

ITEM Nos. 21, 22, 31
FILE No. XXXIII-38

COPY No.

~~UNCLASSIFIED~~
~~SECRET~~
(Ho/79/02)

**UNDERGROUND FACTORIES
IN GERMANY**

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

~~SECRET~~

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

SECRET

UNDERGROUND FACTORIES IN GERMANY

Reported by

C.I.O.S. Party 536.

PERSONNEL OF PARTY.

A.N. Dudor, A.M.I.C.E., M.O.W., Team Leader.
W.C. Ash, B.Sc. M.Inst. C.E. A.M.I.Mech.E., F.Nat.I.Sc. (India)
D.C. Burn, M.A., M.Inst. C.E. A.M.I.Mech.E., M.H.S., R. & E. Dept.
B. Farley, M. of S. D.H.T.
E. Glossop, B.Sc. A.R.S.M.
L.A. Houl, B.Sc. (Eng.) A.M.I.Mech. E., M. of S.
A.B. Mann, B.Sc. (Eng.) A.M.Inst. C.E., M.I.Mech.E.
M. of W. Engineering Division.
A.W. Putnam, B.Sc. (Eng.)
F.H. Webb, M.B.E., M. of W.

C.I.O.S. Target Nos :

See Main Body of Report.

SECRET

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

G-2 Division, S.H.A.E.F. (Rear) APO 413

C O N T E N T S

Pages.

PART I. PREAMBLE

PART II. GENERAL SURVEY OF FACTORIES

(1)	General	1
(2)	Geology and Choice of Sites	3
(3)	Construction Methods	4
(4)	Engineering Services	6
(5)	Production and Layout.	8

PART III. DETAILED DESCRIPTIONS OF FACTORIES.

(A)	"Hydras" Mittelworks, Nidorsachswerfen	13
(B)	"Malachit", Langenstein, Halberstadt.	21
(C)	"Makrele 1" Champignon Caves, Halberstadt.	30
(D)	"Makrele 1" Champignon Caves, Halberstadt.	33
(E)	Elben Altenbauna.	38
(F)	"Dachs IV" Osterode	41
(G)	Oda-works, Aschersleben	47
(H)	Kaliwerke. A.G. Gresschierstads. Aschersleben.	50
(I)	Galgenberg, Wernigerode	51
(J)	"A. 2.B" Denkmal Stollen. Barkhausen.	52
(K)	"Dachs 1" Porta Westfalica. Minden.	58
(L)	"Hammerwerke" Porta Westfalica. Minden.	64

Appendix 1.	Vulnerability to Air Attack.	71
Appendix 2.	Comparison between a German and a British Underground Factory.	79
Appendix 2A.	The Treatment of Internal Rock Surfaces, of Corridors and Galleries at an underground Factory constructed in sandstone in Great Britain during the War.	88
Appendix 3.	Tunnelling plant.	92

STATEMENTS.

Personnel of Party
List of Drawings (18 no.)
List of Photographs (28 no.)

18444

LIST OF PHOTOGRAPHS.

- No. 1 Dachs I. Railway access tunnel.
- 2 Mittelwerke - Tunnel entrance C.
- 3 Mittelwerke - Tunnel entrance D.
- 4 Langenstein
- 5 Langenstein - Entrance N.
- 6 Langenstein - Entrance D.
- 7 Langenstein - Concrete lining in progress.
- 8 Langenstein - Concrete lining in progress.
- 9 Langenstein - Brick lining at intersection of galleries.
- 10 Langenstein - Lining of steel ribs and concrete jack arches.
- 11 Makrele II - Entrance
- 12 Makrele I - Entrance
- 13 Makrele I - Protection to ventilating shaft.
- 14 Elben - Camouflaged spoil dump.
- 15 Dachs IV. Anhydrite quarry.
- 16 Dachs IV. Entrance to workings.
- 17 Dachs IV. Anhydrite quarry
- 18 Odawerke - Regenstein.
- 19 Odawerke - Entrance to workings.
- 20 Denkmal Stollen - Entrance.
- 21 Denkmal Stollen - Outcrop of Porta Sandstone
- 22 Denkmal Stollen - Ground floor
- 23 Dachs I - Oil Refinery
- 24 Dachs I - Entrance
- 25 Dachs I - Oil Refinery
- 26 Hammerwerke, Funicular Railway.
- 27 Hammerwerke, Interior of Factory.
- 28 Waste spreader at Langenstein.
- 29 Salzgitter Lader.

Secret.

Underground Factories in Germany.

Report by C.I.O.S. Party 536.

PART I. PREAMBLE.

"The Party was formed by Sir Hugh Beaver, Controller General, Ministry of Works, following a request from the Chiefs of Staff, and emphasis was laid on the importance of inspecting certain underground factories in the area about to be occupied by the Russians."

(a) Compilation.

Key to Information.

The particulars of Underground Factories in Germany recorded below were collected by a team whose interests include Mining, Civil Engineering, Mechanical Engineering (as applied both to Services and to Production and Layout) and the Technique of Bombing Effects. Most of the documents comprised in the dossier are the result of collaboration between these elements and comments on certain aspects of the whole subject necessarily occur in Sections dealing mainly with other aspects. It is desirable, therefore, to indicate, at the onset, where the various categories of information, factual or commentative, which it may be desired to extract from the Report can be found.

(b) The original quest.

Site Observations Categories.

The observations made in the course of the tour are comprised in Part III, DETAILED DESCRIPTIONS OF FACTORIES. This is divided into twelve sections, A to L, each devoted to a Factory, though not all these were visited. The heads under which the facts, where available, have been set out include:-

- A general description.
- Contacts and references.
- Geology and Site Investigation
- Layout.
- Floor areas and levels.
- Linings and supports.
- Entrances.
- Shafts.
- Progress of Construction.
- Cost.
- Sewage Disposal
- Water Supply

Excavation.
Drilling and Blasting.
Mucking.
Loading and Transport.
Falls of Ground.
Air Attack.
Engineering Services.
Heating.
Ventilation.
Electric Light and Power.
Compressed Air.
Production and Layout.

General Commentary: A commentary of a more general nature is given in Part II, GENERAL SURVEY OF FACTORIES, and it is placed in the Report before the more detailed matter in Part III because it may be of wider interest. Part II deals with the subject, not Factory by Factory as does Part III, but under the heads of:-

- (1) General.
- (2) Geology and choice of Sites.
- (3) Construction Methods.
- (4) Engineering Services.
- (5) Production and layout.

Types of Factory: Section (1) General, includes some historical comments and divides the factories inspected into two general types - "Single-Storey" and "Multi-Storey", all with horizontal approaches. There was also one factory, reported upon but not inspected, to which the access was by means of a 440 metre vertical shaft; but this factory was a converted salt mine and not constructed specifically for war purposes.

Construction Methods: Under (3), Construction Methods, the subjects considered are Excavation, Linings and Entrances. Further particulars in connection with the subject of Excavation will be found in Appendix 3, TUNNELING PLANT.

Services: Section (4), Engineering Services, covers Electric Power Supply and Lighting, Compressed Air and Heating and Ventilation. Services such as Water Supply and Drainage are dealt with as individual cases in Part III, but are not generally commented on in Part II.

