430	21·88
33	Stettin	10,469	9·58	13,280	12·15
34	Anklam	590	9·34	1,310	20·73
35	Nürnberg	10,950	8·95	13,850	11·32
36	Lübeck	3,331	7·51	7,434	16·76
37	Kiel	5,500	6·77	12,000	14·76
38	Stuttgart	8,783	6·63	15,204	11·48
39	Wanne-Eickel	1,520	6·48	2,700	11·51
40	München	10,968	4·13	19,266	7·26
41	Karlsruhe	1,988	3·59	5,068	9·16
42	Innsbruck	564	3·06	2,796	15·16

¹ Speer Docs. (Hamburg Series). *Authors' note:* This document from the Speer papers is named 'not final' but gives a good indication of the extent of the damage as German statistics showed it at the date mentioned. The percentages can be compared with those compiled by aerial survey by R.E.8 given in the following table where it will be seen there is a remarkable correspondence between the two sets of figures made by such different methods.

(xvi)

State of attacked towns, 31st March 1944, extract from Ministry of Home Security's Report, 10th May 1944¹

Town	Percentage of seriously damaged buildings					Percentage of seriously damaged housing
	All buildings	Industrial buildings	Non-industrial buildings	All buildings		
				Within Zones 1 and 2 ²	Within Zones 4 and 5	
		<i>Damage exceeding 50%</i>				
Kassel	54	37	62	78	39	54
Remscheid	53	38	59	96	40	51
Hamburg	51	32	60	73	33	56
		<i>Damage 25% to 50%</i>				
Hannover	44	24	52	63	27	48
Frankfurt	42	35	44	57	36	40
Dusseldorf	41	32	46	68	26	36
Augsburg	40	38	41	49	38	39
Cologne	40	27	46	52	29	32
M. Gladbach	37	22	46	72	20	47
M. Ludwigshafen	37	39	35	38	46	32
Aachen	33	23	39	50	14	42
Wuppertal-Barmen	33	16	41	66	21	37
Wuppertal-Elberfeld	32	24	35	66	23	35
Leipzig	28	15	34	36	28	28
Krefeld	25	16	29	48	8	30
		<i>Damage 10% to 25%</i>				
Mulheim	23	14	27	76	15	23
Essen ³	20	28	16	27	41	24
Schweinfurt	20	18	21	21	25	17
Stettin	20	20	21	19	27	18
Dortmund	19	22	17	36	18	20
Berlin ³	18	11	21	26	18	25
Bochum	17	13	20	48	16	19
Hagen	15	9	20	37	8	16
Nurnberg ³	12	9	13	11	13	13
Stuttgart	12	13	12	17	16	11
Oberhausen	10	5	14	2	3	15
		<i>Damage less than 10%</i>				
Duisburg	8	6	10	14	5	9
Brunswick	6	2	8	9	2	7
Munich	5	8	4	7	9	5
Munster	5	6	5	5	9	4
Magdeburg	2	4	—	—	5	—

¹ No allowance has been made for repairs.

² *Authors' note:* The division into zones is described in Volume I, p. 475, fn. 1.

³ The effects of the attacks of 24/25th March on Berlin, 26/27th March on Essen and 30/31st March on Nurnberg have not been assessed in time for inclusion in this report.

(xvii)

Number of machine tools, total employment and number of employees per machine tool in the aero-engine industry, January 1942 and March 1944¹

Date	Number of machine tools (thousands)	Employment (thousands)	Employees per machine tool
1942, January	46.0	194.0	4.21
1944, March	73.0	310.0	4.25

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 38, p. 230. Source: Aircraft Division, U.S.S.B.S.

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Inventories of machine tools in the United States and Germany, January 1, 1940-45¹

Year	United States	Germany ²
1940	942,000	1,177,600
1941	1,053,500	1,305,800
1942	1,246,500	1,437,800
1943	1,529,386	1,554,900
1944	1,770,935	1,656,800
1945	1,882,841	1,737,100

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 37, p. 230. Sources: Data prepared by the *Wirtschaftsgruppe Maschinenbau* for the Equipment Division of the U.S.S.B.S., at Saalfeld, Germany, July 1945; and War Production Board, Product Reports, Tool Division, April 2, 1945, TO-4B-D.

² For comparison with the United States figures, the German inventory of machine tools has been adjusted to exclude such metal forming machines as presses, forging hammers, extruding machines and shears.

(xix)

*Supply of coal, including brown coal converted to
bituminous coal equivalent,
Germany and occupied territories, 1938-44¹*

(In million metric tons)

Coal year ending March	Production in Greater Germany			Imports	Production in occupied countries
	Prewar Germany	Annexed territories ²	Total		
1938-39	232·3	8·0	240·3	³	92·5
1939-40	233·7	34·0	267·7	³	96·9
1940-41	239·5	76·0	315·5	1·5	87·3
1941-42	241·5	76·4	317·9	2·9	89·9
1942-43	250·3	90·1	340·4	2·9	89·3
1943-44	249·1	98·5	347·6	2·4	84·7

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 57, p. 94. Sources: *Statistischer Bericht: Reichsvereinigung Kohle* various dates. Also other publications of the same agency.

² Approximate: includes production of Alsace-Lorraine, Czechoslovakia, Austria and annexed parts of Upper Silesia.

³ Not available.

(XX)
Quarterly steel production in Germany by districts, 1938-44¹
 (In thousand metric tons)

Year and Quarter	Rhine-land and Westphalia	Sieg, Lahn and Dill Districts; and Hessen	South Germany ²	Saar Pfalz ²	Saxony and Sudeten-land	North, east, and central Germany	Upper Silesia ⁴	Austria	Pre-war Germany	Protec- torate	Alsace Lorraine	Luxem- burg	Greater Germany
1938													
1st quarter	3,891	114	111	627	167	622	110	5,642	—	—	—	—	—
2nd quarter	3,885	112	104	618	161	613	179	5,672	—	—	—	—	—
3rd quarter	4,106	113	109	662	175	624	194	5,983	—	—	—	—	—
4th quarter	4,126	114	108	666	178	650	190	6,032	—	—	—	—	—
Total	16,008	453	432	2,573	681	2,509	673	23,329	—	—	—	—	—
1939													
1st quarter	4,278	112	114	692	184	677	213	6,270	—	—	—	—	—
2nd quarter	4,099	111	114	708	179	659	208	6,078	—	—	—	—	—
3rd quarter	4,108	109	113	493	189	700	215	5,927	—	—	—	—	—
4th quarter	3,739	104	114	140	181	977	203	5,458	—	—	—	—	—
Total	16,224	436	455	2,033	733	3,013	839	23,733	—	—	—	—	—
1940													
1st quarter	3,393	92	111	143	185	453	172	5,095	—	—	—	—	—
2nd quarter	3,359	102	117	203	203	515	191	5,209	—	—	—	—	—
3rd quarter	3,533	107	123	293	203	424	204	5,549	—	—	—	—	—
4th quarter	3,443	109	124	517	201	576	199	5,747	—	—	—	—	—
Total	13,728	410	475	1,156	792	2,068	766	21,540	—	—	—	—	—
1941													
1st quarter	3,398	109	120	571	211	611	195	5,766	—	—	—	—	6,894
2nd quarter	3,444	113	117	614	202	655	188	5,911	—	—	—	—	7,121
3rd quarter	3,400	107	115	609	198	677	205	5,910	—	—	—	—	7,133
4th quarter	3,372	107	112	594	194	676	216	5,884	—	—	—	—	7,085
Total	13,614	435	465	2,387	805	2,618	804	23,469	—	—	—	—	28,233

Quarterly steel production in Germany by districts, 1938-44—Continued

(In thousand metric tons)

Year and Quarter	Rhine-land and Westphalia	Sieg, Lahn Districts; and Hessen	South Germany ²	Saar Pfalz ²	Saxony and Sudeten-land	North, east, and central Germany	Upper Silesia ¹	Austria	Pre-war Germany	Protec-torate	Alsace Lorraine	Luxem-burg	Greater Germany
	Northwest	Southwest	Central	Silesia	Pre-war Germany	Southwest	Southwest	Pre-war Germany	Alsace Lor-raine and Luxemburg	Greater Germany			
1942													
1st quarter	3,005	96	104	553	182	655	557	205	5,357	402	437	229	6,424
2nd quarter	3,105	103	110	558	196	704	574	222	5,572	397	505	375	6,850
3rd quarter	3,323	113	121	582	210	725	624	226	5,924	413	622	460	7,419
4th quarter	3,625	123	127	632	213	794	665	244	6,423	437	686	505	8,051
Total	13,058	434	463	2,326	800	2,878	2,421	897	23,277	1,648	2,350	1,569	28,744
1943													
1st quarter	3,750	1,875	1,038	1,038	700	700	269			430			8,062
2nd quarter	3,191	1,918	1,021	1,021	708	708	265			429			7,532
3rd quarter	3,291	1,870	1,008	1,008	700	700	262			421			7,552
4th quarter	3,212	1,815	1,005	1,005	713	713	259			453			7,457
Total	13,444	7,478	4,072	4,072	2,821	2,821	1,055			1,733			30,603
1944													
1st quarter	3,430	1,876	984	984	720	720	257			451			7,718
2nd quarter	3,334	1,684	1,058	1,058	718	718	268			425			7,487
3rd quarter	3,428	869	1,028	1,028	713	713	264			403			6,707
4th quarter	1,553	98	948	948	727	727	218			397			3,941
Total	11,745	4,527	4,018	4,018	2,878	2,878	1,007			1,676			25,853

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 71, pp. 250-1. Source: *Reichsvereinigung Eisen*. It is not known whether the German production data under the heading 'pig iron' cover output of pig iron only or combined output of pig iron and ferro-alloys; nor is it known whether data under the heading 'crude steel' cover combined output of ingots and castings or output of ingots only. The figure given for the 1938 production of 'pig iron' was referred to in one of the sources as production of 'pig iron and ferro-alloys' but in another source as production of 'pig iron' only. No mention is made of ferro-alloys in connection with the production data for any other year. The figures given for

production of 'crude steel' in 1938-42, inclusive, are in one source defined as 'ingots plus castings' and in another source simply given as 'steel ingot' production. The data for the period 1943-44 are uniformly titled 'crude steel'.
² In 1938 and 1939, includes *Rheinpfalz*.
³ Excludes the Saar plants from September 1939 to October 1940 inclusive.
⁴ From September 1939 includes East Upper Silesia and starting January 1940 includes the Polish regions of Olsa and Dombrowa.
⁵ Not available.

