12(9)

Minutes of the JOINT CROSSBOW WORKING COMMITTEE
27th July, 1944

FIRST MEETING.

Present : Wing Commander Lamb, Chairman
Dr. Robertson
Mr. Lawrence
Wing Commander Mapplebeck
Wing Commander Collier
Captain Whitley
Captain Rostow

RECOMMENDATIONS TO JOINT CROSSBOW COMMITTEE

I. Liquid Oxygen

A. The preliminary paper on liquid oxygen production in Western Europe, prepared by M.E.W., was considered (Enclosure V). It was agreed that a first task was to continue this investigation with special reference to the following :-

1. total "CROSSBOW" requirements;
2. total current production and distribution by uses;
3. problem of conversion from commercial to pure production;
4. problem of storage and transport, in relation to production in Germany.

B. Tentatively Mr. Lawrence appreciated the situation as follows :-

1. the Germans have set aside and equipped a group of factories in Belgium for the production of pure oxygen;

2. there may be other such factories thus set aside and equipped;

3. these believed special plants, which may well have a planned connection with rocket operations, are NOT now active on a large scale;

4. the bulk of current oxygen production in the West is now used in clearing damaged railway yards and bridges, and other urgent uses;

5. these needs are met from a very large number of plants, which are probably not now fully equipped for pure oxygen production: compressors would be the main new facility required;

6. at the present time a watching brief is being kept on one of the main suspected plants, reports being received daily.

C. In view of the above, the Working Committee made the following recommendations :-

1. that M.E.W. complete within the coming week its investigations with respect to the target value of liquid oxygen production;

2. that the following three plants be fully targetted and analyzed for aiming points :-

/Tertre Les Baudour

[redacted] Tertre Les Baudour
Houdeng
Willebroeck

3. that these plants be NOT attacked immediately for the following reasons :-

(a) immediate attack would cause a re-organization of German plans which would involve the activization in pure oxygen production of a very large number of small plants;

(b) immediate attack would destroy what may prove an extremely useful intelligence source, so far as warning of imminence of rocket attack is concerned.

4. that the usefulness of attacking from the air and the ground low priority liquid oxygen plants be explored, as a means of cutting down the alternative German sources of production.

II. Storage

A. The following two probable flying bomb dumps are recommended for attack : MERY SUR OISE (XI/D/7) and TROSSY/ST.MAXIMIN (XI/D/8). An appropriate priority order within this category of targets is believed to be as follows :-

1. RILLY LA MONTAGNE
2. ST. LEU D'ESSERENT
3. MERY SUR OISE
4. TROSSY/ST. MAXIMIN
5. BOIS DE CASSAN

It is suggested that NUCOURT be promptly reinstated, should evidence during the week show repair or other significant activity.

B. It was suggested that A.I.2(h) make every effort to enlarge the list of targets of this type, within the limits of the Intelligence.

III. Special Fuel Depots

The following three fuel depots are suggested for attack on priority immediately below the Storage Depots :-

1. VAAS 4700/G/6
2. DUGNY 4802E/H/7
3. PACY 4704E/H/1

In the case of the first two targets a "CROSSBOW" connection is firm; in the case of PACY it is less strong. It is, however, known as a G.A.F. Fuel Depot.

It was noted that heavy attack against these targets would be required, if effective results were to be achieved.

IV. Special Target

Attack on the FORET DE NIEPPES was recommended because of its generally ominous activities.

V. Electric Power

On the whole the weight of technical intelligence now appears to indicate that A.4 is not electrically launched. It is therefore not considered that systematic attack on electric power would directly affect operations

/of

of the heavy rocket.

The evidence with respect to the possibility of generally affecting "CROSSBOW" activities by systematic attack on electric power in the West is inconclusive. It was, therefore, recommended that a combined analysis be made by USSTAF, A.I.2(h) and A.I.2(g) of the following :-

(a) the appropriate targets for destroying the power network from Ostend to the Seine;

(b) the process by which the destruction of such targets would affect "CROSSBOW" operations, with special reference to the use of electricity in filling compressor bottles.

The results of this investigation will be presented next week.

VI. Hydrogen Peroxide

Although the quantity of peroxide probably used in the heavy rocket now appears much less than was at first thought, no change in the target priority of this system was recommended. Dr. Robertson undertook to investigate for next week the evidence with respect to the use of this fuel in the launching of the flying bomb.

The suspensions of Hollriegelskreuth and Zinnowitz were confirmed. The order of suggested residual aiming points at Peenemunde, in Enclosure VIII b, was confirmed.

VII. Transport

1. The system of rail bridge interdiction of the "CROSSBOW" area presented by A.I.3(e) was examined. It was estimated that the destruction of an additional 29 bridges would impose the need of an additional fleet of 200 lorries to maintain flying bomb activity at its present level. Some additional burden on M/T resources would be imposed by the need to sustain heavy rocket transport.

2. So far as "CROSSBOW" was concerned this benefit was not judged sufficient to justify recommendation of the bridge target system.

3. The present arrangement for forwarding immediately information on "CROSSBOW" traffic movement to A.E.A.F. for opportunity attack by light aircraft, was approved.

4. No other form of attack on "CROSSBOW" transport can be recommended.

VIII. War Head

1. In general it was appreciated that attacks on war head manufacture were not likely to be fruitful.

2. Because of its direct tie to PEENEMUNDE in some not clearly defined capacity, KLAUSTHAL was left on as a target, pending the thoroughgoing analysis of the target possibilities of the explosives system, now under way at M.E.W.

IX. German Production Targets

1. It was appreciated that attacks on "CROSSBOW" production in general were not likely to be effective in the short period, with respect to scale of attack; and that the dispersed nature of manufacture made a substantial long period effect doubtful.

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2. The completion of the destruction of FALLERSLEBEN was, however recommended.

3. Mr. Lawrence and Captain Rostow undertook to examine production targets further, in the light of latest intelligence, in order to enlarge if possible the list of firm assembly points. It is considered that such points have target value similar to substantial storage depots, but that no profound effects were to be expected.

4. Mr. Lawrence has undertaken to acquire and examine cover of a reported Siemens plant in Thuringia believed directly associated with radio equipment for both the flying bomb and A. 4.

5. Dr. Robertson and Captain Rostow undertook to analyze evidence with respect to A. 4 production, and to present findings at the next meeting.

X. Launching Sites

1. It was reported by Wing Commander Lamb that there are 92 located launching sites, of which 20 might be required to sustain the current scale of effort. It is known, further, that a number of sites are active which have not yet been located.

2. It was appreciated that the effect of the present attacks was negligible, and did not justify the continuing very large expenditure of effort.

3. It was noted that, as opposed to other possible low priority "CROSSBOW" attacks, the offensive against the launching sites made no other contribution to the war in general.

XI. Headquarters

1. In general it was agreed that Headquarters attacks were not likely to be fruitful.

2. Their position as targets was referred to the JOINT CROSSBOW COMMITTEE.

(Signed) W.W. ROSTOW, Capt. A.U.S.

Secretary

27th July, 1944

SECRET

Papers for "CROSSBOW" Counter-Measure Working Committee Meeting No.1, 27.7.44

1. Pursuant to the requests made of the Working Committee at the meeting of 21.7.44. the following enclosures are submitted for consideration:-

Enclosure I: Storage Depots, A. I. 2(h)
Enclosure II: Headquarters, A. I. 3(e)
Enclosure III: Flying Bomb production, A.I. 2(a)
Enclosure IV: Flying Bomb Transport System and Its Vulnerability, A.I.3(e)
Enclosure V: Liquid Oxygen Production, M. E. W.
Enclosure VI a: Electric Power Supply and the Large Sites, A. I. 2(h)
Enclosure VI b: Electric Power Supply, Wide Wing
Enclosure VII: Note on Hydrogen Peroxide, A.I. 2(a)
Enclosure VIII a: Peenemunde, Damage Assessment, D. of Ops. (S.O.)
Enclosure VIII b: Peenemunde, Analysis of Results, D. of Ops. (S.O.)
Enclosure IX: Distribution and Classification of Counter "CROSSBOW" Effort, D. of Ops. (S.O.)

Enclosure X: Special Fuel Depots, A. I. 3(e)

2. The following target problems emerge from these papers:-

Enclosure I suggests the immediate addition of MERY SUR OISE and TROSSY/ST MAXIMIN as flying bomb storage depots. The ambiguity with respect to the "CROSSBOW" content of BOIS DE CASSAN is not resolved in this paper and its target position hinges on evidence adduced by Dr. Jones.

Enclosure II suggests that no good purpose is likely to be served by continued attack on believed Headquarters.

Enclosure III suggests no additional high priority flying bomb production targets in Germany, beyond Fallersleben, but raises the question of whether a general attack on a large number of engineering firms in German Europe would be justified for their small individual "CROSSBOW" content.

Enclosure IV suggests that only direct attack on trains or unloading points immediately known to have "CROSSBOW" supplies, or on a ring of bridges interdicting the whole "CROSSBOW" area are justifiable forms of transport attack. Difficulties of intelligence are indicated as limiting the first type of attack. A relatively modest M/T strain would constitute the benefit from the second form of attack, for which a plan is appended.

Enclosure V raises the question of whether thorough going attack on liquid oxygen production and dumps would effectively limit German A.4 operations.

Enclosure VIa suggests that attack on the electric power supply would be justified only if electric power is used to launch the large rocket; VI b presents the case for these attacks.

Enclosure VII notes changes in the hydrogen peroxide position consequent on new intelligence and the recent attacks.

Enclosure VIIIb makes certain operational suggestions with respect to subsequent attack on Peenemunde.