Production and Layout; topics. The concluding Section (5), Production and Layout, of Part II refers to the handicaps under which the Germans laboured in the equipment of these factories, in which production had ceased before the inspection was made. It comments upon the type of layout generally adopted and it offers observations, from the Production Engineer's standpoint, upon the very

important question of the treatment of exposed surfaces in underground Corridors and Galleries. It calls attention to the lack of planning, which was observed in the layout of machine tools and other items of equipment, as well as to the paucity of lifting facilities, mechanical handling appliances, conveyor systems and means for the disposal of swarf. It records the free use which was made of accumulator-driven trucks. Observations are offered on the large range of production which, given proper planning, can be undertaken in Underground Factories and comment is made on the fact that part assembly only was in most cases aimed at.

Recommendations.
(Mechanical)

A summary of recommendations made in Section (4) and (5) is given at the end of Section (5).

Construction periods, labour and costs.

Before the members of the Party set out for Germany, they were asked to devote special attention to certain specific questions arising in connection with Underground Factories. Information regarding a number of these has duly been recorded in Part 3, DETAILED DESCRIPTIONS OF FACTORIES, but it was also thought that additional light could be shed on certain of them, relating to construction, if a comparison were made between a selected German Factory and a British Factory constructed during the war. A statement on this subject will be found in Appendix 2, COMPARISON BETWEEN A GERMAN AND A BRITISH UNDERGROUND FACTORY. The questions which were brought up at the briefing and which are referred to therein are:-

- Appendix 2. Section IV. Periods of Construction.
- do. Section V. Labour Forces.
- do. Section VI. Costs.

(c) Further studies.

Linings and rock ratios.

Appendix 2 deals also with other points, not specifically referred to before the tour started, namely:-

- Section VII. Exposed surfaces of Corridors and Galleries.
- Section VIII. Residual Rock Areas.

Treatment of exposed rock surfaces.

Section VII of Appendix 2 discusses a leading question, which as already stated is alluded to in Part II, Section (5), Production and Layout. This is the question as to whether the walls and roofs of Corridors and Galleries should be lined or whether they should be left bare and treated in some way. The

(iv)

experience of the Chemical Engineer who gave advice in connection with the treatment of the exposed surfaces of the British Factories, used by way of comparison, has been drawn upon and his observations are made in Appendix 2(A) THE TREATMENT OF INTERNAL ROCK SURFACES OF CORRIDORS AND GALLERIES AT AN UNDERGROUND FACTORY CONSTRUCTED IN SANDSTONE IN GREAT BRITAIN DURING THE WAR. It is to be noted, in this connection, that production conditions may necessitate lining the rock surfaces of the galleries and corridors of a Factory, whether over the whole or in part, irrespective of the qualities of the rock.

Residual
Rock Areas

In Section VIII, Residual Rock Areas, of Appendix 2, the question is considered as to whether the Germans, in their haste, were ready to take risks which we in this country would not accept. The conclusion, in so far as the two Factories under comparison are concerned, is that the answer must be in the negative. The question of the respective merits of the layouts of the Corridors and Galleries in the two Factories is not made a subject of comparison.

(d) The Broad Issues.

Ineffect-
iveness of
German
effort.

The most comprehensive question put to the Party, when they were briefed, was that as to whether the efforts made by the Germans on their Underground Factories proved to be worth while. No direct and complete answer has been attempted in the succeeding Parts of this Report. It would be easy to reply "No, because in the majority of cases they started too late." That, however, would merely be begging the question. It was not realised, at the time of the briefing, how little in the way of war production the Party would be able to see in the course of their inspection. Otherwise, the question might have been framed thus:-

- (i) Did the measures undertaken by the Germans ensure to them, given time, the volume of production aimed at?
and (ii) Were the efforts which they put forward out of proportion to the benefits which they stood to gain?

Degree of
protection
achieved

In considering (i), account has mainly to be taken of the degree of protection achieved from air attack. Appendix 1, Vulnerability to Air Attack, written by the Member of the Party whose special province this is, deals with this issue.

(v)

Recommendations as to future policy are also given. This subject is not one to which the rest of the Party have devoted exhaustive study. It is, however, thought appropriate to offer the remarks conveyed in the two following paragraphs.

Paucity of raw materials

The number of Factories which it was possible to inspect in the short time available represented but a small fraction of those known to exist, or to be in course of construction, in Germany. Of these, too, only a certain proportion had come into production on any appreciable scale before the collapse of the German war effort. There was, however, an aspect of the situation which came under the observation of the party and which may have a bearing upon the whole question as to the advisability of resorting to underground construction for Factories as a precaution against future war risks. This was the striking paucity of supplies of raw materials, required for production in any of these installations. It was evident that the Factories which were in production were in the main depending on day-to-day supplies.

Possible cause of shortage

For the reasons underlying this, reference should be made to the observations of other investigators, for such circumstances were beyond the scope of the enquiries of this Mission. It may be that the damage inflicted upon the enemy's transport system precluded the carriage of such materials; or it may be that owing to the destruction caused at the sources of supply the materials were not available. In either event, the Factories appear to have been in no condition to function healthily and it is apparent that the Germans, prior to the collapse, had little expectation of reaping the reward of the vast efforts which they had put forth with a view to the exploitations of the overhead cover offered by their mountains and hills.

Labour commensurate with effort

With regard to (ii), the abundance of labour which the Germans had at their disposal points to a negative reply.

Development in this country

If the question, as originally put, were intended to lead up to the issue as to whether an effort, such as the Germans made, would prove worth while in this country in future, the Party can at this stage do no more than offer for consideration a suggestion as to a plan for a preliminary investigation of the whole

subject. The plan would in part constitute a process of elimination and would run on the following lines:-

<u>Order</u>	<u>Type of Authority to be consulted</u>	<u>Terms of Reference</u>
I	Military	To lay down conditions as regards cover in various types of rock.
II	Geological	To produce maps showing where the conditions could be met and the various rocks which would be encountered.
III	Chemical	To report on means for the induration of rock surfaces.
IV	Industrial & Economic	To eliminate from the geological plans areas which would be unsuitable on account of remoteness or of other considerations.
V	Civil Engineering	To eliminate from the Industrial & Economic plans areas unsuitable on account of local access or other considerations and to assess the extent of the accommodation available.
VI	Mechanical Engineering	To determine which classes of industry are suitable for disposal underground (a) in lined galleries and (b) in unlined galleries suitably treated.

With the issue narrowed down in this fashion, an answer to the question could be hammered out. But so far as the observations go which were made on this tour, there would be little need, in this process, to draw upon German experience.

LIST OF DRAWINGS.

1A.	Nieder Sachsworfen.	General Details.
1B.	"	Geological Section.
1C.	"	Grouping of Machine Tools.
1D.	"	Production Flow.
2A.	Langenstein	General Plan.
3A.	Makrele I.	General Plan.
3B.	Makrele II.	General Plan.
4A.	Elben	Plan.
5A.	Osterode: Dachs IV.	General Plan.
5B.	" "	Geological Section.
5C.	" "	Transverse Sections.
5D.	" "	Longitudinal Sections.
5E.	" "	Programme of Works.
6A.	Regenstein.	Plan.
6B.	"	Plant Details.
7A.	Denkmal Stollen, Barkhausen.	Plan and Sections.
7B.	" " "	Layout of Plant.
8A.	Dachs I. and Hammerwerke.	Plans and Geological Sections.