(xxi)
 Quarterly steel production in Germany and occupied countries, 1941-44¹
 (In thousand metric tons)

Year and quarter	Poland	Meurthe and Moselle ²	Belgium	Northern France	Netherlands	Total occupied countries	Greater Germany	Grand total
1941								
1st quarter	54	161	448	208	49	920	6,894	7,814
2nd quarter	51	166	413	226	46	901	7,121	8,022
3rd quarter	55	154	410	211	47	877	7,133	8,010
4th quarter	59	171	395	212	51	889	7,085	7,973
Total	219	653	1,666	856	192	3,587	28,233	31,819
1942								
1st quarter	49	158	323	187	33	749	6,424	7,173
2nd quarter	58	162	346	192	49	805	6,850	7,655
3rd quarter	64	206	361	188	42	861	7,419	8,280
4th quarter	67	267	394	201	37	967	8,051	9,018
Total	238	793	1,423	767	160	3,382	28,744	32,126
1943								
1st quarter	63	263	347	187	34	894	8,062	8,956
2nd quarter	68	270	429	217	38	1,022	7,532	8,554
3rd quarter	63	278	483	203	42	1,071	7,552	8,623
4th quarter	67	282	445	215	47	1,054	7,457	8,511
Total	261	1,093	1,704	822	161	4,041	30,603	34,644
1944								
1st quarter	63	290	424	216	35	1,474 ³	7,718	9,192
2nd quarter	65	169	120	122	35	934 ³	7,487	8,421
3rd quarter	4	4	4	4	4	221	6,707	6,928
4th quarter	19	—	—	—	—	19	3,941	3,960
Total	4	4	4	4	4	2,648	25,853	28,501

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 72, p. 252. Source: *Reichvereinigung Eisen und Statistische Schnellberichte zur Kriegsverwaltung*. See footnote 1 to Table (xx).

² Comprises the districts of 'Meurthe and Moselle South' and 'Meurthe and Longwy-Ardenne'. Data are available for these districts separately only in 1941 and 1942. 'Meurthe and Moselle South' production by quarters was as follows: in 1941, 111,000, 95,000, 105,000 and 106,000 metric tons and in 1942, 105,000, 100,000, 124,000 and 138,000 metric tons.

³ Includes the output of Northern Italy and Central France (Centre Ouest and Centre Midi), amounting to 446,000 tons in the first quarter and 423,000 tons in the second quarter.

⁴ Not available.

(xxii)

Number of German Aircraft produced by types, annually 1939-44 and monthly 1941-44¹

Year and Month	Fighters	Bombers	Transports	Trainers	Others ²	Total
1939	1,856	2,877	1,037	1,112	1,413	8,295
1940	3,106	3,997	763	1,328	1,632	10,826
1941	3,732	4,350	969	889	1,836	11,776
1942	5,213	6,539	1,265	1,170	1,369	15,556
1943	11,738	8,589	2,033	2,076	1,091	25,527
1944	28,926	6,468	1,002	3,063	348	39,807
1941						
January	136	255	70	89	83	633
February	255	326	72	76	142	871
March	424	392	85	118	155	1,174
April	476	355	92	76	130	1,129
May	446	269	88	62	172	1,037
June	376	325	74	61	204	1,040
July	320	446	72	78	138	1,054
August	285	454	75	56	151	1,021
September	258	416	62	64	187	987
October	261	382	101	77	136	957
November	232	331	93	77	162	895
December	263	399	85	55	176	978
1942						
January	274	444	81	64	155	1,018
February	303	343	83	64	113	906
March	456	598	112	103	131	1,400
April	427	552	83	94	165	1,321
May	384	577	128	100	126	1,315
June	371	587	106	113	105	1,282
July	487	555	98	94	126	1,360
August	475	590	100	94	86	1,345
September	492	520	109	98	91	1,310
October	502	590	123	113	116	1,444
November	488	509	114	123	73	1,307
December	554	674	128	110	82	1,548
1943						
January	512	674	128	125	86	1,525
February	858	781	130	125	110	2,004
March	962	757	173	156	118	2,166
April	936	735	172	145	112	2,100
May	1,013	718	178	179	108	2,196
June	1,134	710	178	194	100	2,316

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 102, p. 277. Source: Reclassification of German figures, Aircraft Division, U.S.S.B.S.

² Including gliders.

*Number of German Aircraft produced by types, annually 1939-44 and
monthly 1941-44—Continued*

Year and Month	Fighters	Bombers	Transports	Trainers	Others ¹	Total
July	1,263	743	191	190	88	2,475
August	1,135	710	201	174	117	2,337
September	1,072	678	201	201	62	2,214
October	1,181	738	184	200	46	2,349
November	985	702	171	183	70	2,111
December	687	643	126	204	74	1,734
1944						
January	1,555	522	141	160	67	2,445
February	1,104	567	112	170	62	2,015
March	1,638	605	139	243	47	2,672
April	2,021	680	134	154	45	3,034
May	2,212	648	133	226	29	3,248
June	2,449	703	104	331	39	3,626
July	2,954	767	136	325	37	4,219
August	3,020	548	46	374	19	4,007
September	3,375	428	16	284	—	4,103
October	2,973	326	16	271	—	3,586
November	2,995	412	13	274	3	3,697
December	2,630	262	12	251	—	3,155

¹ Including gliders.

(xxiii)
German Aircraft Production from 1939 to 1944¹

	1939		1940		1941		1942		1943		1944	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Single-engine fighters . . .	1,541	18.6	1,870	17.3	2,852	24.2	4,542	29.2	9,626	37.7	25,860	65.0
Twin-engine fighters ² . . .	1,050	12.5	1,840	17.0	1,880	16.0	2,422	15.6	4,100	16.0	5,025	12.7
Dive bomber and ground attack ³ . . .	557	6.7	611	5.6	476	4.0	917	5.9	1,844	7.2	909	2.3
Twin-engine bombers ⁴ . . .	1,579	19.1	2,744	25.3	2,816	24.0	3,620	23.3	4,266	16.8	3,063	7.7
Four-engine bombers . . .	6	0.1	38	0.4	58	0.5	251	1.6	491	1.9	518	1.3
Total combat . . .	4,733	57.1	7,103	65.6	8,082	68.7	11,752	75.6	20,327	79.6	35,394	89.0
Transports . . .	1,037	12.5	763	7.1	969	8.2	1,265	8.1	2,033	8.0	1,002	2.5
Trainers . . .	877	10.6	1,132	10.5	889	7.6	1,170	7.5	2,076	8.1	3,063	7.7
Not elsewhere classified ⁴ . . .	1,648	19.8	1,828	16.8	1,836	15.5	1,369	8.8	1,091	4.3	348	0.8
Grand total . . .	8,295	100.0	10,826	100.0	11,776	100.0	15,556	100.0	25,527	100.0	39,807	100.0

¹ *B.B.S.U. The Strategic Air War*, Table 32, p. 106.

² The division of aircraft produced as between twin-engine fighters and twin-engine bombers is not possible for all periods owing to the fact that some types (Ju.88, Do.217, and others) were used for both purposes. Some information is available for 1943 and 1944 from which the proportion for each type could be estimated. For the earlier years an arbitrary figure of 60 per cent for bombers and 40 per cent for fighters has been taken.

³ Dive bomber and ground attack cover the Ju.87 and Hu.129 types only. In 1943 and 1944 the Fw.190 played an increasingly large part in the equipment of ground attack units.

⁴ The category 'Not elsewhere classified' includes gliders, which constitute less than 0.5 per cent of total production in 1944.