Enclosure X indicates several possible special fuel targets, of which DUGNY, PACY and VAAS are probably worth immediate consideration for attack.

3. It will be noted that Enclosures III and IV raise a general problem that is likely to arise also in the case of rocket production. Some counter-"CROSSBOW" effect can be achieved by anattack on substantial target systems which have considerable value in terms of the war as a whole. The ring of interdiction proposed by A. I. 3(e) would obviously increase the German tactical problem of military supply in the West; the engineering firms listed by A. I. 2(a)

/obviously

obviously make a substantial contribution to German armament production. Neither the tactical nor the strategic targets listed, however, have been laid on thus far, on their own merits. The question arises as to whether their "CROSSBOW" content now justifies a rise in their relative priority. This can only be settled by a clear analysis of the types of targets that will NOT be hit, should these systems be accepted.

4. It will be noted that, with the exception of the electric power and liquid oxygen analyses, none of these Enclosures directly touch production or operations of the heavy rocket. It is suggested that a production analysis of the heavy rocket be laid on; that the A.I.3 e transport plan be reconsidered with respect to its effects on the heavy rocket, as well as flying bomb operations, and that other potential target systems be delineated for consideration at the next meeting.

W W Rostow, Capt. A.U.S.

27.7.44 Secretary

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ENCLOSURE I

Storage Depots

A. Storage Depots (known to have been used)

The following depots are known to have been supplying flying bombs to launching sites:-

RILLY LA MONTAGNE	XI/D/12 and 12A
ST. LEU D'ESSERENT	XI/D/10 and 11
NUCOURT	XI/A/119

2. All these depots have been recently damaged, but RILLY is probably in working order now and ST. LEU is being repaired and may become active within the next few days. NUCOURT has been very severely damaged and is not likely to be active for some days.

B. Possible Storage Depots

1. MERY SUR OISE (XI/D/7) is an ammunition depot suspected of Crossbow activity. Rail-served quarrying and tunnelling activity began in old mushroom quarries about November 1943, i.e. about the time when activity at NUCOURT and ST. LEU was first observed. The site consists of a complex of tunnel entrances, some rail-served and some road-served, all camouflaged. The tunnels are said to lead to large underground chambers, reinforced with concrete. Electric power and telephone communications have been provided. The site has been variously reported as an ammunition dump, a factory, a headquarters and a site for a "long-range gun". Details possibly associating it with "Crossbow" are:-

(i) the general similarity in extent and nature of work with that at NUCOURT and ST. LEU.

(ii) a report that the work is similar to that at RILLY la MONTAGNE.

(iii) the employment of labour from PARIS apparently under a scheme which included PARMAIN, TAVERNY and ISLE ADAM, all areas where similar tunnelling activity is known to be proceeding and which have been reported as having been reconnoitred by the enemy as possible Crossbow storage places.

(iv) a report of consignments of flying bombs evacuated from LT. LEU arriving at VALMONDOIS railway station 173/965695 which is the junction for MERY and is only about 2 miles from the site.

2. (i) TROSSY/ST. MAXIMIN (XI/D/8) is a quarry site across the OISE from ST. LEU. It has not been reported in a specifically Crossbow connection, but is at present the scene of great activity. The site consists of a quarry with tunnel entrances served both by road and by rail, and last cover (20 July 44) shows four large circular pits in one of which a tank has just been installed. Ground sources report this site as a fuel depot. Its situation 1 mile from ST. LEU and the general appearance of the activity are consistent with the hypothesis that this site is concerned in Crossbow either actively or prospectively.

/(ii)

ENCLOSURE I (ii)

(ii) BOIS DE CASSAN (XI/D/13). Known ammunition depot: suspected of being connected with Crossbow.

3. There are other caves in this area which are being kept under observation but as yet the evidence for their use for Crossbow storage is by no means complete, and they are not yet sufficiently advanced in construction for them to be used at the present time.

C. Forward underground supply depots

1. Photographic reconnaissance has shown that the undermentioned quarries are intended to be brought into use by the enemy for some purpose. Ground information does not yet connect them with Crossbow. Nevertheless, work on these depots commenced generally in March 1944 which is the same time that work began on railway turntables and modified flying bomb sites. A careful watch is being kept on these depots, in conjunction with railway stations in the area North of the SEINE where unloading of flying bombs has bden reported, with a view of possibly being able to connect the unloading with storage in the underground depots. No concrete evidence is yet available to support this possible connection between the two.

2. There are 13 of these underground depots on which observation is being kept and they lie at the eastern edge of the belt of modified flying bomb sites, fairly evenly spaced in distance between each other.

3. These depots do not yet appear to have proceeded sufficiently far in their construction to allow of their immediate use for Crossbow.

4. The depots referred to are:-

BEAUMONT	9E/3. 379332
AGENVILLE	84. 993897
BERGEUEUSE	61. 115218
LA POURCHUITE	50. 050465
AUTHIEUX - RATIEVILLE	9E/3. 240322
AUCHY LES HESDIN	72. 988154
SALOUEL	10D/5. 058544
ST. RIQUIER	83 (855865 (872856
INVAL-BOISON	9D6/705660
PONT REMY	10D3/826788
RAIMBERT	62/247264
ROLLENCOURT	72. 0215

A.I.2. (h)
26.7.1944

ENCLOSURE II : HEADQUARTERS.

The 6 H.Q. targets here discussed appeared on "CROSSBOW Targets Schedule No. 30," but were suspended for investigation.

It will be seen from the following summary of reports received that the Chateaux de Ribeaucourt, d'Helicourt, and de Frohen come under strong suspicion as H.Q. for the "works and bricks" side of the "CROSSBOW" construction programme. It is considered unlikely that their destruction would have any disrupting effect whatever on present Flying Bomb operations. The Chateau d'Ansenne is only twice reported (by the same source) in January 1944. The Chateau de Merlemont is the most interesting and convincing of the reported H.Qs., since it is specifically connected with Flak Regt. 155(W). But the last agent's report dates from the beginning of April, and as we have advertised our knowledge of this and all the other mentioned targets by bombing them since Flying Bomb operations began, it is possible that if the operational H.Q. of Flak Regt. 155(W) was still there in June it has now arranged to move elsewhere.

CHATEAU DE RIBEAUCOURT

Jan. 44.	H.Q. here reported in charge of Flak defence of Doullens.
24.2.44.	Count Westfalen here: receives orders from C.-in-C. G.A.F. in former de Noailles chateau near MERU. (Note: possibly at that time H.Q. of Airfield Regional Command Beauvais).
6.5.44.	H.Q."G.A.F.Artillery Group", with secret sites technicians. Underground work below Chateau with 200 workers.

CHATEAU DE MERLEMONT

12.43.	H.Q. of "Wachtel" Flak Regt. reported transferred from Doullens to chateau in CREIL region.
1.4.44.	H.Q.of Wachtel's staff here with 200 personnel including 30 officers. Administers 10,000 G.A.F. gunners distributed among various sites.
27.4.44.	PR of 27.4.44. shows no apparent change since 14.5.43,when 3 groups of huts and sheds were visible in woods to W. and S., including an M/T park. Photos of 27.4.44. suggest possibility that there may be a training area with H.Q. here.

CHATEAU D'HELICOURT (4250/9D6/591736)

9.43.	Engineer H.Q. here in charge of G.A.F. construction in district.
14.11.43.	2 officers and 10 German engineers here keep plans for works on what are clearly indicated as secret weapon launching sites.
24.4.44.	Major General and Staff here, due to leave 10 May.

CHATEAU D'ANSENNE (4250/9D6/611689)

18.1.44. and JAN-FEB. 1944.	G.A.F. H.Q. which is to be in command of all secret weapon positions has arrived. 2 generals, 2 colonels, and a number of officers. Administrative offices a little to E. of Chateau.
26.3.44.	Good P.R. shows two camouflaged huts, shelter trenches, M/T, and overhead cable at Chateau.

CHATEAU DE FROHEN (4040/84/0592)

8.43.	H.Q.here issues directions for constructional work.
10.43.	Similar report.
11.43.	" "
9. 1.44.	Meeting here of German engineers and contractors.
17. 1.44.	H.Q.controlling workfor secret weapon. 3 generals and numerous senior officers.
24. 2.44.	Special G.A.F.Artillery H.Q. O.C.Major Count Westfalen,reported supervisor of all civilian contractors for secret weapon installations. Plans and archives kept in large hut just E.of Chateau.

/(Note:

ENCLOSURE II : HEADQUARTERS (11)

(Note: Westfalen also mentioned under Chateau de Ribaucourt. He cannot be identified from our records).

18.3.44. In charge all secret sites from Belgian frontier to Calvados.
4.4.44. P.R. shows huts, one new since 21.12.43. Possibly M/T present.
30.4.44. Technicians in charge works in Barly and Villers l'Hopital regions in Chateau here.

DOULLENS CITADEL

In 11.43 it was reported that subterranean work had been going on for some time in the W. part of the Citadel, a star-shaped fortress surrounded by ramparts 32-50 feet high. In Dec.43 this work was associated in rumours with the Secret Weapon. At the end of Dec.1943 Flak Regt. 155(W) was reported to have moved from Doullens to the Creil area, maintaining an important telephone link with Doullens under cover-name "Dohle". (Note: this sounds authentic and is largely confirmed by evidence from a PW. belonging to the Signals Abteilung of Flak Regt.155(W).) On 16.2. the Citadel was reported to be the H.Q. for Army Corps to command fortified line Doullens-Abbeville; there were 800 officers and men, and 1000 civilians employed on on various tasks, with 120 telephone lines.