PART II. - GENERAL SURVEY OF FACTORIES

(1) General

There can be no doubt as to the importance which the German Government attached to underground factories as an answer to our air attack on their industries, and the members of this party were impressed both by the magnitude of their construction programme and by the wide variety of processes which were carried out or to be carried out below ground. Owing to their haste and to their disregard for the well being of their workers little trouble was taken over ventilation and matters of welfare and safety, but it is our opinion that a very wide range of processes can be carried out underground, and that conditions can be made as tolerable as those on the surface. Indeed there is no reason why underground factories should not be constructed which are almost completely self contained as regards power, water supply, and living accommodation and facilities for recreation for the workers, during periods of especial danger.

Evidently the possible need for underground protection had been foreseen before the war and parts of the "Mittelwerke" at Niedersachsenwerfen are said to have been built in 1936, but apparently it was not till the spring of 1944 that the Germans realised their full danger and made desperate efforts to get their factories below ground before it was too late. The amount of underground excavation which they completed in the year remaining to them is most impressive and though the high rate of progress was due to their ruthless and wholesale use of slave labour the rapidity with which underground plants such as Dachs I were designed and installed is equally remarkable.

In their haste to secure protection for key industries the Germans, as well as starting a very large programme of underground workings, made use of existing underground space such as caves and mine workings, although some of these were small and others most inconvenient. Thus near Halberstadt (MAKRELE II) caves previously used for mushroom culture with a floor area of only 9,000 square feet were used for the production of detail parts of Junkers aircraft and at Gross Schierstadt near Aschersleben Junkers aircraft components were manufactured in old workings of a producing salt mine which could be reached only through a vertical shaft 1,200 feet deep.

Manufacturers appeared to have received instructions from the Government department concerned to provide underground accommodation for their plant and to make their own arrangements for the execution of the work, which was generally supervised by an Engineer-Architect in private practise. At Dachs IV (q.v.)-an oil refinery constructed for the Shell-Rhenania-Ossag-the underground workings were designed by the Deutsche Bergwerke und Huttenbaugesellschaft n.b.H. and mining work was carried out by the Grossdeutsche Schachtbau und



talpo.it

talpo.it

talpo.it

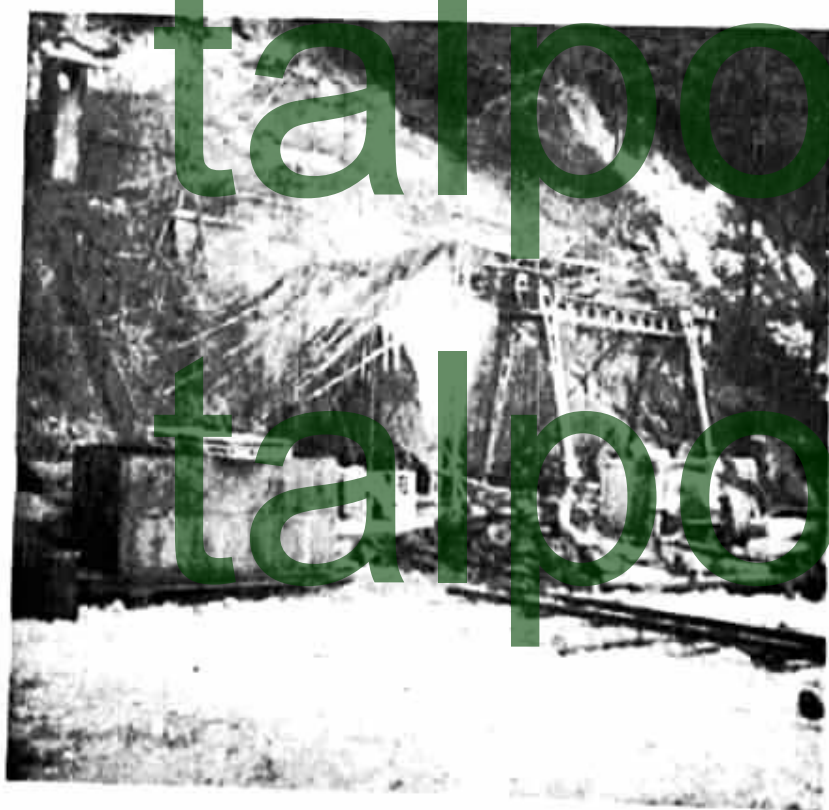
PHOTOGRAPH No.1. Temporary support for railway access tunnel to DACHS 1.



PHOTOGRAPH No.2.

Mittelwerke,
Neidersachswerfen.

Tunnel entrance "C"



PHOTOGRAPH No.3.

Mittelwerke,
Neidersachswerfen.

Tunnel entrance "D"



PHOTOGRAPH No.4.

Langenstein.
Cross Gallery.



PHOTOGRAPH No.5.

Melechit,
Langenstein.

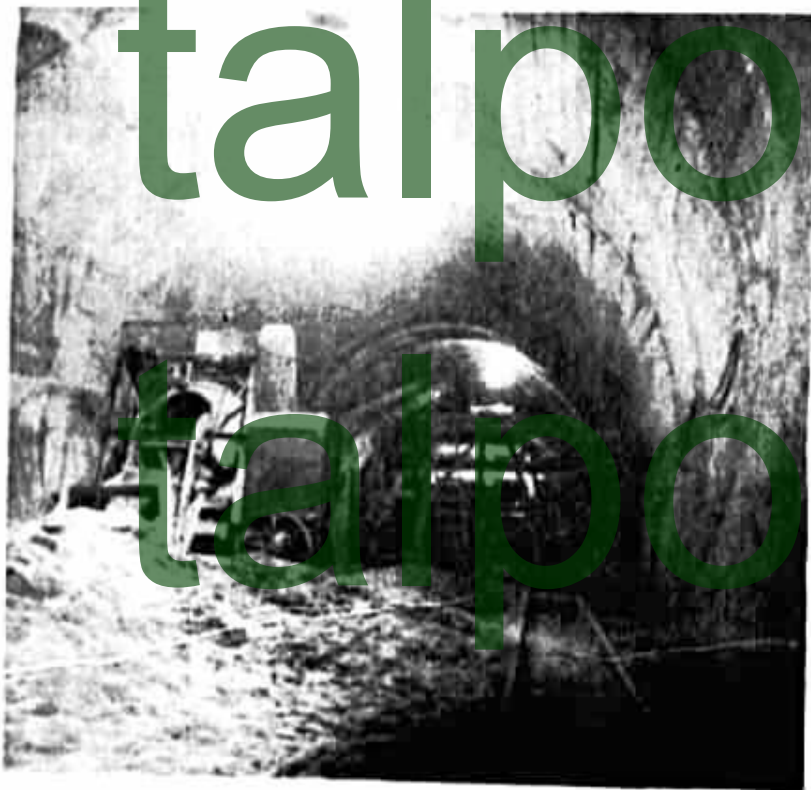
Entrance "N".