(xxiv)
 German, British and United States Aircraft Production for Selected Operational Types given as Monthly Averages
 at Quarterly Intervals¹

Date	Single-Engine Fighters			Twin-Engine Aircraft ²			Four-Engine Aircraft			
	German	British	United States	German	British	United States	German	British	United States	Not Known
1939										
1st Quarter	128	70	—	219	134	—	0.5	—	—	—
2nd Quarter		82	—		141	—		—	—	—
3rd Quarter		74	—		153	—		—	—	—
4th Quarter		114	—		174	—		—	—	—
1940										
1st Quarter	156	155	—	382	151	24	3	1	—	5
2nd Quarter		340	12		288	24		3	—	—
3rd Quarter		563	91		365	28		11	—	6
4th Quarter		420	156		339	20		25	—	9
1941										
1st Quarter	160	452	146	366	375	51	5	34	—	8
2nd Quarter	326	491	152	353	428	106	5	50	—	17
3rd Quarter	242	550	174	454	438	169	6	57	—	18
4th Quarter	221	559	320	373	407	224	3	89	—	64
1942										
1st Quarter	396	625	395	434	465	326	12	142	—	125
2nd Quarter	349	692	473	504	511	376	20	191	—	182
3rd Quarter	420	681	517	521	503	526	24	232	—	237
4th Quarter	449	659	484	555	517	575	27	321	—	329
1943										
1st Quarter	642	697	595	698	488	625	31	387	—	457
2nd Quarter	865	687	741	683	472	808	45	383	—	700
3rd Quarter	932	672	993	743	443	707	34	428	—	914
4th Quarter	763	661	1,205	663	452	1,010	54	483	—	1,194
1944										
1st Quarter	1,236	663	1,305	567	525	1,138	64	481	—	1,435
2nd Quarter	1,927	666	1,290	779	489	1,185	72	460	—	1,516
3rd Quarter	2,779	563	1,394	795	476	1,067	36	412	—	1,383
4th Quarter	2,645	534	1,221	554	434	908	Nil	412	—	1,113
1945										
1st Quarter	2,078	483	1,283	492	421	837	Nil	350	—	1,066

¹ B.B.S.U. Effects of Bombing the German Aircraft Industry, First table on p. 34.

² German twin-engine aircraft were mostly bombers during the first part of the war and mostly fighter types from 1943 onwards.

(xxv)

*Comparison of Allied Intelligence Estimates of
German Aircraft Production with Actual Production¹*

(Average monthly figures for six-month intervals)

	Single-Engine Fighters		Total Airplane Production	
	Allied Intelligence Estimates	Actual	Allied Intelligence Estimates	Actual
1st half 1941	325	244	1,575	880
2nd half 1941	360	232	1,725	870
1st half 1942	410	323	1,820	1,115
2nd half 1942	435	434	1,880	1,341
1st half 1943	595	753	2,030	1,985
2nd half 1943	645	851	2,115	2,172
1st half 1944	655	1,581	1,870	2,811

¹ U.S.S.B.S. *Aircraft Division Industry Report*, Table V-7, p. 74.

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*Production of Aircraft for GAF at Principal Plants
outside of Germany¹*

Country-City	Manufacturer	Model	Number of Airplanes Produced			
			1941	1942	1943	1944
<i>France</i>						
Paris	Coudron	C-445	62	334	119	—
St. Nazaire	SNCA	Ar-196	—	13	10	—
Bordeaux	SNCA	FW-189	—	87	194	12
Paris	Amiot	Ju-52	—	40	321	155
Satrouville	SNCA-N	Do-24	—	2	20	26
Les Moreaux	SNCA-N	ME-108	—	50	108	12
Bourges	Morane	Fi-156	—	121	403	260
	SNCA	SI-204	—	21	110	37
Total			62	668	1,285	502
<i>Czechoslovakia</i>						
Chotzen	MRAZ	Fi-156	—	—	—	64
	MRAZ	DFS-230	—	—	—	14
	LBB	Fi-156	—	—	1	72
Prague	BMM	SI-204	—	—	206	286
		DFS-230	322	74	—	—
Prague	Aero	SI-204	—	—	136	379
	Aero	FW-189	151	183	3	—
Prague	Avia	Ar-96	346	311	459	628
Prague	Letoc	Ar-96	—	—	—	512
Total			819	568	805	1,955
<i>Holland</i>						
Amsterdam	Fokker	Ar-196	—	—	11	58
	Fokker	BU-181	—	31	342	335
	Aviolanda	Do-24	16	44	61	49
Total			16	75	414	442
<i>Hungary</i>						
Budapest	Donauflug Győr	Me-210	—	—	34	74
		Me-109	—	—	39	270
Total			—	—	73	344
<i>Italy</i>						
Total	Savoia- Machetti	SM-82	—	—	32	79
			—	—	32	79
GRAND TOTAL			897	1,311	2,609	3,322

¹ U.S.S.B.S. Aircraft Division Industry Report, Table II-2, p. 22a.
S.A.O.—IV—KK

(xxvii)
German Aircraft Production, Wastage and Strength¹

Quarter Ending	Input				Wastage			Surplus of Total Input over Total Wastage	First Line Strength	Reserve Training Units	Change in Strength
	New Aircraft Produced	New Aircraft Accepted	New Aircraft Allocated	Repaired Aircraft Allocated	Total Allocations	Destroyed, Missing	Damaged				
31 December, 1942	—	3,317	—	—	—	—	—	—	5,257	1,293	—
31 March, 1943	—	4,544	—	—	—	2,354	1,596	3,950	6,527	1,527	+ 1,504
30 June, 1943	—	5,246	—	—	—	3,120	2,521	5,641	7,193	1,595	+ 734
30 September, 1943	—	5,510	—	—	—	4,100	3,078	7,178	6,186	1,542	- 1,060
31 December, 1943	5,312	4,936	5,057	1,395	6,452	3,219	2,125	5,344	6,688	1,665	+ 695
	—	20,227	—	—	—	12,793	9,320	22,113	—	—	+ 1,803
31 March, 1944	6,301	5,991	5,843	1,598	7,441	4,107	2,987	7,094	6,777	1,600	+ 24
30 June, 1944	8,973	8,713	8,469	2,514	10,983	5,541	4,373	9,914	6,746	1,569	+ 62
30 September, 1944	11,228	11,092	10,672	3,027	13,699	6,002	4,177	10,179	6,986	1,488	+ 159
31 December, 1944	9,601	9,598	8,880	2,309	11,189	4,360	2,610	6,970	7,244	1,854	+ 624
1944	36,103	35,394	33,864	9,448	43,312	20,010	14,147	34,157	—	—	+ 745

¹ B.B.S.U. Effects of Bombing the German Aircraft Industry, Table IX, p. 25. Authors' note: Communications, glider and trainer aircraft are excluded from this table.

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German Air Force Establishment, Strength, Serviceability and Crews at Quarterly Intervals, 1939-1944¹

SINGLE ENGINE FIGHTERS

Date	Establishment	Strength	Serviceability	Per cent Serviceability	Fully Operational Crews	Surplus Crews
September, 1939	1,174	1,125	870	77	898	+ 28
December, 1939	966	1,022	769	75	674	- 95
March, 1940	1,449	1,258	817	65	944	+127
June, 1940	1,171	1,107	856	77	906	+ 50
August, 1940	1,171	1,065	878	82	869	- 9
September, 1940	1,132	932	721	77	688	- 33
November, 1940	1,141	921	673	73	673	-
December, 1940	1,162	832	587	70	720	+133
March, 1941	1,375	1,158	846	73	1,136	+290
June, 1941	1,426	1,266	885	70	1,130	+245
September, 1941	1,472	1,226	774	63	1,039	+269
December, 1941	1,472	1,116	670	60	751	+ 81
March, 1942	1,456	1,129	747	66	922	+175
June, 1942	1,568	1,277	901	70	1,048	+147
September, 1942	1,580	1,491	1,024	69	1,136	+112
December, 1942	1,592	1,360	908	67	916	+ 8
March, 1943	1,712	1,535	1,006	66	1,187	+181
June, 1943	2,172	1,849	1,361	74	1,444	+ 83
September, 1943	2,228	1,646	1,080	66	1,447	+367
December, 1943	2,244	1,561	1,095	70	1,441	+346
March, 1944	2,320	1,696	1,188	70	1,322	+134
June, 1944	3,016	1,523	895	59	1,325	+430
September, 1944	3,852	1,984	1,413	71	1,740	+327
December, 1944	4,084	2,260	1,521	67	1,744	+223

¹ B.B.S.U. *Effects of Bombing the German Aircraft Industry*, App. B, pp. 31-32. These figures have been taken from the records of the 6 Abteilung of the O.K.L. Generalquartiermeister's staff. They are recorded in an A.D.I.K. Report. Only the main operational types of aircraft are shown.

*German Air Force Establishment, Strength, Serviceability and Crews
at Quarterly Intervals, 1939-1944—Continued*

BOMBERS

Date	Establishment	Strength	Serviceability	Per cent Serviceability	Fully Operational Crews	Surplus Crews
September, 1939	1,188	1,213	1,014	83	1,037	+ 23
December, 1939	1,453	1,367	1,000	73	926	- 74
March, 1940	1,757	1,656	1,102	67	1,209	+107
June, 1940	1,652	1,380	841	61	931	+ 90
September, 1940	1,638	1,420	818	57	1,074	+256
December, 1940	1,700	1,330	722	54	955	+333
March, 1941	1,742	1,460	932	64	1,158	+226
June, 1941	1,885	1,321	763	58	1,132	+369
September, 1941	1,938	1,538	630	41	815	+185
December, 1941	1,950	918	383	41	640	+257
March, 1942	1,869	977	480	49	607	+127
June, 1942	1,885	1,381	885	65	841	- 44
September, 1942	2,049	1,416	741	52	760	+ 19
December, 1942	2,094	1,193	611	51	444	-167
March, 1943	2,025	1,522	844	55	480	-364
June, 1943	2,111	1,663	1,070	64	828	-242
September, 1943	2,025	1,080	639	59	793	+154
December, 1943	2,053	1,604	1,078	67	802	-276
March, 1944	1,901	1,331	825	62	859	+ 34
June, 1944	1,672	1,089	694	64	878	+184
September, 1944	1,424	929	644	69	761	+117
December, 1944	824	528	359	68	446	+ 87