On 7.2.44 the continuous arrival of Flak guns at Doullens and their immediate distribution throughout the region was reported. On 5.5.44. the H.Q. of a Flak Regt. in the citadel was reported, controlling permanent emplacements in the region.

In Dec.1943 work was reported in large concreted underground rooms at the Citadel and at GEZAINCOURT. Again on 5.5.44 an underground cable was reported connecting the Citadel with a telephone exchange 14 metres underground at Chatea GEZAINCOURT, and also connecting with COCOCHES and Chateau St.Sulpice.

Comment. Only one of the above lines of enquiry leads directly to the "CROSSBOW" organisation - the report that Flak Regt.155(W) was at Doullens before moving to the Creil area.

A.I.3(E).
27th July, 1944.

SECRET

ENCLOSURE III

A.I.2.(a) Report No. V.1/44 dated 26.7.44.

Production of the Flying Bomb.

A Target Analysis of German Production of the Flying Bomb

PRODUCTION HISTORY

There is some evidence that the flying bomb first went into production in the summer of 1943. The airframe appears to have been designed by the firm of Fieseler at Kassel, and early models may have been made there and sent to Peenemunde for test. There is no good information with respect to the design of the power unit. From the beginning it is clear that the production plan involved elaborate dispersal; and it must be assumed that no single component is produced uniquely at a single factory. It would appear from the trials that difficulties were experienced with the operation of the bomb, as opposed to problems of launching, until January 1944. These probably centred in the power unit. Mass production of the air frame may well have begun earlier, but it is not unlikely that mass production of the power unit in its final form began only in the early months of this year.

RATE OF PRODUCTION

There is no firm evidence with respect to the current production rate for the flying bomb. Works numbers for both air frames and for components give a wide range of figures for cumulative production, depending on the extent to which all works numbers are assumed to have been filled. Maxima would be about 30,000 (from numbers on air frames) and 20,000 (from numbers on a power unit component) up to the end of June. Cumulative production of that order seems most unlikely.

A ground report of reasonable reliability offered a production rate for June of 1,200 and a stock of 8,500 at that time. These figures appear a fair approximation for the following reasons:

(a) they are roughly consistent with cumulative production as indicated by works numbers on air frames, under a reasonable assumption as to the extent to which bands have been filled;

(b) they are consistent with the rate of fire over the first month, assuming that the Germans were using a combination of stocks and current production such as to sustain the current rate for a period of about three months;

(c) they are consistent with the reported April rate for Fallersleben (1,000 per month), which is believed to be one of probably three main assembly units.

As noted below, however, there is nothing in the construction of the bomb or the resources required to inhibit the Germans from producing at a very much greater rate. It must be stated frankly that a figure of 1,000 - 1,500 appears low in view of the number of factories apparently contributing components and the low cost, in terms of labour and material, of the weapon itself. At this juncture in its production history a rising production trend would be normal. In fact, the future rate of production is likely to depend on the German appreciation of the weapon's effectiveness, and their V.1 plan as a whole. The resources required even for a very substantial increase in production are not large.

The reasons for taking a fairly modest rate for June-July are based, therefore, not on firm evidence with respect to production itself, but rather on the fact that a much higher rate would be inconsistent with the achieved rate of launchings over this period, and the probable level of stocks.

RESOURCES REQUIRED

The man-hours required for manufacturing the flying bomb are calculated at about 800, excluding the explosive charge. The whole enterprise, if fully concentrated, would thus constitute a factory of somewhat less than 6,000 hands for a monthly production of 1500: similar, say, to the aero engine factory

/at Kassel/Altenbauna .....

at Kassel/Altenbauna or Brunswick/Querum; or to a plant manufacturing about 100 S.E.F. per month.

PATTERN OF PRODUCTION

It is evident, from the intelligence, that this enterprise is spread widely through the engineering industry of German Europe, with components and sub-components produced at many points. Component erection, for the fuselage, the control mechanism, and the jet unit etc. is undoubtedly better centralised; three assembly lines appear indicated for the fuselage; and something like that degree of dispersal is likely for the controls and power unit. It should be noted, however, that losses from bombing attack are likely to consist of little more than stocks in process, since the flow of sub-components might easily be switched. A recent report that fuselage assembly is moved, month by month, is probably incorrect; but technically, it might well be true. The enterprise thus consists in effect, of a large group of shops, scattered through German Europe, none employing, probably, more than a few hundred men, almost all included within large engineering works carrying out other tasks.

QUALITY OF THE INTELLIGENCE

There is abundant intelligence with respect to flying bomb production. It suffers, however, from an almost universal failure to distinguish the exact function or stage of manufacture performed, and a failure even to define the exact weapon under construction. Thus, a great many plants can be firmly associated with production. Only a very few can be associated with a particular component.

OPTIMUM FORM OF ATTACK

Ideally, it would be desirable to attack systematically and persistently all points of fuselage assembly. A second form of attack, which would take effect, however, only with longer delay, would be to strike systematically at all producers of the power unit or the control mechanism. At the present time the intelligence does not permit the organization of so straight-forward a method of attack.

SUGGESTED ATTACK ON PRODUCTION

In view of this position it is suggested that production targets be organized into two groups:

A. Factories firmly associated with flying bomb fuselage assembly;

B. Factories believed associated with some stage of flying bomb manufacture.

It is suggested that the first group be accorded very high priority in attack and that a high standard of physical destruction be applied; and that the second group be included only as low priority targets, to fill out missions in particular areas.

SUGGESTED TARGETS

Group A: Volkswagenwerk, Fallersleben

Group B: Fieseler, Kassel
Opel, Russelsheim
Vomag, Goerlitz
Link-Hoffman, Breslau
Klein, Schanzlin, and Becker, Frankenthal
Argus, Berlin/Reinickendorf
Walter, Prague
Volkswagenwerk, Neudek
Heinkel, Jenbach
Dainler-Benz, Sindelfingen
Hotchkiss, St. Denis
Siemens, Berlin
Siemens, Nurnberg
Siemens, Vienna
Askania, Berlin
Natsweiler (Underground factory)
Houilles Carrieres (Underground factory)

It will be noted that most of these Group B factories are of general war importance. Attack on them should not, however, be permitted to interfere with the pursuance of the various systematic air offensives now under way.

EXPECTED RESULTS OF ATTACK

Group A targets will constitute accumulations of flying bombs under assembly, stocks of components, and perhaps some assembly line facilities. In terms of effect they can be counted similar to flying bomb depots in France. In fact, the more effective the attack on French dumps, the prompter the effect of the production attacks.

Attack on Group B targets offers the likelihood of causing some reduction in production, and the possibility of a more substantial bonus, through a chance bottleneck. Neither in extent nor promptness of effect can these targets promise a great deal.

CURRENT STOCK POSITION

In general it should be noted that a stock of roundly 10,000 bombs is likely to have been in existence at the time when the German offensive was launched. In the course of the first five weeks of the offensive, about 4,000 bombs were launched. It is likely that about 1,000 were destroyed in attacks on French depots. Making some allowance for loss of production at Fallersleben, at least 1,000 new bombs were probably produced. Thus the Germans should have something of the order of 6,000 bombs still in storage, at unknown points in Germany and in the West. These alone could sustain an average rate of fire of 100 per day over a two month period. So far as the period July - September is concerned, the weight of attack is unlikely to be significantly mitigated by production attacks. They are a means of further reducing the sustained scale of effort the Germans could support, when present stocks have been launched or destroyed.

A.I.2.(a)
(D. of I.(R).)
26th July, 1944

DISTRIBUTION:

D.C.A.S.	1	H.Q. S.H.A.E.F. for G/C.Humphries	2
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ENCLOSURE IV

SECRET

THE FLYING BOMB TRANSPORTATION SYSTEM AND ITS VULNERABILITY TO ATTACK

1. INTRODUCTORY This appreciation is written in accordance with the request contained in paragraph 14 (ii) of the Minutes of the Joint Crossbow Committee meeting held on 21.7.44.

So far as it is at present known, an account of the Flying Bomb Transportation system was given in an A.I.3(E), D. of I(O) paper dated the 20th July entitled "The German Flying Bomb Organisation: Part II Use of Railways for Supply". A copy of this paper is attached hereto at Appendix A. The only substantial change noted since the 20th July is that flying bombs may now be being fired from the islands in South Western Holland.

2. Extent to which Transport is Used. It was appreciated in the former paper that there was good evidence for the arrival of an average of one train per day in the area of the Pas de Calais on a route which crossed Belgium, and that it was believed that an average of one other train a day crossed Eastern France towards the more southerly supply depots north of Paris. It was thus thought that there was on an average a total of some two trains a day to Northern France and that they might be carrying some 200 flying bombs between them. There is no evidence to suggest that the long haul from Germany to the flying bomb front has hitherto been carried out by any means other than rail.

3. Methods of Interference with Traffic. It is considered that it would be quite useless to attempt to interfere with this small flow of traffic by attacks on railway centres. The routes lead through a part of Europe containing a dense network of lines and the flying bomb traffic is given an extremely high priority over other types of goods. The following methods only are therefore thought to be worth while considering:-

a) The shooting up and bombing of a train carrying flying bombs: this method is clearly worth while and a successful attack might account for a large number of the 80 - 120 bombs in the train. The difficulty is that it is rare for us to know beforehand when and where a flying bomb train will be. Hitherto this has only happened on two occasions, and in each case the information has been passed to A.E.A.F. at the earliest possible moment.

b) The bombing of flying bomb trains at their destination stations. The difficulty here is that though there has been a number of references to destination stations, it is not known how often any particular one is used or for how long the trains remain there unloaded.