PHOTOGRAPH No.6.

Malachit,
Langenstein.

Entrance "D".



PHOTOGRAPH No.7.

Malachit,
Langenstein.

Concrete lining in
progress.



PHOTOGRAPH No.8.

Malachit,
Langenstein.

Concrete lining
in progress.



PHOTOGRAPH No.9.

Malachit,
Langenstein.

Brick lining at
intersection of
galleries.



PHOTOGRAPH No.10.

Malachit,
Langenstein.

Lining of steel
ribs with brick
jack arches.

talpo.it



PHOTOGRAPH No.11.

Mikrele II.
Halberstadt.

Entrance to
Champignon caves now
used as a factory.

talpo.it



PHOTOGRAPH No.12.

Makrele I.
Halberstadt.

Entrance to
Champignon caves.



PHOTOGRAPH No.13.

Makrele I.
Halberstadt.

Protection to
ventilation shaft.

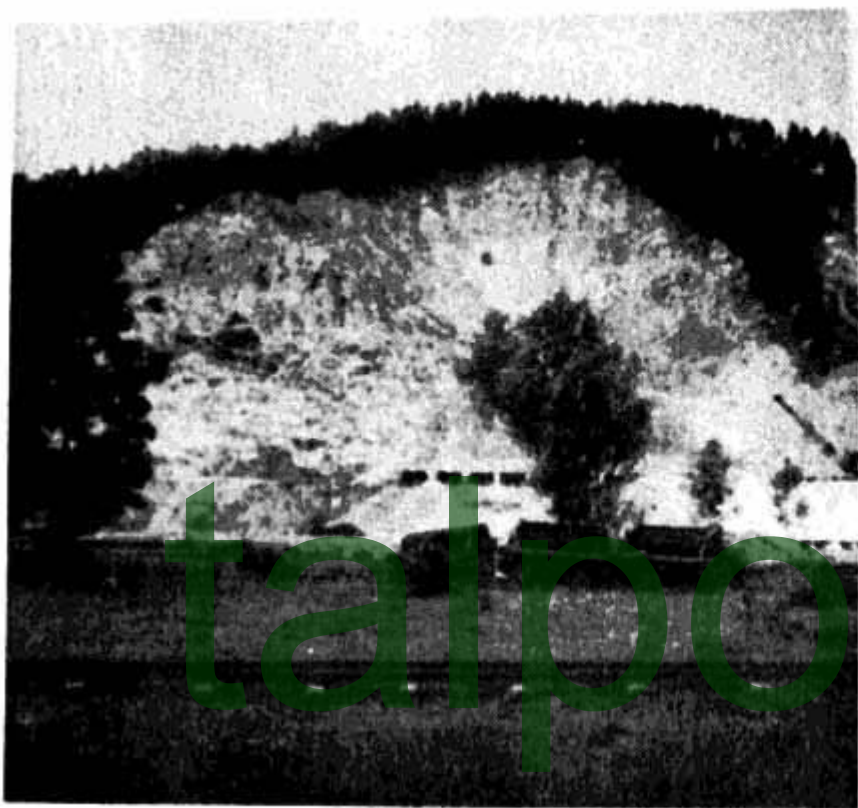


PHOTOGRAPH No. 14.

Elben.

Camouflaged spoil
dump.

talpo.it



PHOTOGRAPH No.15.

Dechs IV,
Osterode.

Anhydrite quarry.



PHOTOGRAPH No.16.

Dechs IV,
Osterode.

Entrance to workings.



PHOTOGRAPH No.17.

Dachs IV,
Osterode.

Anhydrite quarry,
compressor plant
in foreground.

talpo.it

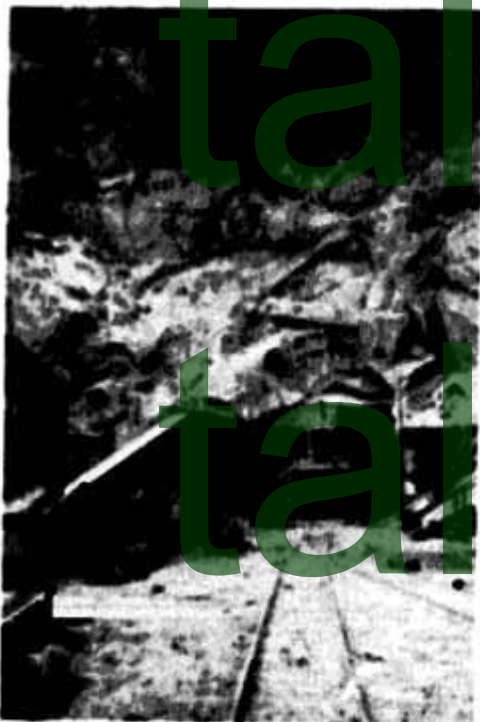
talpo.it

talpo.it



PHOTOGRAPH No.18.

Odawerke,
Regenstein.



PHOTOGRAPH No.19.

Odawerke,
Regenstein.

Entrance to workings.



PHOTOGRAPH No.20.

Denkmal Stollen,
Berkhausen.

Entrance to
factory, showing
blast well.



PHOTOGRAPH No.21.

Denkmal Stollen,
Berkhausen.

Outcrop of porce
sandstone showing
dip.



PHOTOGRAPH No.22.

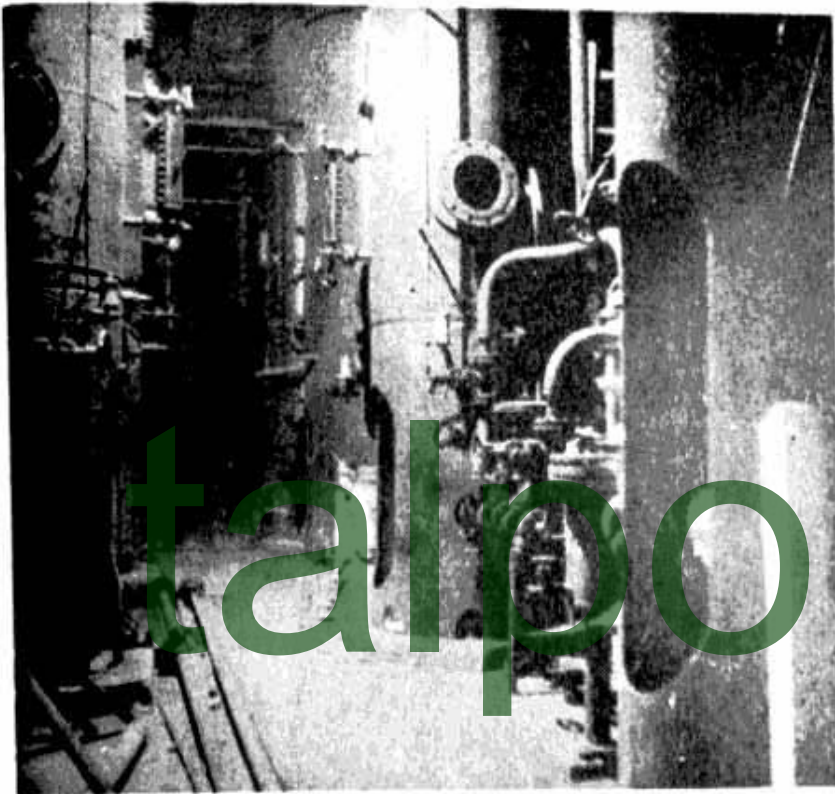
Denkmal Stollen,
Barkhausen.