NIGHT FIGHTERS

Date	Establishment	Strength	Serviceability	Per cent Serviceability	Fully Operational Crews	Surplus Crews
December, 1940	195	165	104	63	61	- 43
March, 1941	215	199	124	62	115	- 9
June, 1941	227	244	172	70	117	- 55
September, 1941	254	245	140	57	119	- 21
December, 1941	406	223	132	59	155	+ 23
March, 1942	367	248	134	54	203	+ 69
June, 1942	406	244	162	66	189	+ 27
September, 1942	506	350	245	70	223	- 22
December, 1942	653	389	278	72	258	- 20
March, 1943	665	493	360	73	309	- 51
June, 1943	795	554	371	67	307	- 64
September, 1943	978	574	248	60	387	+ 39
December, 1943	966	611	405	66	369	- 36
March, 1944	1,047	565	361	64	376	+ 15
June, 1944	1,059	778	528	68	570	+ 42
September, 1944	1,071	1,018	854	84	794	- 60
December, 1944	1,319	1,256	913	73	599	-314

*German Air Force Establishment, Strength, Serviceability and Crews
at Quarterly Intervals, 1939-1944—Continued*

DIVE BOMBERS AND GROUND ATTACK

Date	Establishment	Strength	Serviceability	Per cent Serviceability	Fully Operational Crews	Surplus Crews
September, 1939	420	384	267	69	358	+ 97
December, 1939	456	459	356	78	337	- 19
March, 1940	459	453	368	81	417	+ 49
June, 1940	507	483	337	69	341	+ 4
September, 1940	505	482	401	83	396	- 5
December, 1940	507	482	375	78	402	+ 17
March, 1941	465	444	353	79	389	+ 36
June, 1941	465	410	278	68	366	+ 88
September, 1941	468	397	280	70	348	+ 68
December, 1941	468	256	132	51	210	+ 78
March, 1942	507	406	205	50	306	+ 101
June, 1942	507	461	300	65	388	+ 88
September, 1942	507	413	273	66	324	+ 51
December, 1942	498	286	160	56	206	+ 46
March, 1943	510	469	325	70	332	+ 7
June, 1943	525	523	444	85	353	- 91
September, 1943	803	562	395	70	582	+ 86
December, 1943	899	601	466	77	550	+ 84
March, 1944	928	776	516	66	645	+ 129
June, 1944	964	1,005	751	75	752	+ 1
September, 1944	964	816	606	74	588	- 18
December, 1944	964	892	637	71	674	+ 37

German Air Force Establishment, Strength, Serviceability and Crews at Quarterly Intervals, 1939-1944—Continued

TWIN ENGINE FIGHTERS (ZERSTÖRER)

Date	Establishment	Strength	Serviceability	Per cent Serviceability	Fully Operational Crews	Surplus Crews
September, 1939	168	194	141	73	168	+ 27
December, 1939	438	410	299	73	279	- 20
March, 1940	369	325	222	68	324	+ 102
June, 1940	384	357	261	73	293	+ 32
August, 1940	448	414	320	77	268	- 52
September, 1940	272	181	114	63	126	+ 12
November, 1940	225	211	145	69	126	- 19
December, 1940	228	241	168	70	162	- 6
March, 1941	303	322	224	69	286	+ 62
June, 1941	225	210	131	62	173	+ 42
September, 1941	186	155	83	53	126	+ 43
December, 1941	51	48	21	43	37	+ 16
March, 1942	466	112	61	55	88	+ 27
June, 1942	426	362	210	58	345	+ 135
September, 1942	424	297	166	56	176	+ 10
December, 1942	402	212	111	52	173	+ 62
March, 1943	436	401	206	52	239	+ 33
June, 1943	464	414	305	74	424	+ 119
September, 1943	380	392	243	62	295	+ 52
December, 1943	356	290	199	69	226	+ 27
March, 1944	344	251	148	59	210	+ 62
June, 1944	444	242	124	51	201	+ 77
September, 1944	196	142	122	86	123	+ 1
December, 1944	104 ¹	105	85	81	77	- 8

¹ In December, 1944, Fliegerkorps IX, which was converting from bombers to the Me.262, had a separate establishment of 764. However, they achieved a strength of only 85, with 46 aircraft serviceable, and at this date had only 16 fully operational crews. Fliegerkorps IX figures are not included in the above table.

(XXIX)

Geographical Distribution of output of Ball-bearings in Germany¹

Places	Plants	No. of Bearings	Per cent	Value in Thous. RM	Per cent
Schweinfurt	3	3,771	45·0	12,250	52·2
Cannstatt/Stuttgart	1	1,533	18·3	1,921	8·2
Berlin	2	1,094	13·0	2,049	8·7
Steyr, Austria	1	854	10·2	2,734	11·7
Other Plants in Germany	35	1,127	13·5	4,499	19·2
Total	42	8,379	100·0	23,453	100·0

¹ U.S.S.B.S. *The German Anti-Friction Bearings Industry*, Table 8, p. 18.

(XXX)
Production of Finished Bearings¹
(Thousands of pieces)

1943

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
VKF	3,920	3,833	4,627	4,040	4,614	4,034	4,385	4,020	4,240	3,767	4,077	3,744
FAG	1,904	1,987	2,250	1,972	2,211	2,115	2,126	1,924	1,984	1,820	2,137	1,983
Steyr	526	583	777	726	750	795	854	835	838	838	869	879
Muller	335	364	368	354	415	387	400	246	434	188	371	406
DKF	90	102	98	93	95	98	100	95	109	103	117	112
Kling	58	59	82	79	73	61	68	66	86	82	83	85
Small Firms	356	357	374	359	409	406	446	414	439	418	428	425
TOTAL	7,189	7,285	8,576	7,623	8,567	7,896	8,379	7,600	8,130	7,216	8,082	7,694

1944

VKF	2,657	2,008	1,280	1,299	1,995	2,716	2,786	2,944	3,458	3,799	3,258	3,201
FAG	2,041	1,687	1,428	844	975	1,460	1,618	1,621	1,896	1,897	2,042	1,799
Steyr	934	737	631	44	98	292	591	705	758	719	730	545
Muller	427	384	504	393	711	726	605	637	630	615	628	602
DKF	104	103	99	103	91	79	56	79	95	92	104	85
Kling	50	57	72	40	63	85	77	82	70	60	82	77
Small Firms	653	686	1,151	1,186	1,235	1,358	1,347	1,479	1,658	1,593	1,652	1,556
TOTAL	6,966	5,662	5,165	3,909	5,168	6,716	7,080	7,547	8,565	8,775	8,496	7,865

1945

	Jan.	Feb.
VKF	2,967	1,803
FAG	1,775	1,250
Steyr	316	176
Muller	393	210
DKF	90	80
Kling	50	75
Small Firms	1,300	1,000
TOTAL	6,891	4,594

¹ U.S.S.B.S. The German Anti-Friction Bearings Industry, Table 20, p. 57. Source: *Sondering Waerzlager*.

(XXXI)

Index of Production, German Anti-Friction Bearing Firms, July 1943-December 1944
All Bearings and Bearings in the Medium Size A Range¹

Monthly Average 2nd Quarter 1943 = 100

ALL BEARINGS

Firms	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
VKF	103	95	100	89	96	89	63	47	30	31	47	64	65	70	82	89	77	75	70	43
FAG	101	92	94	88	102	95	97	86	68	40	46	70	77	77	90	90	97	86	85	66
Steyr	113	110	111	111	115	116	123	98	83	6	13	39	78	93	100	95	96	72	42	23
Muller	104	64	113	49	96	105	110	100	130	102	185	190	157	165	164	159	162	155	101	54
Kling	94	93	120	115	117	120	70	80	101	57	90	120	110	114	99	85	113	108	71	106
Small Firms	114	105	112	107	110	108	167	175	286	300	310	348	344	379	423	407	422	397	331	255
TOTAL	105	95	100	90	100	95	86	70	64	49	64	84	88	94	107	109	106	98	86	57

BEARINGS IN MEDIUM SIZE A RANGE

VKF	120	95	91	66	84	70	55	45	35	34	41	56	57	51	59	55	56	53		
FAG	91	68	83	45	39	60	71	71	61	22	23	32	52	68	78	63	68	64		
Steyr	120	115	103	103	86	66	115	81	66	0	4	38	60	85	97	88	91	86		
DKF	104	98	110	112	123	117	118	120	105	105	103	85	44	93	96	102	119	102		
Kling	125	92	97	60	71	100	62	90	83	86	93	100	63	93	66	81	108	81		
TOTAL	108	87	90	65	68	67	72	64	55	29	33	46	57	70	75	65	69	64		

¹ U.S.S.B.S. *The German Anti-Friction Bearings Industry*, Table 19, p. 56. Source: Records of the *Sonderring Waelzlager*. Figures do not include needle or other special bearings.