The following destination stations have been reported:-

AIRAINES
AMIENS
BERGUES
BERGUETTE
BLENDECQUES
BOUQUEMAISON
CANAPLES
CHOCQUES
CORBIE
FLIXECOURT
FURNES
LIERCOURT
LONGPRE LES CORPS SAINTS
MENESQUEVILLE
NEUFCHATEL EN BRAYE
RENESCURE
ST. AIRE SUR LYS
ST. VENANT
VIEUX ROUEN SUR BRESLE
WAVRIN

/In...

ENCLOSURE IV(ii)

In addition there have been reports of train arrivals at the stations serving such big supply depots as NUCOURT, RILLY and ST. LEU.

It is doubtful whether attacks on destination stations would be worth-while when they do not contain flying bomb trains: if they were attacked, trains would be routed to other stations of which there are many, as it is thought that unloading cranes mounted on M/T could be and are used. This type of target, which is almost identical with the type of target mentioned in sub-para. a) is thus dependent on rapid reporting by sources and immediate interpretation of photo recce reports. Indeed in the case of both types of targets the object of the attack is really not a transportation target, but the flying bomb itself.

c) The only set of railway transportation targets that are thought worth-while consist of a series of bridges running from the Zuider Zee in Northern Holland to the estuary of the River Loire at Nantes. Particulars of these bridges are given at Appendix B and are shown in green on the accompanying 1 in 800,000 map. The bridges number 43 in all, of which 14 were already impassable on 25 July; the number at present requiring destruction is thus 29. If all these bridges can be attacked successfully and their repair prevented by further attacks, no trains can be run through from Germany to Southern Holland, Belgium or Northern France (including Normandy and Brittany). Two other bridges should perhaps be mentioned for the sake of completeness, one at Clamecy (south of Auxerre) which leads to a line from which the rails have been removed and the other at Les Ponts de Ce, south of Angers which was destroyed in 1940: both these bridges have been attacked and are now impassable, the Clamecy bridge because it was feared that the rails might easily be relaid, and the Angers bridge because for the first time for four years there were signs of repair.

The cuts have been taken northwards through Holland to the Zuider Zee because of the recent reports of the firing of flying bombs from South West Holland.

4. Effects of Complete Rail Severance. If all the bridges mentioned in the foregoing sub-paragraph 3(c) were destroyed and kept destroyed, the Germans would be compelled to resort to road traffic; for the sites in South West Holland water-borne traffic would provide a more suitable alternative. Interference with water-borne traffic to these sites presents a separate problem which will have to be considered when more information about these sites is forthcoming. In this appreciation the only alternative to rail traffic considered is road-borne traffic.

The bridge attacks would create cuts about 95 miles from Flushing, about 100 miles from St. Pol (chosen as representing the centre of the railway destinations north of the Somme) and a little over 40 miles from L'Lisle Adam (chosen as representing the centre of the big supply depots north of Paris): on the other hand, the approaches to the Rilly tunnel are cut less than 10 miles therefrom.

At present it is considered that about ⅓rd of the flying bombs are being fired from the area served by the depots north of Paris and that the remaining two-thirds come from the sites north of the Somme. For the purposes of this paper it is assumed that 150 flying bombs are fired per day and that 1 5-ton lorry can carry two: it is further assumed that each bomb requires 1300 lbs. of propellant fuel, and that this fuel would be carried in a 3-ton lorry.

On these figures it is considered that the Germans would require an additional fleet of at least 200 lorries for flying bombs and 100 lorries for fuel: these figures are reached on the assumption that the 100 mile haul to the supply sites north of the Somme as well as the 40 mile haul to

/the...

the supply depots north of Paris could be made in one night and that the lorries could return empty the next night: allowance is made for unserviceable M/T. The consumption in petrol for the M/T would be of the order of 3 tons a day.

The Germans are known to be extremely short both of M/T and of the fuel that the M/T consumes, but in the opinion of M.I.14 a fleet of lorries of the size here indicated could be set aside without taking M/T from the front in Normandy; the M/T required would, they think, come from Germany and so far as the M/T is taken from new production the fighting fronts will suffer; in proportion, however, to the requirements of the fighting fronts the amount of M/T needed to haul flying bombs by road instead of by rail is small.

Apart from the transport of flying bombs, it is considered that the bridge-cutting programme herein mentioned would be of considerable advantage to our military operations in Normandy.

A.I.3(E).
D. of I.(O)
27.7.44.

ENCLOSURE V

SECRET

ENEMY BRANCH (FOREIGN OFFICE AND
MINISTRY OF ECONOMIC WARFARE),
Lansdowne House,
Berkeley Square,
London, W.1.

25th July, 1944.

Dear Mr. Sandys,

The enclosed report contains the substance of what we know about the liquid oxygen position. We have not as yet been able to analyse these facts in the light of the recent conclusions or to form views on the vulnerability of targets and the probable effects of attacking them. We shall, of course, continue to work on the subject urgently, both from the production and from the target angle.

As a target system it is obviously unpromising; but it does not follow that targets cannot be found in it which will produce results.

The grouping of plants and storage as shown by the Map (Appendix D) is of interest.

Yours sincerely,
(Sgd.) GEOFFREY

Duncan Sandys, Esq. M.P.,
Ministry of Supply,
Shell Mex House,
Strand, W.C.2.

[redacted] SECRET

LIQUID OXYGEN

The principal normal demand for liquid oxygen is for oxy-acetylene welding and cutting. Owing to the weight of the cylinders which have to be used for transportation the practice has grown up of having small plants scattered about so as to minimise the amount of transport, rather than to have a few large central installations. Wartime requirements have increased enormously the amount of oxygen required for this purpose, not only for the oxy-acetylene flame welding for constructional work, but latterly it has also been wanted on a large scale for clearance purposes. In many cases the only way of clearing a marshalling yard or say a bridge after aerial bombardment is to cut many steel portions apart with the oxy-acetylene flame so as to be able to transport the parts out of the way.

Liquid oxygen is also needed for blasting charges in the mining industry.

Another wartime use, of course, is for oxygen for air pilots. It can also be used for demolition charges, for which purpose the Germans are short of other suitable explosives, and which may be required in large quantities in German retreat in N. France.

For some time past the oxygen plants in France and Belgium have been working to capacity, and even so liquid oxygen was in short supply. The position was aggravated in France by the putting out of action of the Boulogne-sur-Seine plant of the Air Liquide Company, which was the largest plant in France.

For some months past reports have come to hand of desire on the part of the Germans to get still further increased quantities of liquid air on a large scale. It was proposed to do that by having recourse to existing synthetic ammonia plants working on the Casale and Claude processes, of which there are a considerable number in France and Belgium. In these plants oxygen is produced as a byproduct in the manufacture of nitrogen, and it was the practice to allow the oxygen to go to waste. In any case the oxygen was of low purity, say some 85%. The Germans want oxygen of 98-99% purity. In the case of at least three large Belgian plants, namely:-

1. Tertre-Les-Baudour, owned by the Soc. Carbo-Chimique.
2. Houdeng, owned by the S.A. d'Engrais Azotes.
3. Willebroeck, owned by St. Ammoniaque Synthetique et Derives, S.A.

reports statethat the Germans told the Belgians that they must instal new Linde compressors for purifying their waste oxygen; this plant was to be furnished them free of charge. Further reports stated that the Belgians had raised all sorts of objections and so far as we know there has been no reports that the plant was ever either delivered or installed. An urgent request for information as to what had actually happened, through "C" sources, was passed to D.D.I.2. on June 7th, but no reply has been received.

Concurrently with the report about the three Belgian factories there were a number of reports that the Germans themselves had taken over part of the steel works at Angleur-Athus and that they had delivered there a number of compressors for making liquid oxygen, but that they would not put those into operation until they required them. A recent report (14.5.44) stated that this plant had now been started up and was filling standard oxygen cylinders. This gives the impression that this particular oxygen is required for oxy-acetylene welding, which would be quite normal in view of the destruction of the plant at Boulogne-sur-Seine and consequently reduced available capacity of welding oxygen.

STORAGE

In view of the volatile nature of liquid oxygen unless stored at low temperatures, the problem of storage is quite a considerable one and special arrangements have to be made if large quantities of liquid oxygen had to be stored even for several days. Reports have been received of the installation of several large storage tanks, said to be for liquid oxygen. These were said to be insulated with Kieselgur, which is stated to be suitable for liquid oxygen, and the location for those reported were:-

/Lostrom

Lestrem	5 of 50,000 litres each	
Henin-Lietard.	2 " " " "	
Pont-a-Vendin.	2 capacity not stated	report dated
Le Bourget	5 " " " "	
La Madeleine-les-Lille	2 " " " "	17.12.43.
Angleur-Athus	5 " " " "	

TRANSPORT

Liquid oxygen in bulk is usually transported by road in large spherical insulated containers with a top vent. They are very characteristic and it should be possible to detect their movements quite easily. In addition there have been reports of special tank waggons of large size, specially built with a vent at each end and which have been related to the carriage of liquid oxygen because it has been reported that their outlets were covered with ice. Such tanks have been located in photographs at:-

Friedrichshafen-Oberraderach
Pennemunde (?)

and in reports at:-

Blizna, as coming from Breslau, Dresden and Brockau

Appendix A gives a list of the regular oxygen plants in France and Belgium. Many of these are quite small.

Appendix B gives a list of the Casale plants in France and Belgium which could be used for the manufacture of liquid oxygen. Those marked with an asterisk are the ones which have been specifically mentioned in this connection.

Appendix C gives a list of plants in Germany which are likely possibilities.

Appendix D is a map showing the geographic location of the plants mentioned in Appendix A and B.