Groundfloor. Note
roof construction.

talpo.it

talpo.it

talpo.it



PHOTOGRAPH No.23.

Dachs I,
Porta Westfalica.

Oil Refinery.



PHOTOGRAPH No.21.

Dachs I,
Porta Westfalica.

Entrance to oil
refinery in Porta
Sandstone,
Ornatentone above.



PHOTOGRAPH No.25.

Dachs I,
Porta Westralica.

Oil Refinery

talpo.it

talpo.it

talpo.it



PHOTOGRAPH No. 26.

Hammerwerke,
Porta Westfalica.
Funicular railway from
the entrance to
Hammerwerke. Entrance
to Dachs I below,
River Weser in
distance.



PHOTOGRAPH No. 27.

Hammerwerke,
Porta Westfalica.



PHOTOGRAPH No.28

Langenstein
Spoil spreader
on dump.

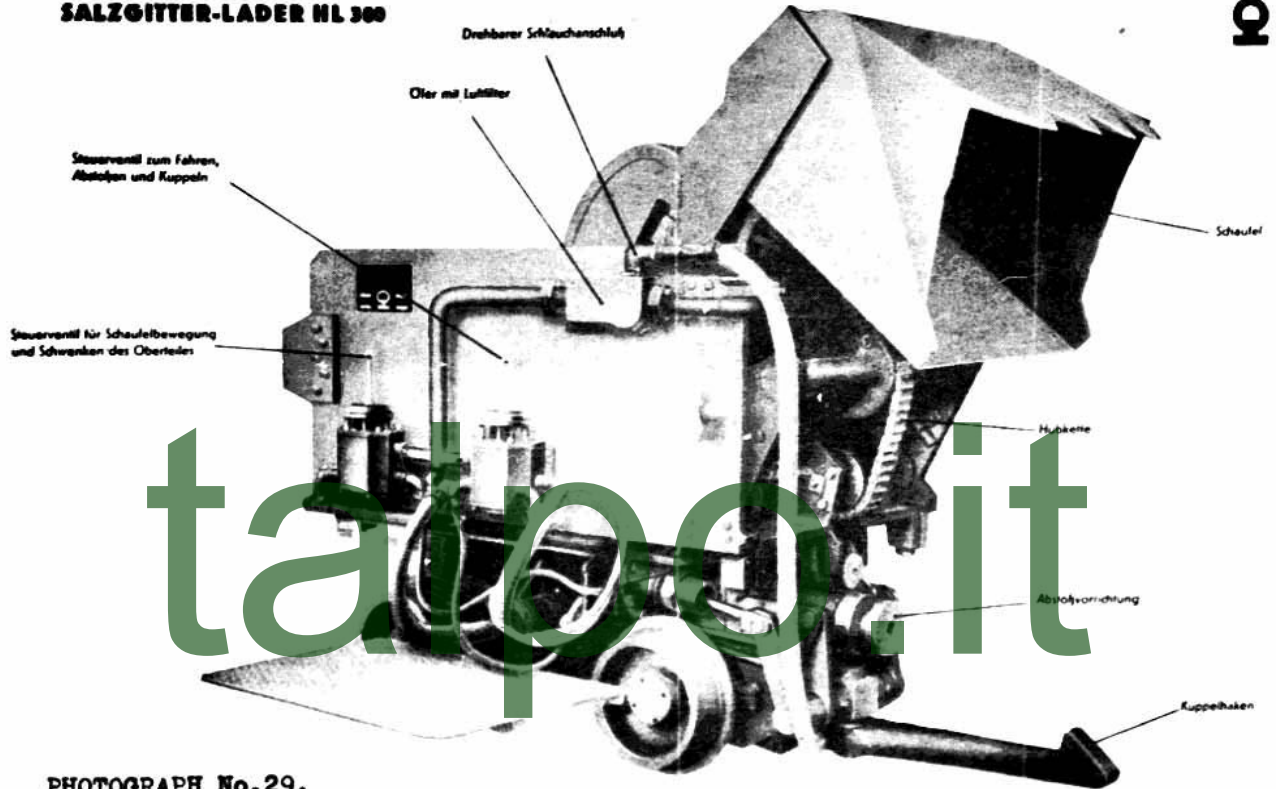
talpo.it

talpo.it

talpo.it

SALZGITTER-LADER HL 300

9



PHOTOGRAPH No.29.
Salzgitter-Lader

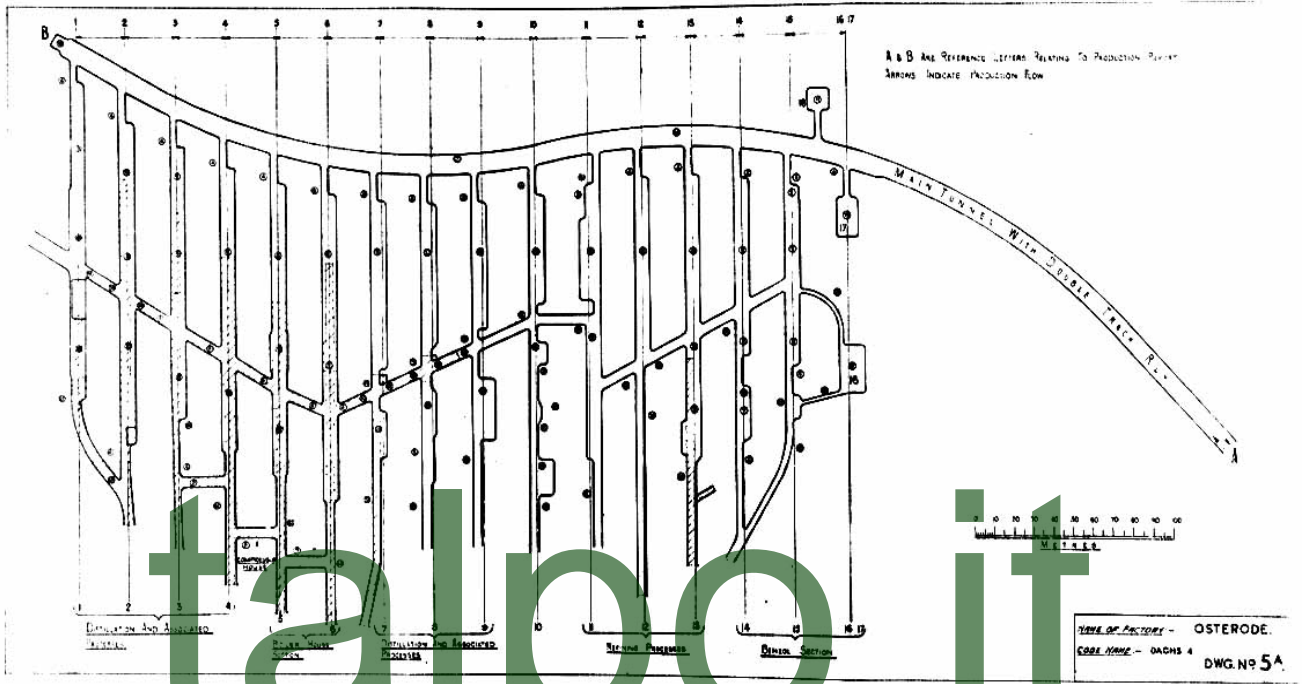
talpo.it

talpo.it

talpo.it



APPROXIMATE DISPOSITION OF TUNNELS SHOWN THUS

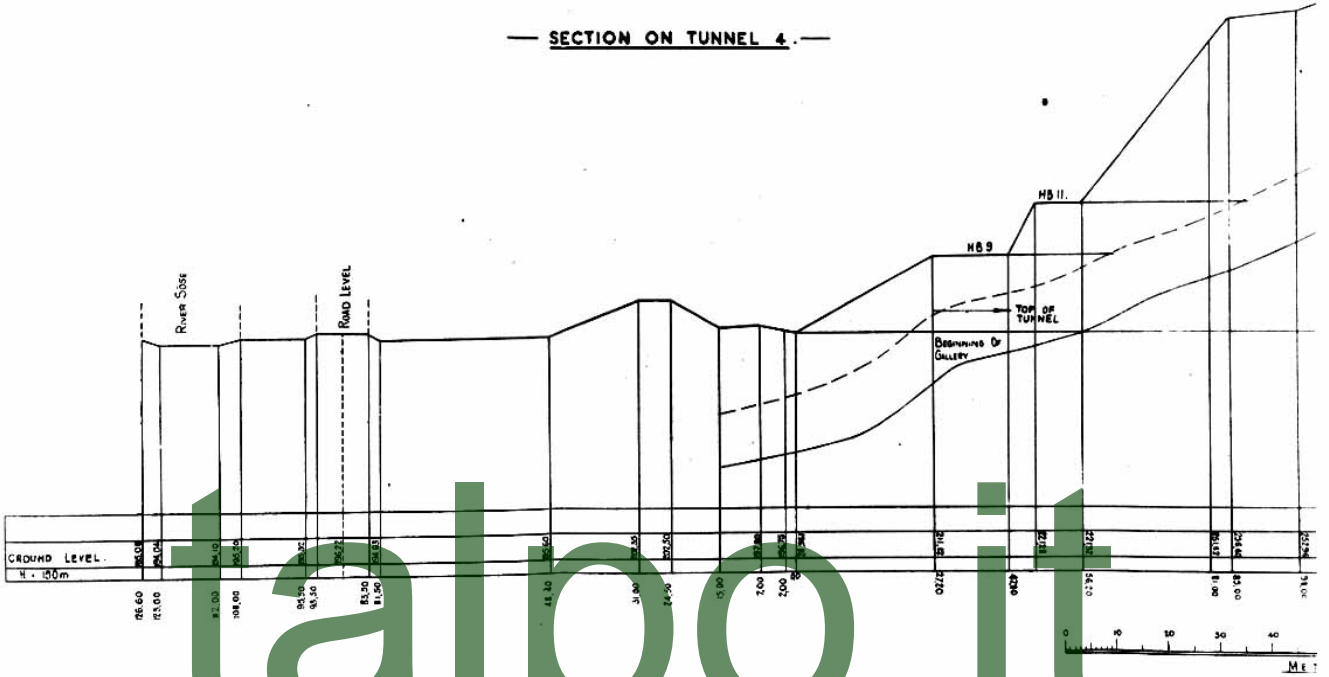


talpo.it

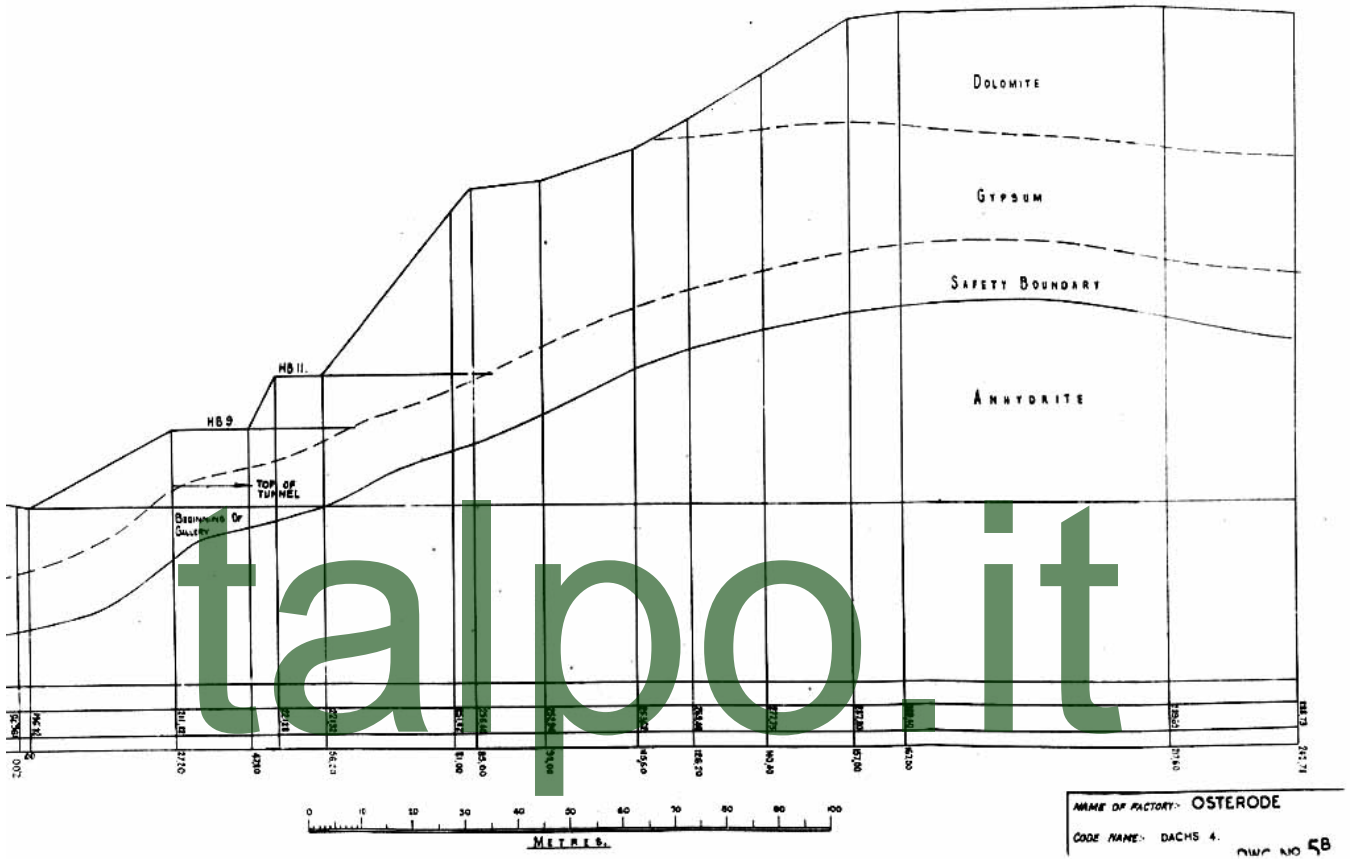
talpo.it

talpo.it

SECTION ON TUNNEL 4.