(xxxii)
Oil Position on Mobilization, July 1939¹

Products	War-time Needs			Production in Germany except West fortification zone		Stocks available in Germany except West fortification zone				Probable duration of full covering of the war-time demands by domestic production and available stocks	
	Services	Com- merce	Total	Tons per Month	Percent- age of Mobil- ization Demand	On 1st August 1939		On 1st October 1939		On 1st August 1939	On 1st October 1939
	Tons per Month	Tons per Month	Tons per Month	Tons per Month	Tons	Total	Of this National Reserve Stock	Total	Of this National Reserve Stocks	Months	Months
						Tons	Tons	Tons	Tons	Months	Months
Aviation fuel	152,500	—	152,500	46,200	30	480,000	385,000	450,000	355,000	4.8	4.5
Tetra-ethyl-lead for aviation and other motor fuels	430	—	430	158 ²	32	860	615	800	550	2.6	2.7
	43	—	43	193 ³	39						
	473	—	473								
Other motor fuels	115,000	70,000	185,000	117,000	63	350,000	—	300,000	—	5.2	4.4
Aviation diesel fuel	3,300	—	3,300	—	—	48,000	40,000	48,000	40,000	14.5	14.5
Diesel fuel, including tractor diesel fuel	39,000	103,000	142,000	45,000	32	308,000	93,000	308,000	93,000	3.2	3.2
Fuel oil for economy	—	25,000	25,000	6,000	24	50,000	—	50,000	—	2.6	2.6
Fuel oil for the Navy	137,000	—	137,000	32,000	24	260,000	—	260,000	—	6.4	6.4
Ship diesel fuel for the Navy	20,000	—	20,000	6,300	32	500,000	—	500,000	—	7.0	7.0
	157,000	—	157,000	38,300	24	760,000	—	760,000	—	13.0	13.0
Aviation motor oil	9,500	—	9,500	2,400	25	50,000	33,000	50,000	33,000	—	—
Other motor oils	8,500	7,000	15,500	8,800	57	88,000	30,000	88,000	30,000	—	—
Total (excluding T.E.L.)	484,000	205,000	689,800	263,700	—	2,134,000	581,000	2,084,000	551,000	—	—

¹ Oil as a Factor in the German War Effort, 1933-1945, report by the C.O.S. Technical Sub-Committee on Axis oil, 8th March 1946.

² = 1st August.

³ = 1st October.

(xxxiii)
Oil Production in Greater Germany, 1940-44¹
 (In thousands of metric tons)

	1940										1941									
	Aviation Gasoline	Motor Gasoline	Diesel Oil	Fuel Oil	Lubricating Oils	Kerosene	Liquefied Gases	Miscellaneous Production ^a	Total		Aviation Gasoline	Motor Gasoline	Diesel Oil	Fuel Oil	Lubricating Oils	Kerosene	Liquefied Gases	Miscellaneous Production ^a	Total	
Crude refining ^a	18	135	202	207	451	124	4	313	1,454		11	157	287	192	545	108	4	288	1,612	
Hydrogenation	612	299	365	51	4	—	169	4	1,504		847	319	620	78	6	—	226	11	2,107	
Fischer-Tropsch	—	223	131	—	6	—	52	37	449		—	228	119	—	11	—	68	48	474	
Coal tar distillation	—	24	83	470	1	—	—	34	612		—	26	88	2	—	—	—	35	692	
Alcohol	—	80	—	—	—	—	—	—	80		—	60	—	—	—	—	—	—	60	
Benzol	14	364	—	—	—	—	—	175	553		31	360	—	—	—	—	—	206	597	
Total	644	1,125	781	728	462	124	225	563	4,632		889	1,150	1,114	811	584	108	298	588	5,542	

Oil Production in Greater Germany, 1940-44—Continued

(In thousands of metric tons)

1942

	Aviation Gasoline	Motor Gasoline	Diesel Oil	Fuel Oil	Lubricating Oils	Kerosene	Liquefied Gases	Miscellaneous Production ^a	Total
Crude refining ^a	7	174	377	56	657	152	5	301	1,729
Hydrogenation	1,340	292	722	122	17	—	262	17	2,772
Fischer-Tropsch	—	228	97	—	8	—	52	61	446
Coal tar distillation	—	35	89	669	1	—	—	36	830
Alcohol	—	6	—	—	—	—	—	—	6
Benzol	40	302	—	—	—	—	—	243	585
Total	1,387	1,937	1,285	847	683	152	319	658	6,368

1943

Crude refining ^a	4	150	429	53	767	182	5	343	1,933
Hydrogenation	1,745	386	787	135	35	—	323	20	3,431
Fischer-Tropsch	—	254	99	—	15	—	60	56	484
Coal tar distillation	—	34	94	820	—	—	—	37	985
Alcohol	—	18	—	—	—	—	—	—	18
Benzol	35	320	—	—	—	—	—	302	657
Total	1,784	1,162	1,409	1,008	817	182	388	758	7,508

1944

Crude refining ^a	3	145	466	66	614	124	235	4	1,653
Hydrogenation	996	293	318	68	24	—	176	4	1,875
Fischer-Tropsch synthesis	—	160	62	—	10	—	74	4	306
Coal tar distillation	—	—	—	—	—	—	—	4	—
Alcohol	—	363	65	753	—	—	352	4	1,578
Benzol	45	—	—	—	—	—	—	4	—
Total	1,044	961	911	887	648	124	837	4	5,412

¹ Oil as a Factor in the German War Effort.

² Includes products from imported crude and unfinished oils.

³ Includes solvent naphthas, asphalt and paraffin.

⁴ Included with liquefied gases.

(xxxiv)

German Production, Imports, and Total Supply of Aviation Gasoline, Motor Gasoline, and Diesel Oil, 1940 to 1944¹

(Metric tons)

	Aviation Gasoline	Motor Gasoline	Automotive Diesel Oil	Total
1940				
Production ²	643,000	1,138,000	781,000	2,562,000
Imports, etc. ³	78,000	683,000	501,000	1,262,000
Captured stocks	245,000	309,000	200,000 ⁴	754,000
TOTAL SUPPLY	966,000	2,130,000	1,482,000	4,578,000
1941				
Production	889,000	1,160,000	1,114,000	3,163,000
Imports, etc.	21,000	1,124,000	612,000	1,757,000
TOTAL SUPPLY	910,000	2,284,000	1,726,000	4,920,000
1942				
Production	1,370,000	1,002,000	1,285,000	3,657,000
Imports, etc.	102,000	1,021,000	208,000	1,331,000
TOTAL SUPPLY	1,472,000	2,023,000	1,493,000	4,988,000
1943				
Production	1,788,000	1,133,000	1,358,000	4,279,000
Imports, etc.	129,000	804,000	435,000	1,368,000
TOTAL SUPPLY	1,917,000	1,937,000	1,793,000	5,647,000
1944				
Production	998,000	935,000	889,000	2,822,000
Imports, etc.	107,000	542,000	371,000	1,020,000
TOTAL SUPPLY	1,105,000	1,477,000	1,260,000	3,842,000
Total five years				
Production	5,688,000	5,368,000	5,427,000	16,483,000
Imports, etc.	682,000	4,483,000	2,327,000	7,492,000
TOTAL SUPPLY	6,370,000	9,851,000	7,754,000	23,975,000

¹ U.S.S.B.S. Oil Division Final Report, Table 14, p. 26.² Products from imported crude and unfinished products refined in Germany are included under 'Production'.³ In years other than 1940 'Imports, etc.' includes captured stocks. Imports include shipments from sources outside Germany direct to German armed forces outside Germany.⁴ Estimated.

(XXXV)
The Annual Oil Stock Position¹
(In thousands of tons)

	Aviation Spirit			Motor Gasoline			Diesel Oil			Total of Three Products						
	Average Monthly Consumption		Total Cons. Prod. ²	Average Monthly Consumption		Total Cons. Prod. ²	Average Monthly Consumption		Total Cons. Prod. ²	Total Cons. Prod. ²	Total Cons. Prod. ²					
	Mil.	Civ.	Exp.	Mil.	Civ.	Exp.	Mil.	Civ.	Exp.	Total Cons. Prod. ²	Total Cons. Prod. ²					
Stocks at 1.1.40	511			280			138				929					
1940	70	—	—	863	77	70	2	1,811	2,130	23	85	1,7	1,335	1,417	4,009	4,513
Stocks at year end	613			626			296									1,535
1941	100	—	—	1,274	134	53	21	2,504	2,284	48	78	27	1,856	1,726	5,634	4,920
Stocks at year end	254			379			164									797
1942	101	6	10	1,426	120	28	24	2,089	2,023	46	54	25	1,519	1,493	5,034	4,988
Stocks at year end	324			313			138									775
1943	134	11	6	1,825	128	24	21	2,088	2,148	74	46	24	1,307	1,793	5,220	5,858
Stocks at year end	440			436			244 ³									1,120
1944	116	—	—	1,403	121	23	5	1,805	1,477	76	33	9	1,435	1,260	4,643	3,842
Stocks at year end	146			118			121									385

¹ Oil as a Factor in the German War Effort. Authors' note. For the special difficulties as to the calculation of stocks see Vol. I, p. 288, fn. 2.

² There is no apparent explanation in German Statistics for this discrepancy. The surplus of production over consumption of 486,000 tons is not fully reflected in the figures.

³ Production includes imports and loot.

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*Extract from a Report by the Joint Intelligence Sub-Committee
on the Oil Position in Axis Europe. First six months of 1944
dated 27th May 1944*

THE STATISTICAL POSITION

As a result of our previous detailed studies of the Axis Europe oil position it was agreed that stocks at the beginning of 1943 were then at such a level that further withdrawals to make up any material deficit between current supply and consumption were no longer possible. An estimate of the extent of these stocks cannot be satisfactorily calculated, although it is considered that since they comprise oil in process and in distribution, the extent to which a proportion of them might be potentially consumable at the expense of subsequent shortage would be very limited. In conjunction with the United States Enemy Oil Committee it was agreed that the nominal figure of 4,000,000 tons should be taken as a datum level as at the beginning of 1943. An analysis of the stock position is given in Annex V.