Appendix E gives a list of oxygen factories in Holland.

W. A. BURTON
E. B. 6.
24. 7. 44.

SECRET

SPLEEN

Liquid OXYGEN: BELGIUM

The present position of the liquid air industry in Belgium is somewhat obscure. There are definite indications that the German authorities have been taking steps to increase capacity largely, but it is not clear to what extent the new installations are in a sufficiently advanced state to begin production, nor does it appear that the current level of production is at all large. Several reliable sources have alleged that up to about two months ago at least, the German policy was to press for the overhauling of existing plants and the rapid installation of new capacity, but the production would only be called for as and when required.

The chief plants involved are the following:

Location	Name of Firm	Oxygen Capacity	Kg/24 hrs	Remarks
BRUSSELS	SOC. ANON DES GAS INDUSTRIEL (probably Schaerbeck)	486 kilos liquid oxygen per hour	11,660	Probably now operating. Another source alleges that this firm has a plant at Machelen which has not been identified. It is possible that the Brussels address is an administrative office only.
HAREN (believed near Willebroek)	SOC. ANON DES GAS INDUSTRIEL	Liquid ox: 270 kg. per hour. 800 c. metres nitrogen p.h. A comparatively small plant		Probably now operating.
LINGERBRUGGE	SOC. AIR LIQUIDE (Jointly with Centrale Electriques des Flandres)	Maximum 300 m^3 per hour (calculated on nitrogen output for adjacent chemical plant)	10,300	In production but certainly not the maximum capacity.
COUILLET	SOC AIR LIQUIDE	Unknown		Probably operating. New capacity planned or installed to treble output.
OUGREE-LEZ-LIEGE	SOC. AIR LIQUIDE (Jointly with Soc. Belge de L'Azote)	Maximum (Calculated on nitrogen output for ammonia plant). 500m^3 per hour	17,200	Producing, but well below maximum capacity
SCHELLE	SOC. AIR LIQUIDE	Unknown but probably quite small.		

/In addition.....

Liquid Oxygen: France (North of River Loire) and Belgium.

The following lists comprise:-

A: What are considered to be the more important plants.

B: Those less important

Very small plants are excluded.

TABLE A.

Location	Name and address of firm	Hourly oxygen capacity where known	Kg/24 hrs.
INDRE-ET-LOIRE			
TOURS	ETS.J.SCHMID 168,R.GENERAL-RENAULT	2 units of 30m3) 2 " " 60m3)	6,300
LOIRE INFERIEURE			
ST.NAZAIRE	L'AIR LIQUIDE CALE DU BOIS		
MORBIHAN			
KERGLAW, near HENNEBONT	L'AIR LIQUIDE approx. 4 kms.from Hennebont in bend of river Le Baluet.		
NORD			
BLANC-MISSERON	BARDIER, BENARD TURENNE	1 unit of 15m3) 1 " " 30m3) 1 " " 60m3) 1 " "120m3)	7,845
OISE			
LAMOTTE-BREUIL	SOC.BOZEL-MALETRA	180m3	6,180
VILLERS-ST-PAUL	ETS.KUHLMANN	1 unit of 125m3	4,410
PAS-DE-CALAIS			
DOURGES	MINES DE DOURGES	2 units of 60m3	4,240
SARTHE			
LE MANS	L'AIR LIQUIDE 39 R.DE L'AUSTRALIE		
SEINE			
BAGNOLET	L'AIR LIQUIDE 108 AV.GALLIEN		
BILLANCOURT	ETS.RENAULT 8-10 AV.ZOLA	360m3 divided in:- 1 unit of 20m3 2 units " 50m3 1 unit " 80m3 1 unit "160m3	12,360
BOLOUGNE-SUR-SEINE	L'AIR LIQUIDE 17, RUE DE SILLY	200m3 or more	

Location	Name and address of firm.	Hourly oxygen capacity where known.	K/24 hrs.
ARDENNES			
MEZIERES-CHARLEVILLE	L'AIR LIQUIDE RTE DE PRIX, MOHON		
CALVADOS			
CAEN	L'AIR LIQUIDE (1) R.DES JACOBINS (possibly a store) (2) 140, R.PASSE.		
FINISTERE			
BREST	NAVAL ARSENAL & SHIPYARDS	32m³ per hour, divided in two units of 7 and 25m³ each (30/3/43).	1,100
LANDEZELLEC, Nr.Brest.	L'AIR LIQUIDE		
HAUTE MARNE			
ST.DIZIER	L'OXYGENE DE ST. DIZIER, 4 R.JEANNE D'ARC.	60m³	2,060
ILLE-ET-VILAINE			
RENNES	L'AIR LIQUIDE RTE DE LORIENT		
LOIRE INFERIEURE			
NANTES	L'AIR LIQUIDE 20.AV.PITRE-CHEVALIER		
	CHANTIERS ET ATELIERS DE PENHOET	2 units of 30m³	2,060
MAINE-ET-LOIRE			
TRELAZE	SOC.ARMORICIENNES DE L'ANJOU	1 unit of 50 litres	2
MANCHE			
CHERBOURG	ETS.TRUFFERT FRERES 57,R.ERMITAGE	40m³ divided in two units of 20m³	1,380
MARNE			
REIMS	L'AIR LIQUIDE 140,R.ERNEST RENAN		
MEURTHE-ET-MOSELLE			
BRIEY	L'AIR LIQUIDE AV.CLEMENCEAU		
JOEUF	ETS.LE MENDEL	150 litres, divided in two units of 75 litres each.	5

Location	Name and address of firm	Hourly oxygen capacity where known	Kg/24 hrs.
LONGWY	L'AIR LIQUIDE AV.DE SAINT-IGNON		
NANCY	L'AIR LIQUIDE 77 BD.LOBAU		
MORBIHAN			
LORIENT	L'AIR LIQUIDE PORT-DE-PECHE, at KEROMAN		
"	NAVAL ARSENAL AND SHIPYARDS	1 unit of $20m^3$	690
MOSELLE			
HAYANGE	ETS.DE WENDEL	225 litres divided in 3 units of 75 litres each.	8
NORD			
ESCAUT PONT	L'AIR LIQUIDE		
LILLE	L'AIR LIQUIDE 69, R.BERKEM		
MADELEINE-LEZ-LILLE (LA)	L'AIR LIQUIDE 185 BD.LIBERTE		
ROUSIES, nr MAUBEUGE	L'AIR LIQUIDE		
ST.ANDRE-LEZ-LILLE	L'OXHYDRIQUE FRANCAISE CHEMIN DE MESSINE.		
PAS-DE-CALAIS			
BULLY-LES-MINES	CIE DES MINES DE BETHUNE	1 unit of $20m^3$	690
CHOQUES	SOC.L'AIR LIQUIDE RTE.LABEUVRIERE		
HENIN LIETARD	SOC.L'AIR LIQUIDE RTE.DE LENS.		
SEINE			
AUBERVILLIERS	L'AIR LIQUIDE 81 R.DES CITES		
	BARDOT ET CIE R.DU PILIER 18.		
CHAMPIGNY-SUR-MARNE	L'AIR LIQUIDE 57 AV.CARNOT		
MALAKOFF	L'OXHYDRIQUE FRANCAISE 8 AV.JULES FERRY		
PLAINE ST.DENIS	OXCOM, 3 R.PAUL LAFARGUE.		
SEINE INFERIEURE			
PEDIT QUEVILLY Nr.ROUEN	L'AIR LIQUIDE 102 R.DE LA GARE		
YAINVILLE	CIE DES PRODUITS ELECTROLYTIQUES		
SEINE-ET-OISE			
CARGES LES GONESSES	BADOT ET CIE.		

APPENDIX 'B'

Plant location	Company	Ammonia Process	Capacity 1938-39 M.t. of nitrogen	Equivalent M.t. tons of Oxygen.
BELGIUM				
* Tetre-lez Baudour	Ste.Carbo-chimique S.A.	Casale	36,800	9,200
* Ougree	Ste.Belge de L'Azote S.A.	Claude		
Ostend Zandvoorde	Union Chimique Belge S.A.	Casale	23,500	5,875
* Vilvorde	Ste.des Produits Chimiques due Marly S.A.	Claude	26,200	6,550
* La Louviere Houdeng-Goegnies	Ste.Anonyme pour la fabrication d'Engrais Azotes.	Casale	15,500	3,875
Selzaete	Ste.des Fours a coke.	Casale	16,000	4,000
CZECHO-SLOVAKIA				
Mahrisch-Ostrau	Tschechoslovakische Stickstoffwerke A.G.	Claude	23,000	5,750
FRANCE				
Bully-Grenay	Comp.des Mines de Bethune.	Claude	26,100	6,525
Soulom	Ste.des Phosphates Tunisiens et des Engrais et Produits Chimiques.	Casale	8,250	2,062.5
Waziers	Ste.Chimique de la Grande Paroisse	Claude	22,150	5,542.5
Lievin	Ste.de L'Ammonique de Lievin	Claude	7,550	1,887.5
Anzin	Comp.des Produits Chimiques Anzin-Kuhlmann	Casale	4,800	1,200
* Pont-a-Vendin (1) Douvrin (Lens) (II)	Ste.Ammonia	Casale Casale	7,360	1,840
Firminy	Establissements Kuhlmann	Casale	5,500	1,375
Chocques	Ste.de Produit Chimiques Marles Kuhlmann	Casale	7,960	1,990
Carling	Ste.Houillere de Sarre et Moselle	Casale	4,480	1,120