talpo.it
talpo.it
talpo.it



talpo.it

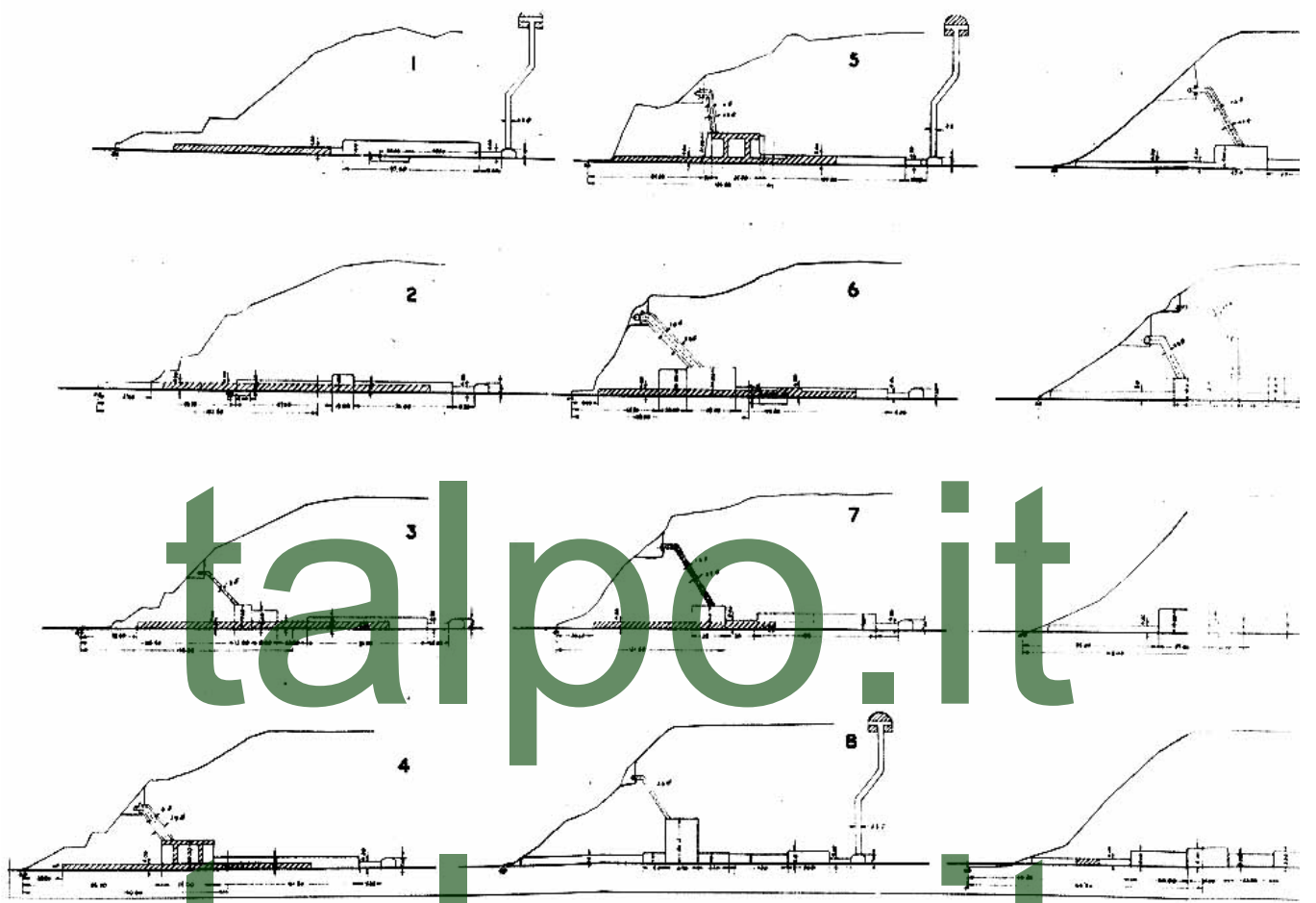
talpo.it



talpo.it

talpo.it

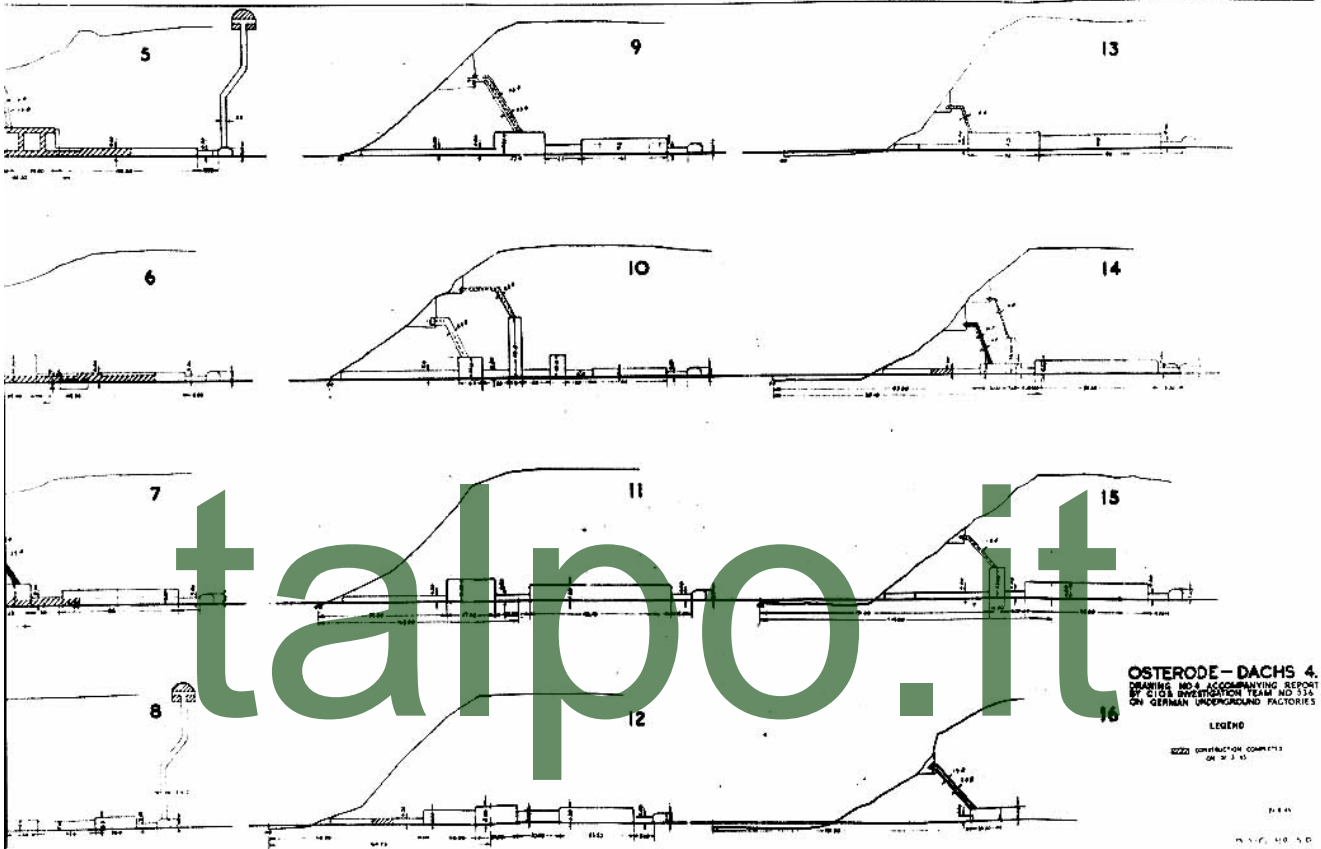
talpo.it



talpo.it

talpo.it