Balance Sheet, 1943

	<i>Metric Tons</i>
Stocks at nominal datum level at 1st January, 1943	4,000,000
Production (see Annex II and Appendix, Table I):	
(i) Crude and Shale Oils	8,240,000
(ii) Synthetic Oils	5,425,000
(iii) Substitutes and Miscellaneous	2,300,000
	<hr/> 15,965,000
	<hr/> 19,965,000
Consumption (see Annex III):	
(i) Armed Forces:	
(a) Armies	4,217,000
(b) Naval	1,731,000
(c) Air Force	2,423,000
(d) Todt	320,000
	<hr/> 8,691,000
(ii) Civil, including exports to Neutrals	7,147,000
Losses in retreats and by air attacks	325,000
Losses by tanker sinkings	100,000
	<hr/> 425,000
	<hr/> 16,263,000
Leaving a balance of Stocks at 31st December, 1943, of	<hr/> 3,702,000

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Tentative Balance Sheet as at 30th June, 1944

	<i>Metric Tons</i>
Stock figure carried forward from above balance	3,702,000
Production 1st January–30th June, 1944 (see Annex II and Appendix, Table II):	
(i) Crude and Shale Oils (Note 1)	3,907,000
(ii) Synthetic Oils (Note 2)	2,922,000
(iii) Substitutes and Miscellaneous	1,150,000
	7,979,000
	11,681,000
Consumption (see Annex III):	
(i) Armed Forces:	
(a) Armies (Note 3)	2,305,000
(b) Naval	870,000
(c) Air Force	1,146,000
(d) Todt	160,000
	4,481,000
(ii) Civil, including exports to Neutrals	3,017,000
Losses in retreats and by air attacks (Note 4)	100,000
	7,598,000
Leaving a balance at 30th June, 1944, of	4,083,000

Tentative Balance Sheet for the Month of June, 1944

Based on the same assumptions as are adopted in the above balance sheet, and on the hypothesis that military activity will be at about the same level as during April–May, the following balance for the month of June indicates a deficiency of production to consumption of at least 65,000 tons.

	<i>Metric Tons</i>
Production:	
(i) Crude and Shale Oils	530,000
(ii) Synthetic Oils	435,000
(iii) Substitutes and Miscellaneous	190,000
	1,155,000
Consumption:	
(i) Armed Forces:	
(a) Armies	345,000
(b) Naval	145,000
(c) Air Force	200,000
(d) Todt	27,000
	717,000
(ii) Civil	503,000
	1,220,000
Leaving a deficit of	65,000

Note. This deficit does not allow for any losses that might be caused by Allied attacks during the month.

(For Notes 1 to 4 see page 514.)

- Note 1. Assuming that Roumanian production during the first four months has been 10 per cent lower than the estimate of 5,450,000 tons for 1943, and that production in May and June was reduced by 50 per cent of the preceding months.
- Note 2. Assuming production in May and June lowered by a total of 175,000 tons as a result of air attacks on certain synthetic oil plants on 12th May, but not lowered further by later attacks.
- Note 3. Excluding losses in retreats estimated at 15,000 tons in both February and March and which are included in the 100,000 tons for all losses on account of Allied action.
- Note 4. Apart from the War Office estimates for February and March, there is no information as to the extent of these losses.

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*Estimated Output of Axis Oil Plants from information available
up to October 1944, dated 3rd October 1944¹*

(All figures in thousands of metric tons per month)

	Normal Finished Products Output	Estimated Output of Finished Products			
		July	August	September	October
SYNTHETIC PLANTS:					
1. Bergius Hydrogenation	368	98	46	45	179
2. Fischer Tropsch	112.5	56	50	22	51
Total from Synthetic Plants	480.5	154	96	67	230
Percentage of pre-raid total	100%	32%	20%	14%	48%

¹ Joint Oil Targets Cttee. Weekly Bulletin.

REFINERIES	Normal Capacity Finished Products Output ^a	Normal Finished Products Output	Estimated Output of Finished Products				
			July	August	September	October	
4. Germany	149	(From avail- able crude) ^d	31	29	27	64	
5. France	260		6	0	0	0	
6. Belgium	42		0	0	0	0	
7. Holland	52		0	0	0	0	
8. Czechoslovakia	48		31 ^e	29 ^e	8	15 ^e	
9. Poland	78		43 ^e	13	0	0	
10. Austria	54		7	19	18	34	
11. Hungary	60		14	5	9	6	
12. Italy	80		3	0	0	0	
13. Jugoslavia	21		3	0	0	0	
14. Albania	2		2	0	0	0	
15. Roumania	740		185	143	0	0	
Total from Crude Oil	1,586		697.5	325	238	62	119
Percentage of pre-raid total			100%	46.5%	34%	9%	17%
GRAND TOTALS							
(i) Synthetic Plants		480.5	154	96	67	230	
(ii) Crude Oil		697.5	325	238	62	119	
(iii) Other Sources ^e		166	192	192	175	175	
TOTAL		1,344	671	526	304	524	
Percentage of pre-raid total		100%	50%	39%	23%	40%	

^a Assumes imports of crude to extent of available capacity.^b Crude oil refinery capacity less 10% for refining loss.^c Figures for normal finished products output from available crude by individual countries not indicated. Total figure is used for comparative purposes.^d From sources comprising benzol, alcohol, tar oils, etc.

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*Monthly German production and imports of finished oil products,
January 1944–March 1945¹*

(In thousand metric tons)

Year and month	Synthetic production		Domestic refining of crude oil	Production in occupied territories	Imports	Total
	Hydrogenation and Fischer-Tropsch process	Other synthetic production				
1944						
January	336	162	175	48	179	900
February	306	172	160	48	200	886
March	341	201	191	49	186	968
April	348	153	157	48	104	810
May	285	151	170	47	81	734
June	145	153	129	44	40	511
July	86	143	115	38	56	438
August	47	137	134	16	11 ²	345
September	26	126	113	5	11	281
October	38	117	124	3	34	316
November	78	107	105	10	37	337
December	56	108	108	9	22	303
1945						
January	37	3	3	3	3	3
February	13	3	3	3	3	3
March	12	3	3	3	3	3

¹ U.S.S.B.S. *Effects of Strategic Bombing*, Table 41, p. 79. Sources: *Produktion der Hydrier- und Synthese Werke* in 1000 moto, chart prepared by Dr. Butefisch, May 1945; *Statistische Schnellberichte zur Kriegsproduktion*, Planungsamt, Ministry for Armament and War Production.

² The Russians occupied Ploesti on 22nd August 1944.

³ Not available.

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*Report by Luftwaffe Economic Intelligence in January 1945 on Aircraft Fuel Production
from January to December 1944 to a scale of 1,000 tons per month*

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Hydrogenation</i>	39.6	47.8	49.9	52.6	49.9	—	2.8	5.4	2.2	6.0	14.7	13.2
Pölitz	30.0	26.0	31.5	30.3	32.6	12.2	—	—	0.2	—	—	—
Gelsenberg	9.8	9.6	18.5	24.2	9.4	1.8	9.1	—	0.8	3.2	9.7	—
Leuna	23.2	20.9	23.9	22.8	9.6	—	—	—	—	—	7.9	6.9
Brüx	19.0	18.3	17.5	19.5	19.0	13.2	6.2	—	—	0.4	—	—
Schölvén	15.2	14.0	15.2	15.7	15.0	9.5	2.7	—	—	—	—	—
Wesseling	7.7	11.1	8.0	—	—	—	—	—	—	—	—	—
Böhlen	6.0	6.1	3.6	1.4	7.1	3.6	—	3.6	—	4.3	1.1	2.5
Moosbierbaum	3.4	4.3	4.6	4.6	4.6	4.3	4.6	2.1	—	0.1	—	0.2
Oppau	4.4	3.9	4.1	2.5	4.8	6.1	3.9	—	0.6	—	—	—
Welheim	0.9	0.8	2.9	0.9	3.2	2.2	0.9	0.7	—	—	0.1	—
Heydebreck	—	—	—	—	—	—	—	—	—	1.3	1.3	0.3
Blechhammer	0.1	0.2	0.2	0.2	0.3	0.2	—	0.4	0.9	0.4	0.4	0.1
Schkopau	0.2	0.2	0.2	0.4	0.4	0.2	—	0.3	0.6	0.7	0.2	0.2
Hüls	159.5	163.2	180.1	175.1	155.9	53.3	30.2	12.5	5.3	16.4	35.4	23.4
<i>Benzol and Petroleum Processing</i>	—	0.5	0.3	0.3	0.2	0.5	4.5	4.6	4.7	4.6	3.6	1.1
TOTALS	159.5	163.7	180.4	175.4	156.1	53.8	34.7	17.1	10.0	21.0	39.0	24.5

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Statistics of the Rumanian Oil Industry¹

(In thousands of metric tons)

Year	Crude Oil Output	Drilling (Thousand metres)	Refinery Runs	Domestic Consumption	Exports
1938	6,610	288	6,228	1,674	4,495
1939	6,240	256	5,837	1,785	4,178
1940	5,810	235	5,472	1,862	3,493
1941	5,577	253	5,255	1,811	4,072
1942	5,665	339	5,237	2,098	3,374
1943	5,266	344	4,903	2,007	3,150

¹ Oil as a Factor in the German War Effort.