	Plant location	Company	Ammonia Process	Capacity 1938-39 m.t. of nitrogen	Equivalent m.t. tons of oxygen
*	Henin-Lietard	Ste.des Mines de Courges.	Casale	2,435	608.75
	Drocourt	Comp. de Mines de Vicoigne, Noeux et Drocourt.	Casale	4,160	1,040
	Decazeville	Ste. de Commentry Fourchamboult et Decazeville	Claude	5,000	1,250
	St.Auban	Comp.d'Alais Froges et Carmargue.	Casale	1,800	450
	Montereau	Ste.Chimique de la Grand Paroisse	Claude	2,150	537.5
	St.Etienne	Ste.des Houilleres de St.Etienne	Claude	1,400	350
	Rouen (Grand-Quevilly)	Ste.Chimique de la Grand Paroisse	Claude	7,600	1,900
GERMANY					
	Sterkrade-Holten	Ruhrchemie A.G.	Casale	62,200	15,550
	Rauxel	Gewerkschaft Victor Stickstoffwerke	Claude	58,140	14,535
ITALY					
	Nora Montaro	Soc.Anon.per l'Industria e l'Elettricita Terni	Casale	27,000	6,750
	Vado Ligure	Soc.Anon.Azogene	Claude	8,200	2,050
	Terni	Soc.Italiana Richerche Industriali	Casale	2,900	725
	Buzzi	Soc.Anon.Azogeno	Claude	2,200	550
	Verrez (Aosta)	Soc.Construzions A. Bramhilla.	Casale	7,000	1,750

APPENDIX C

Company	Plant Location	Maximum capacity of Oxygen (m. tons p.a.)
A - Most probable		
Ruhr-Chemie A.G.	Oberhausen-Holten	15,400
Gewerkschaft Viktor Stickstoff und Benzinwerke	Castrop-Rauxel	7,140
B - Less Probable		
Gewerkschaft Friedrich der Grosse	Herne-Sodingen	13,650
Bergwerksgesellschaft Hibernia A.G.	Wanne-Eickel	11,400
Bergwerke A.G. Recklinghausen	Scholven	11,400
Gewerkschaft des Steinkohlenberg-werks Ewald	Oer-Erkenschwick	6,430

The above are normally nitrogen fixation plants, which, however, could produce liquid oxygen.

Besides these there are a large number of regular oxygen producers belonging respectively to the I.G. Farben and Linde Groups which would normally not produce liquid oxygen of the required purity, but may quite well have installed plant to do so. Many of them are, however, situated at a considerable distance from the theatre of operations.

APPENDIX 'B'

CX.33110/VI/P.8/939
13.4.44. 20.5.44.

Dutch Factories Producing Oxygen.

Name	Locality	Capacity	Kg/24 hrs.	Operation
De Alblas	Alblasserdam	100 M^3/hour	3,430	75 to 80%
Compagnie Neerlandaise De l'Azote N.V.	Sluiskil	1700-1800 M^3/hour	60,000	Closed since May 1940
Amsterdamsche Droogdok Mij Meeuwenlaan	Amsterdam	27 M^3/hour	930	100%
Elektro Suur en Waterstoffabriek Distelwegz 90.	Amsterdam	350 M^3/hour	11,970	100%
-do-	Eygelshoven-Limburg	24 M^3/hour	850	100%
Hoek's Machinen en Zuurstofffabriek Havenstraat 19.	Schiedam	240 M^3/hour	8,500	+ 60%
	Amsterdam	100 M^3/hour	3,430	+ 80%
	Heugelo	40 M^3/hour	1,370	+ 90%
	Utrecht	60 M^3/hour	2,060	+ 90%
	Dieren	40 M^3/hour	1,370	+ 70%
	Groningen	60 M^3/hour	2,060	+ 80%
"Holland" Scheepswerf en Mach. Handel.	Hendrik-Ido-Ambacht	20 M^3/hour	690	+ 80%
Loos & Co's fabrieken Keizersgracht 689	Graasweg 53 Amsterdam N.	110 M^3/hour	3,780	80%
Mekog	Ijmuiden	75 M^3/hour	2,570	100%
Overmeer & Co. Ijsfabriek, vries-Koelinrichtung de Ijsbeer Amst.Weg. 57/61	Arnhem	30 M^3/hour	1,030	Very little used for own use.
"Oxygenium". Buitenhovenweg 50.	Schiedam	10 M^3/hour	340	
Plaatwellerij Velsen	Noordzijde Kanaalweg polder 24 Velsen N.	12 M^3/hour	410	Idle
Frank Ripdijk's Ind. Oud.	Hendrik-Ido-Ambacht	90 M^3/hour	3,090	Operates 5 days and not both at the same time
Staatsmijnen Haarlem	SBB der Sm. Lutterade	Various plants		
		380 M^3/hour	13,000	
		380 "	13,000	
		380 "	13,000	
		380 "	13,000	Own use only
		900 "	30,900	
		78 "	2,680	
		82 "	2,810	
		139 "	4,790	

/Stickstoffbindings

Name	Locality	Capacity	Kg/24 hrs.	Operation
Stickstoffbindings inst. "Nederland"	Kilkade Zechaven Dordrecht	90 M^3/hour	3,090	+ 25%
Ned.Gas Accumulator Mij Heerengracht 370, Amsterdam - C.	Duivendrecht	Liquid oxygen		Not in commission
-do-	Overschie	-		
N.V.Philips	Eindhoven	120 M^3/hour	4,110	90% for own use
		20 "	690	
		34 "	1,040	50%
Scheldo	Vlissingen	20 M^3/hour	690	80%

SUMMARY:- (4180 M^3/hour) operating (60,000 Kg/24 hrs. for chemical industry) 143,000
(290 M^3/hour) in reserve 10,000
(1792 M^3/hour) idle (of which 60,000/24 hrs. at Sluiskil) 92.4% 61,500

TOP SECRET

ENCLOSURE VIa.

Electrical Power Supply in Relation to the Large "CROSSBOW" Sites.

The requirements for power on a long range rocket launching site fall into three classes:-

(i) Light

(ii) Power for handling the projectile and its filling.

(iii) Power for launching if electrical launching is employed.

It is clear from elementary considerations that even if the so-called Large Sites are connected with rocket launching, which is by no means certain, the requirement of electric power for lighting could very easily be supplied by local generating plants. In view of the great size of the installations at the large sites, it is moreover not unreasonable to suppose that a standby electric generating plant would be installed of sufficient size to supply power for handling the projectiles and their filling. The maximum power required for this purpose, including the lighting and heating load is unlikely to exceed at the outside 200 - 300 K.W.

It is only in the event of electric launching being employed that it becomes of any significance at all to isolate the Large Sites from the electric grid and in these circumstances it would be necessary to put out of action all of the following plants:-

Electric Power Transformer and Switching Stations

		Tactical Target No.
1	GOSNAY (a) GOSNAY (b)	5002E/M/11
2	CHOCQUES(a) CHOCQUES(b)	5002E/M/4
3	ISBERQUES (a) ISBERQUES (b)	5002E/M/10
4	BEUVRY (a) BEUVRY (b)	5002E/M/2
5	MAZINGARBE (a) MAZINGARBE (b)	5002E/M/13a 5002E/M/13b
6	BULLY (a) BULLY (b)	5002E/M/3
7	PONT-A-VENDIN	5002E/M/12
8	LA VAUPALIERE	4901E/M/4
9	DIEPPE	4901E/M/1
10	YAINVILLE	4900/M/5
11	AMIENS	4902E/M/1

A.I.2(h).

27th July, 1944.

ENCLOSURE VI (b)

"CROSSBOW" and POWER

1. The power supply in the Pas de Calais and the Somme to Seine areas had been well developed before the outbreak of the present war. The power stations were gridded together and of sufficient power to take care of normal growth for some time to come. However, electric power plays a big part in any war picture. As between mobile, auxiliary power generating plants or interlocked central power stations there is no question if there is a choice.

2. The supply must be sufficient to meet every essential user's needs, for those minutes or hours of need, at the time it is necessary to have the power to do the job. Military jobs could not wait, and the German army, even before the advent of Crossbow, found the electrical current supplies in the above mentioned regions insufficient to meet the armies' needs. The auxiliary and mobile units at hand did not exist in sufficient quantity; neither did they have sufficient men nor material that they wished to spare, if other means could be found to meet the situation.

3. Previous to the occupation by the German army a 45 Kv grid sufficed. Now a 90 Kv grid is at times, and for various reasons, not meeting present demands. Just as soon as evidence of a shortage became apparent, much work was done on high tension grid connections of 90 Kv to replace the standard 45 Kv. Seventeen transformer stations make up the grid, and the power required at any of these points can be supplied from: (a) local small power stations connected to the main grid at 45 Kv or lower voltage; (b) main power stations feeding the grid at 90 Kv; or (c) high tension line from outside. A list of the seventeen transformer stations and the stations feeding the power to the grid system are given in the annex. It is this grid system which supplies the power to the large Crossbow sites. The attached map shows that in each case a power line runs close by each installation.

MARQUISE-MIMOYECQUES - A 90 Kv connection between BOULOGNE and CALAIS passes within a few yards of this site. To date there is no evidence of a 90 Kv transformer located here.

A low tension power supply has been seen from LANDRETHUN-LE-NORD. This village is supplied by low tension grid and can be supplied from DUNKERQUE, HOLQUE or COULOGNE.

WATTEN - The 90 Kv connection between HOLQUE and LONGUENESSE passes close to this site. An overhead line has been seen extending from one of the 90 Kv pylons to this site, but no information on the voltage is available.

WIZERNES - The 90 Kv connection between LONGUENESSE and GOSNAY or TINGRY passes over this site. There is no photographic evidence of a 90 Kv transformer at this site.