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Rumanian Oil Exports by Countries¹

(Metric tons)

	1938	1939	1940	1941	1942	1943
Germany ²	999,240	1,285,153	1,429,807	2,885,229	1,822,207	1,795,555
German Army	—	—	—	34,351	369,452	715,749
Italy ³	560,475	629,350	342,943	761,667	862,179	391,354
Bulgaria	79,768	93,744	95,151	53,057	43,394	21,559
Greece	200,215	75,293	187,304	10,161	30,622	25,967
Switzerland	88,873	113,801	92,481	107,268	87,910	57,605
France	289,338	238,062	87,144	19,412	82,433	14,664
Turkey	53,616	30,424	148,267	57,939	1,380	12,794
Hungary	198,076	165,016	34,643	277	—	—
Other Countries	1,643,604	1,243,136	910,535	125,361	57,693	59,845
Bunker Sales	381,557	303,592	164,662	17,584	16,272	64,076
	4,494,762	4,177,571	3,492,937	4,072,306	3,373,542	3,159,168

¹ Oil as a Factor in the German War Effort.² Including Czechoslovakia.³ Including Albania.

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Numbers of Unexploded Bombs hitting German Oil-chemical Plants and Refineries¹

Plant	Bombs Hitting Target		Bombs Exploded on Target		Unexploded Bombs on Target			Per Cent of Unexploded Bombs on Target			Total
	8th A.F.	R.A.F.	Unidentified	8th A.F.	R.A.F.	Unidentified	8th A.F.	R.A.F.	Unidentified		
										Per Cent	
Leuna	7,425	1,218		6,390	926		1,095	292	14.8	24.0	16.0
Ludwigshafen	2,396	1,203		2,132	980		264	223	11.0	18.5	13.5
Oppau	1,097	975		1,013	740		84	235	7.7	24.1	15.4
Zeitz	3,500	1,020		3,100	860		400	160	11.4	15.6	12.3
Leverkusen	4	314		3	270		1	44	25.0	14.0	14.1
Meerbeck-Homburg		540			375			165		30.6	30.6
Rhenania-Ossag,											
Harburg	1,256	362		1,155	334		101	28	8.1	7.7	7.9
Europäische Tanklager	637	224		590	215		47	9	7.4	4.0	6.5
Ebano Asphalt Werke	231	98		223	89		8	9	3.5	9.1	5.2
Deutsche Vacuum Oel	82	200		78	197		4	3	4.9	1.5	2.5
Castrop-Rauzel			1,177			894					24.0
Bottrop-Welheim			3,025			2,645					12
Scholven			3,450			2,286					33.7
Subtotal	16,620	6,154	7,652	14,624	4,986	5,825	2,004	1,168	12.2	18.9	33.7
Total bombs, all sources		30,434			25,435			4,999			16.4

¹ U.S.S.B.S. Oil Division Final Report, Table 46, p. 130. At Deurag-Nerag refinery 1,463 high-explosive bombs exploded in the plant, and the management estimated that 12 per cent of the total falling in the plant were unexploded bombs. At Sterkrade-Holten the plant management estimated that 750 (30 per cent) of the 2,500 bombs hitting the plant failed to explode.

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*Coal and Transportation Statistics*¹

	Production (thousand tons)	Movement by water exclusively (thousand tons)	Movement by rail to Duisburg, then water (thousand tons)	Total move- ment by water (thousand tons)	Essen coal car placements (10 ton units, thousand cars)	Coal stocks at mines (thousand tons)	Index of stocks, adjusted for seasonal
1944							
January	10,554	1,518	164	1,682	6,180	1,204	140
February	10,482	1,623	212	1,835	5,820	1,115	151
March	11,049	1,335	108	1,443	6,180	774	158
April	10,037	1,781	245	2,026	5,800	457	164
May	10,705	2,003	342	2,345	5,910	386	171
June	10,339	1,915	307	2,222	6,050	249	176
July	10,143	2,000	354	2,354	5,860	186	180
August	10,417	1,817	397	2,214	5,650	415	190
September	9,381	1,513	263	1,776	4,360	872	209
October	7,169	636	88	724	2,520	1,894	249
November	5,203	443	11	454	2,320	2,109	277
December	5,370	490	15	505	2,530	2,339	300
1945							
January	5,470	—	—	441	2,821	2,626	336
February	4,678	—	—	—	2,081	2,767	376
March	1,876 ^a	—	—	—	706	2,754 ^b	426

¹ U.S.S.B.S. *Effects of Strategic Bombing on German Transportation*, Exhibit 78, p. 80.

^a Until March 17th (estimate for March, 2,800).

^b As of March 13th.

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 Daily average of Movements of Coal and Coke by Waterway from the Ruhr. January, 1943–January, 1945¹

Month	By canal			By Rhine			
	Grand total	Eastwards and within the canal system	Percentage of grand total	Upstream	Percentage	Downstream	Percentage
1943	1,000 tons	1,000 tons		1,000 tons		1,000 tons	
Daily average January–December	61.0	22.0	36.0	31.7	51.9	7.5	12.3
1944							
Daily average January–June	66.2	22.7	34.3	36.5	55.1	6.9	10.4
July	76.0	25.3	33.3	45.3	59.6	5.4	7.1
August	72.3	25.0	34.6	42.7	59.1	4.6	6.4
September	59.2	17.7	29.9	40.1	67.7	1.4	2.4
October	23.4	4.5	19.2	18.2	77.8	0.5	2.1
November	15.1	5.9	39.1	9.1	60.3	0.1	0.6
December	16.3	4.6	28.2	11.3	69.3	0.4	2.5
1945							
January	14.2	2.2	15.5	10.4	73.2	1.6	11.3

¹ B.B.S.U. *The Effects of Air Attack on Inland Communications*, Table 9, p. 184.

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Total Numbers of Goods Waggon allocated in the Reich
 (Thousands per day)¹

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1938	112	124	133	124	128	131	135	138	131	132	141	125	129
1939	129	138	142	123	132	145	140	127	103	111	120	107	126
1940	94	102	112	131	121	130	141	144	140	151 ²	153	124	129
1941	116	127	120	124	125	128	139	136	140	140	131	124	129
1942	100	95	104	113	112	131	145	139	144	141	134	130	124
1943	117	131	140	140	139	141	143	134	135	134	127	118	133
1944	122	145	128	128	129	134	128	127	115	105	99	83	118

¹ B.B.S.U. *Effects of Air Attack on Inland Communications*, Table 1, p. 179.

² All totals, from October 1940, include Alsace-Lorraine and Luxembourg allocations.

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Average Daily Waggon Allocation to the Coal Trade in Ruhr and Saar¹

	Ruhr	Ruhr, west of the Rhine	Saar
January–March, 1943	20,000	1,200	4,950
January–March, 1944	20,000	1,100	5,200
January, 1945	9,500	400	360
February, 1945	7,800	—	770 ²
March, 1945	2,200	—	1,000 ²

¹ *B.B.S.U. Effects of Air Attack on Inland Communications*, Table 19, p. 187.

² First week of March only.

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Coal Position, December 1944¹

	Dec. 31, 1944 number of days supply (based on 'minimum needs')	1943 range, month end days supply (based on actual consumption)	
		High	Low
Manufacturing industry	13	77	32
Food industries	12	60	38
Manufactured gas	10	41	21
Electric power	16	84	26
Total	13	65	29

¹ *U.S.S.B.S. The Effects of Strategic Bombing on German Transportation*, p. 86.

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Losses of U-boats caused by the Bombing of Germany Month by Month throughout the War¹

Month	Production Losses	Sinkings	Total
1943			
May	1 Type VII	—	1 Type VII
July	—	1 Type VII	1 Type VII
August	4 Type VII	—	4 Type VII
September	2 Type VII, 1 Type IX	—	2 Type VII, 1 Type IX
October	3 Type VII, 1 Type IX	—	3 Type VII, 1 Type IX
November	3 Type VII	—	3 Type VII
December	2 Type VII	—	2 Type VII
1944			
January	4 Type VII	—	4 Type VII
February	2 Type VII, 1 Type IX	—	2 Type VII, 1 Type IX
March	3 Type VII	—	3 Type VII
April	3 Type VII	1 Type IX	3 Type VII, 1 Type IX
May	2 Type VII	—	2 Type VII
July	2 Type XXI	2 Type VII, 1 Type IX, 1 Type XXIII	2 Type VII, 1 Type IX, 2 Type XXI, 1 Type XXIII
August	2 Type XXI	—	2 Type XXI
September	5 Type XXI	—	5 Type XXI
October	7 Type XXI, 2 Type XXIII	1 Type VII	1 Type VII, 7 Type XXI, 2 Type XXIII
November	14 Type XXI, 1 Type XXIII	—	14 Type XXI, 1 Type XXIII
December	2 Type XXIII	1 Type VII	1 Type VII, 2 Type XXIII
1945			
January	8 Type XXI	1 Type VII, 2 Type XXI	1 Type VII, 10 Type XXI
February	6 Type XXI, 7 Type XXIII	1 Type XXI	7 Type XXI, 7 Type XXIII
March	16 Type XXI, 7 Type XXIII	9 Type VII, 5 Type XXI, 1 Type XXIII	9 Type VII, 21 Type XXI, 8 Type XXIII
April	—	1 Type II, 4 Type VII, 2 Type IX, 7 Type XXI	1 Type II, 4 Type VII, 2 Type IX, 7 Type XXI
Date unknown	—	1 Type VII	1 Type VII
Total	29 Type VII, 3 Type IX, 60 Type XXI, 19 Type XXIII 111 U-boats	1 Type II, 20 Type VII, 4 Type IX, 15 Type XXI, 2 Type XXIII 42 U-boats	1 Type II, 49 Type VII, 7 Type IX, 75 Type XXI, 21 Type XXIII 153 U-boats

¹ B.B.S.U. *The Effects of Strategic Bombing on the Production of German U-Boats*, Table 9, p. 24.

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*Details of Sinkings in Air Raids of U-boats
delivered to the Navy¹*

Date	Place	Number and Type of Boats
July, 1943	Hamburg	1 Type VII
January, 1944	Pola	1 Type VII
March, 1944	Toulon	2 Type VII
April, 1944	Stettin	1 Type IX
July, 1944	Toulon	2 Type VII
	Bremen	1 Type IX
	Kiel	2 Type VII
	?	1 Type XXIII
August, 1944	Konstanza	1 Type II
	Toulon	1 Type VII
September, 1944	Salamis	2 Type VII
October, 1944	Wilhelmshaven	1 Type VII
	Bergen	2 Type VII
December, 1944	Hamburg	1 Type VII
	Horten	1 Type VII
January, 1945	Hamburg	2 Type XXI
	Konigsberg	1 Type VII
February, 1945	Bremen	1 Type XXI
March, 1945	Wilhelmshaven	1 Type VII
	Bremen	2 Type VII, 1 Type XXI
	Hamburg	2 Type VII, 4 Type XXI,
		1 Type XXIII
	?	4 Type VII
April, 1945	Hamburg	1 Type VII, 3 Type XXI
	Kiel	3 Type VII, 2 Type IX,
	?	4 Type XXI
		1 Type II
Date unknown	Wilhelmshaven	1 Type VII
	Total	2 Type II, 31 Type VII, 4 Type IX, 15 Type XXI, 2 Type XXIII
		54 U-boats

¹ B.B.S.U. *The Effects of Strategic Bombing on the Production of German U-Boats*, Table on p. 34.

Abbreviations

A.A.	Anti-aircraft
A.A.S.F.	Advanced Air Striking Force
A/C	Aircraft
A.C.A.S.(I)	Assistant Chief of the Air Staff (Intelligence)
A.C.A.S.(Ops)	Assistant Chief of the Air Staff (Operations)
A.C.A.S.(T.R.)	Assistant Chief of the Air Staff (Technical Requirements)
A.C.-in-C.	Air Commander-in-Chief
A.E.A.F.	Allied Expeditionary Air Force
A.E.F.	Allied Expeditionary Force
A.F.V.	Armoured Fighting Vehicles
A.G.L.(T) Trg.	Automatic Gun Laying (Turret) Training
A.H.B.	Air Historical Branch (Air Ministry)
A.I.	Air Interception, or Air Intelligence Branch (Air Ministry)
A.M.	Air Ministry
A.M.P.	Air Member for Personnel
A.M.S.R.	Air Member for Supply and Research
A.O.C.	Air Officer Commanding
A.O.C.-in-C.	Air Officer Commanding-in-Chief
A.P.	Armour piercing (bomb)
A.R.P.	Air Raid Precautions
A.S.V.	Air to Surface Vessel
A/Tk.	Anti-Tank
A.U.S.(G)	Assistant Under-Secretary (General)
B.A.F.F.	British Air Forces in France
B.A.T.	Beam Approach Training
B.A.U.	Bombing Analysis Unit
B.B.R.M.	British Bombing Research Mission
B.B.S.U.	British Bombing Survey Unit
B.C.	Bomber Command
B.D.U.	Bombing Development Unit
B.N.	Blind Navigation
B.S.	Bomber Support
B.S.D.U.	Bomber Support Development Unit
C.A.M.	<i>Compagnie d'Application Mécanique</i>
C.A.S.	Chief of the Air Staff
C.C.S. or C.C.O.S.	Combined Chiefs of Staff
C.-in-C.	Commander-in-Chief
C.I.D.	Committee of Imperial Defence
C.I.G.S.	Chief of the Imperial General Staff

ABBREVIATIONS

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C.I.U.	Central Interpretation Unit (Medmenham)
Cmd.	Command
C.O.	Commanding Officer
Con. Unit	Conversion Unit
C.O.S.	Chiefs of Staff
C.S.	Capital Ship (bomb)
C.S.B.S.	Course Setting Bombsight
D.C.A.S.	Deputy Chief of the Air Staff
D.C.-in-C.	Deputy Commander-in-Chief
D.D.O.	Deputy Director of Organization
D.D.O.I.	Deputy Director of Operations and Intelligence
Def. Cttee.	Defence Committee
D.K.F.	<i>Deutsche Kugellager Fabrik</i>
D.N.I.	Director of Naval Intelligence
Do.	Dornier
D. of Plans	Director or Directorate of Plans
D.R.	Dead Reckoning
D.T.S.D.	Director Training and Staff Duties
E.A.B.	Enemy Activities Branch (Foreign Office and Ministry of Economic Warfare)
F.A.F.	French Air Force
F.A.G.	Kugelfischer A.G.
F.O.	Foreign Office
F.T.U.	Ferry Training Unit
FW.	Focke-Wulf
G.A.F.	German Air Force
G.C.I.	Ground Controlled Interception
G.F.	Gunnery Flight
G-H	See Code Names
G.P.	General Purpose (bomb)
G.S.C.	General Staff Corps (U.S.)
H.C.	High Capacity (bomb)
He.	Heinkel
H.E.	High Explosive (bomb)
H.Q.B.C.	Headquarters Bomber Command
I.B.	Incendiary Bomb
I.E.	Initial Equipment
I.F.F.	Identification Friend or Foe
I.R.	Initial Reserve
J.I.C.	Joint Intelligence Committee
Ju.	Junkers

K.G.F.	Kugelfischer
L.R.	Long Range
M.A.A.F.	Mediterranean Allied Air Forces
M.A.N.	<i>Maschinenfabrik Augsburg-Nürnberg, A.G.</i>
M.C.	Medium Capacity (bomb)
Me.	Messerschmitt
M.E.W.	Ministry of Economic Warfare
M.T.	Motor Transport
OKH	<i>Oberkommando des Heeres</i>
OKW	<i>Oberkommando der Wehrmacht</i>
O.R.B.	Operations Record Book
O.R.S.	Operational Research Section
O.S.S.	Office of Strategic Services (U.S.)
O.T.U.	Operational Training Unit
PAK	<i>Panzerabwehrkanone</i>
P.F.F.	Pathfinder Force
P.F.N.T.U.	Pathfinder Navigation Training Unit
P.I.S.	Photographic Interpretation Section
Pol.	Polish
P.O.W.	Prisoner of War
P.R.U.	Photographic Reconnaissance Unit
P.S.	Private Secretary
P.U.S.	Permanent Under-Secretary
Pz.	<i>Panzer</i>
Pzkwfwg.	<i>Panzerkampfwagen</i>
R.A.A.F.	Royal Australian Air Force
R.C.A.F.	Royal Canadian Air Force
R.D.F.	Radio Direction Finding
R.E.8.	Research and Experiments Department 8 (Ministry of Home Security)
Rhod.	Rhodesian
R.I.V. or RIV	R.I. Anelli, Villar Perosa
R.N.Z.A.F.	Royal New Zealand Air Force
S.A.A.F.	South African Air Force
S.A.P.	Semi-Armour Piercing (bomb)
S.C.A.E.F.	Supreme Commander Allied Expeditionary Force
S/E	Single Engine
S.H.A.E.F.	Supreme Headquarters Allied Expeditionary Force
S.I.S.	Special Intelligence Service
S.O.	Special Operations
S.O.E.	Special Operations Executive
T/E	Twin Engine

ABBREVIATIONS

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T.I.	Target Indicator
T.I.M.	Magnetic mine with a delayed fuse
T.R.1335	<i>Gee</i>
U.E.	Unit Establishment
U.S.S.A.F.E. or U.S.ST.A.F.E. or U.S.St.A.F.E.	United States Strategic Air Forces in Europe
U.S.S.B.S.	United States Strategic Bombing Survey
U.S.S.T.A.F.	United States Strategic Air Forces
V.D.M.	<i>Vereinigte Deutsche Metallwerke</i>
V.H.F.	Very High Frequency (radio)
V.K.F.	<i>Vereinigte Kugellager Fabrik</i>
W.A.	Western Air (Plans)
W.O.	War Office
W/T	Wireless Telegraphy

Code Names

<i>Crossbow</i>	The attack on V-weapon launching sites
<i>Gardening</i>	Minelaying
<i>Gee</i>	Radar aid to navigation and target identification
<i>G-H</i>	Blind bombing radar device
<i>H2S</i>	Radar aid to navigation and target identification
<i>H2X</i>	American version of <i>H2S</i>
<i>Hurricane I and II</i>	Plans for concentrated air attack on the Ruhr and Axis Europe
<i>Oboe</i>	Blind bombing radar device
<i>Overlord</i>	The allied invasion of France in 1944
<i>Pointblank</i>	The directive for the Combined Bomber Offensive, June 1943, subsequently used to refer to the Combined Bomber Offensive in its strategic aspects
<i>Rankin</i>	The plan for an occupation of Europe in the event of a German collapse
<i>Thunderclap</i>	Plan to deliver a sudden, catastrophic blow by bombing Berlin with a view to bringing about surrender
'W' mines	Small mines for use in shallow fresh water

S.O. Code No. 63-111-24-10*

Wt. 2039. K.48. 3/6t. B. & T. Ltd. Gp. 51/9812