An overhead line has been seen connecting the site with the low tension grid system which runs from LONGUENESSE to WIZERNES. It is believed that this line connects with TINGRY.

LOTTINGHAM - The 90 Kv connection TINGRY to LONGUENESSE or GOSNAY passes about two miles south of the site.

An overhead low tension line is seen leaving this site to the west. It is believed connected with the village of LOTTINGHAM. Grid information suggests that the site can be supplied at low tension from TINGRY or LONGUENESSE.

/SIRACOURT

ENCLOSURE VI (ii)

SIRACOURT - This site is not located close to a 90 Kv grid connection.

Low tension lines running from the site appear to connect with low tension lines next to the road along the site. The area may be supplied direct from DOULLENS but ABBEVILLE and GOSNAY also are believed able to supply. LIGNY, DIVION and HAILLICOURT power stations can also feed this part of the low tension grid via PERMES transformer station.

4. A study of the launching of large rockets at PEENEMUNDE showed that various means have been used to give the initial acceleration necessary before the jets of the rocket itself can take hold. Various forms of assisted rockets have been tried, but as far as could be made out the unequal thrust of the rocket assistors seriously interfered with the accuracy of the large projectile. Electric solenoids were tried. The heavy underground cable and size of the transformers and coils are not known, but careful calculations show that with the proper hook-ups it should take in the neighbourhood of 33,500 KW to impart a sufficient acceleration of the large projectile for its own jets to take hold, provided it is launched from tubes like those that have been believed to have been installed at PEENEMUNDE. Reports on the installations at MARQUISE-MIMOYECQUES speak of like tube installations and other reports from reliable sources tell of the removal of the 35,000 KW transformers from VANDAIRES to this site. In any case any electrical launching aids for large rockets would take a great deal of current for a short interval of time.

5. Destroying the only possible source of electrical energy such as would be necessary to give the essential acceleration would prevent such launchings either from launching tubes in the ground or launching platforms, as long as electricity is employed as the means of launching. Even if it were not, there would be a call for a plentiful supply of current for all the air compressors, pumps, etc.(ordered from BROWN BOVERI and SIEMENS) known to have been shipped to this area. These are believed to be used for filling the large air bottles etc., of both the large rockets and the flying bombs. All are known to be electrically driven. Incidentally, no evidence is available which would show any provision for diesel or other auxiliary generator device at any site to carry on operations should the power supply and/or grid supply be knocked out. The transformers for the eletric compressors found at both types of sites were 3 phase 400 volt 72 amperes each. The new modified type of ski site does not appear to have any such large electric compressors at the site itself. It seems more than likely that at some nearby supply point such compressors will be found. Photographic evidence does reveal some current is supplied via power lines even to the new type of sites, and ground reports do tell of complaints that the drain on the local current sources has at times been too great to permit the operation of present flying bomb sites.

6. The power supply of these regions, in which all these sites are located, can be effected in various ways. Destruction of the low tension transformers at the feed points of the low tension grids only take a short time to replace. Destruction of the 90 Kv transformers at the grid nodal points are difficult to replace, but in a short time a limited supply of power should be re-established if one feed point in the area remains in action. Destruction of the power plants feeding the grid and high tension transformers would now be next to impossible to replace. Any all out attack on the eighteen power plants and grid points at present would seriously interfere with all secret weapons activity in the CALAIS and SENTE to SOMME areas, not mention the RADAR and other military installations dependant on this source of power. Attacks so far by the 8th U.S. Air Force have been of a very minor nature. However the attacks on the HOLGNE power station brought on feverish activity on the part of the Germans until the station was repaired. Bombing of some of the sites has broken the power cables running to those sites and that was the first thing that was repaired.

/CONCLUSION

ENCLOSURE VI (iii)

CONCLUSION

7. There is little that U.S.S.T.A.F. can do of any immediate aid with regard to flying bomb attacks, or possible large rocket attacks against England. Results of serious efforts to do so ever since last October, when sites were easier to find and attack, show the wisdom of sticking to attacks on source of supplies which are essential to the weapons and which call for such manufacturing skill that manufacture can only take place in certain key plants. For large rockets and flying bombs, gyros, automatic pilots, compasses and pumps are primary objectives; but the power plant attack should bring quick results, and, like fuel, it is a target system worthy and suitable for air force operations.

SECRET

Enclosure VII

Note of Hydrogen Peroxide

1. Two developments within intelligence over the past week alter the analysis of the hydrogen peroxide position:-

   (a) An analysis of elements from the rocket which came down in Sweden appears to show that peroxide is NOT a main fuel for the large rocket. It is, however, used in small quantity to drive the fuel pumps. The indications that peroxide is not the main fuel are strong, but not final.

   (b) It now appears fairly firm that the flying bomb is fully air borne at the end of its run on the launching ramp and that, consequently, a somewhat lower level of peroxide consumption per launch should be taken; say, 300 lbs., rather than 450 lbs.

2. Taking these factors into account consumption of peroxide at the present rate of expenditure is likely to be of the order of 1500 tons per month, of which about 1000 tons would be for military purposes.

3. These alterations strengthen the view expressed in the original analysis that the attack on peroxide is not to be regarded as a means of affecting the operation of the large rocket.

4. The attacks on Peenemunde and Hollriegelskreuth affected the production of about 400 tons per month, or approximately a quarter of total known production. Peenemunde is believed to have been affected for a period of about one month; first reports from Hollriegelskreuth indicate probably more severe damage. Peenemunde remains as a target, with a reduced number of aiming points; Hollriegelskreuth should be suspended awaiting further analysis of damage.

5. Damage thus far done is not yet likely to affect the scale of current operations although it may make the Germans look to measures of economy and substitution.

A. I. 2(a)
27th July, 1944

[redacted]SECRET

ENCLOSURE VIIIa

PEENEMUNDE : DAMAGE ASSESSMENT.

1. The Electrolytic hydrogen peroxide plant.

Damage to the two large buildings containing this plant is confined to one small hole in the roof of the concentrator building. The building containing the electrolytic cells and the stills is untouched, as is also the rectifier station in the building alongside.

Time lost from production would in all probability not exceed that necessary for examining the plant for leaky joints.

2. The Electrostatic hydrogen peroxide plant.

One wing of the fan house has been destroyed by a direct hit. The damage was probably increased by an explosion within the house. The pipes leading from the fan house to the synthesis unit have been cut near the fan house. The synthesis unit has suffered only superficial damage by blast. There has been slight damage to the railroad connections by cratering.

3. The elliptical earthwork.

There have been many strikes in and around the ellipse; the only positive items of damage which can be seen are as follows:-

A strike on the roof of the large building has necessitated stripping the roof covering for an area of about 65' x 20'. It should be noted that the purlins of the roof are not damaged. A direct hit has taken a small chip out of the roof of the building embedded in the seaward side of the bank. This building has been identified as a liquid air plant. One of the three large cranes present has a small hole in its roof which may have been caused by blast. Craters have cut the railway lines leading to the ellipse and to the large building.

4. The Power Station and boiler plant.

A strike on the roof of the boiler house has penetrated it and may have damaged two of the boilers. Damage would probably be confined to the I.D. fans and their ducting. On 23rd July part of the roof covering had been stripped preparatory to repairs. One stack was smoking on the same date. It does not appear that the damage to the steam and power plant would interrupt the operation of the electrolytic hydrogen peroxide plant.

5. The electrolytic hydrogen plant.

Three bombs have penetrated the roof of this plant. Any internal damage caused would be aggravated by dust from the debris, since freedom from dust is essential in this plant. The full operation of the electrostatic hydrogen peroxide plant depends on the serviceability of this hydrogen plant.

6. The airfield.

The airfield buildings and some of the dispersed aircraft have suffered severe damaged.

HOELLRIEGELSKREUTH

No satisfactory photographs of the damage to the works have been received. A signal from MAPRW dated July 26th reporting on Sortie SM/337 of July 25th by 682 Sqn. gives the following details. Central and northern parts of works devastated. The main building of Lindes Eismaschinen A.G. (throught to be a hydrogen peroxide plant) is heavily damaged. The liquid air plant and other buildings in the Linde complex are completely destroyed. In the Electrochemischerwerke Muenchen A.G. the old hydrogen peroxide plant, a second possible hydrogen peroxide plant and several other buildings are all heavily damaged or destroyed.

ENCLOSURE VIIIb.

PEENEMUNDE : ANALYSIS OF RESULTS OF BOMBING

Aiming Points in order of Priority.

1. The electrolytic hydrogen peroxide plant.
2. The power and steam plant.
3. The elliptical earthwork.
4. The electrostatic hydrogen peroxide plant.

Delay to Operation of Plant caused by attack.

1.	Electrolytic hydrogen peroxide plant.	One to two days.
2.	Power and steam plant.	Nil to seven days to two out of twelve boilers.
3.	Elliptical earthwork.	Three to seven days.
4.	Electrostatic hydrogen peroxide plant.	Four to six weeks.
5.	Electrolytic hydrogen plant.	One to two weeks.

Recommendation of Weapons for Future Attacks.

Bombs of twice the weight of those used in the attack under consideration must be used. In addition, aircraft detailed to attack the electrolytic hydrogen peroxide plant could usefully carry a proportion of bombs containing MnO_2.

D.of Ops.(S.O.)

27th July, 1944.

ENCLOSURE IX

DISTRIBUTION AND CLASSIFICATION OF COUNTER-CROSSBOW EFFORT

1. From 12th June 1944 to 06:00 hours on 26th July 1944 48,608 tons of bombs have been dropped against CROSSBOW targets.

2. The following Table shows the weight and distribution of effort over the week ending 06:00 hours on 26th July:-

	No. Aircraft Attacking	Tonnage	No. Targets	Per cent. Tonnage to Total Tonnage
Launching Sites	778	2,723	18	64%
Supply Depots (Thiverny)	100	545	1	13
Large Sites (Wizernes and Watten)	125	677	2	16
Hydrogen Peroxide (Hollriegelskreuth)	106	240	1	7
TOTAL	1,109	4,185	22	100%

SECRET

ENCLOSURE X

SPECIAL FUEL DEPOTS

1. Firm intelligence links a dump at VAAS with special "CROSSBOW" fuel. A dump at this place is already targetted in the T.T.D's as an underground ammunition depot. The question in intelligence is whether it may be assumed that a portion of the known dump is used for fuel; or whether a second dump at this place is likely.

2. Firm intelligence links the large G.A.F. fuel dump at DUGNY with special propellant. Heavy attack is recommended.

3. The fuel dump at PACY is known to contain methanol, and may also contain "CROSSBOW" fuel. Fairly high priority among tactical fuel targets may properly be recommended.

4. The fuel dump at CORMEIL, now in process of targetting, also contains methanol, and is held to be suspicious with respect to "CROSSBOW" fuel.

5. As a supplement to "CROSSBOW" fuel attacks in Germany attack on DUGNY can be immediately recommended. Attack on VAAS can be recommended, depending on the view with respect to the likelihood of two dumps at this place. In view of the general tactical attacks on fuel dumps, PACY can be recommended although no firm intelligence links this depot with "CROSSBOW".

A.I.3(E).
27th July, 1944.

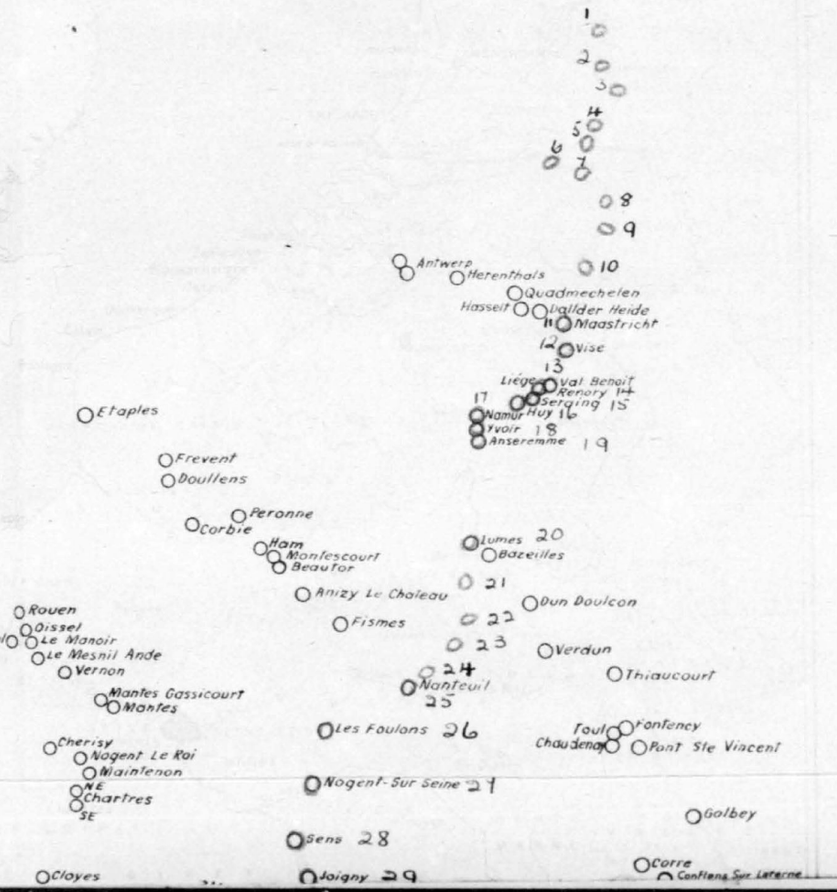
[redacted] SECRET

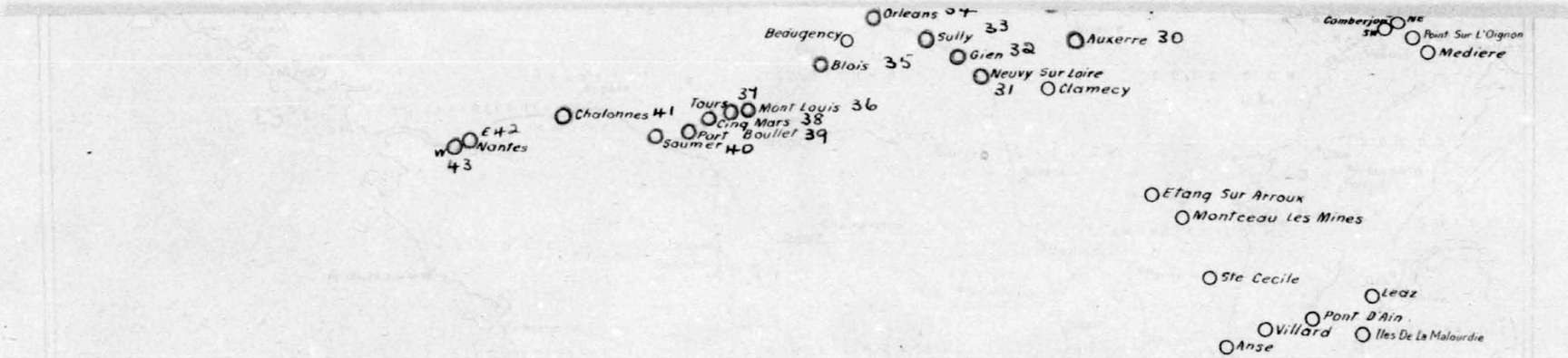
Copy No 321

SHAEF RAIL BRIDGES INTERDICTION
STATUS AT :

LEGEND

- RED — IMPASSABLE
- BLUE — RECCE REQUIRED
- GREEN — PASSABLE





Note: For Details See SHAEF Interdiction Handbook, Part II:

Sheet Reference 15: ROUEN-MANTES-CLOYES-BEAUGENCY-NANTES
Sheet Reference 16: ETAPLES-MANTEUIL-AUXERRE-LEAZ
Sheet Reference 17: ANTWERP-LUMES-MEDIERE
Sheet Reference 18: ORLEANS-SULLY-GIEN-NEUVY SUR LOIRE

APPENDIX 'A'

SECRET.

DAILY AVERAGE EFFORT

Week ending:	Daily average launched
18th June	102
25th June	100
2nd July	136
9th July	117
16th July	88
23rd July	110
30th July	101
Mean average	108

APPENDIX B.

JUNE 30th - JULY 6th							JULY 7th - 13th						JULY 14th - 20th						JULY 21st - 27th					
ZONES				NO. OF SITES ATTACKED		AVERAGE TONNAGE DROPPED PER ATTACK IN ZONES	ZONES			NO. OF SITES ATTACKED		AVERAGE TONNAGE DROPPED PER ATTACK IN ZONES	ZONES			NO. OF SITES ATTACKED		AVERAGE TONNAGE DROPPED PER ATTACK IN Z ZONES	ZONES			NO. OF SITES ATTACKED		AVERAGE TONNAGE DROPPED PER A ATTACK IN ZONES
Priority of Activity	Zone No.	Sites per Zone	No. of Shots detected	CAT. A	Other Attacks		Priority of Activity	Zone No.	No. of Shots detected	CAT. A.	Other Attacks		Priority of Activity	Zone No.	No. of Shots detected	CAT. A.	Other Attacks		Priority of Activity	Zone No.	No. of Shots detected	CAT. A.	Other Attacks	
1	11	11	69		1	454	1	14	61		2	112	1	11	46		6	80	1	11	88		6	109
2	14	7	49		2	92	2	7	47	1	3	85	2	7	43		3	82	2	4	70			
3	7	13	48	1	6	43	3	11	46	1	7	81	3	4	40	1	3	115	3	13	44	1	3	115
4	10	3	32				4	13	36		4	61	4	5	36		1	26	4	5	42	1		68
5	13	6	26		1	576	5	9	26				5	2	30		1	193	5	10	37		1	26
6	5	9	23	1	5	51	6	5	23		2	150	6	6	25		4	59	6	14	34		1	22
7	6	9	19		1	19	7=	6	22	1	1	106	7	A	20				7	3	33		2	85
8	4	11	14	2	6	97	7=	10	22		2	104	8	10	16		1	19	8	2	32			
9	12	1	12	1		475	9	12	17				9	3	12				9	7	30		4	33
10	9	2	10				10=	4	16	1		76	10	14	10	1	4	81	10	A	29			
11=	2	7	7	1	4	72	10=	8	16				11=	1	9		3	189	11	6	25			
11=	15	2	7				12	2	14				11=	13	9				12	9	21		1	122
13=	8		2				13	15	12				13	9	8		1	196	13	1	18		1	174
13=	3	8	2		1	71	14	3	8				14=	8	3				14	12	16			
15=	1	4	1				15	1	6		1	189	14=	12	3				15	8	9			
15=	17	2	1				16=	16	1				16	15	2				16	15	7			
15=	19	2	1				16=	19	1					16					17	B	6			
	16							17						17					18	C	4			
	18							18						18					19	17	2			
	20	3						20						19					20	16	1			
	A							A						20						18				
	B							B						B						19				
	C							C						C						20				
TOTALS	-	-	323	6	27		-	-	374	4	22	-	-	-	312	2	27	-			548	2	19	-

Appendix C

SECRET