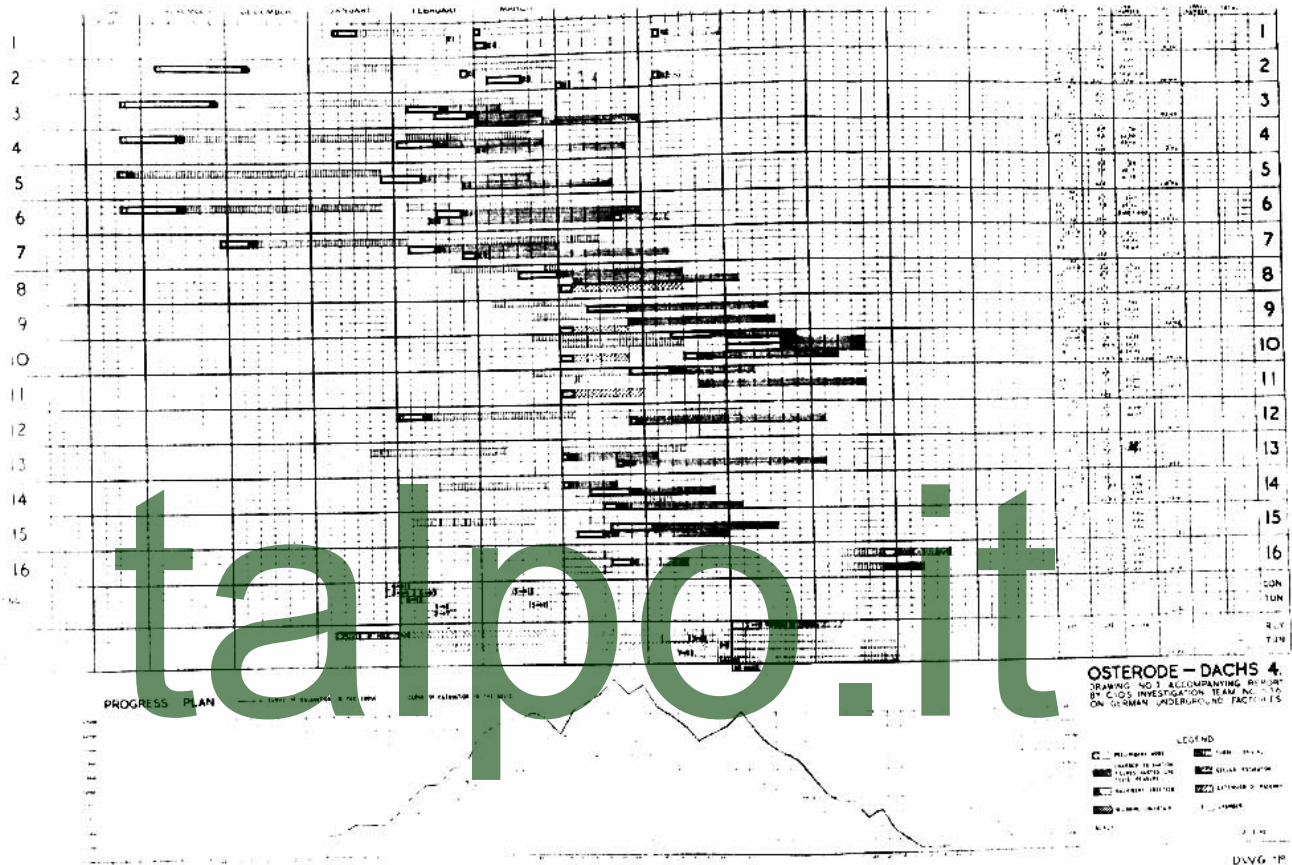
talpo.it



talpo.it

talpo.it

talpo.it

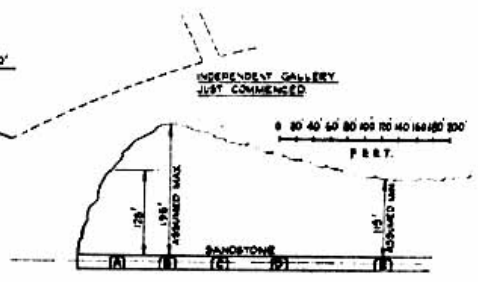


talpo.it

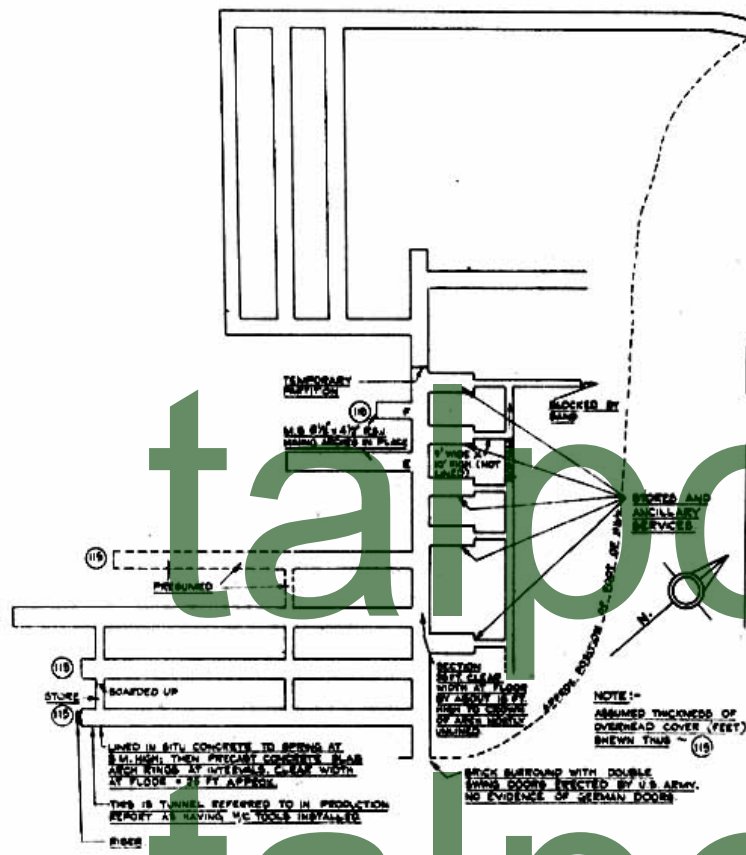
talpo.it

talpo.it

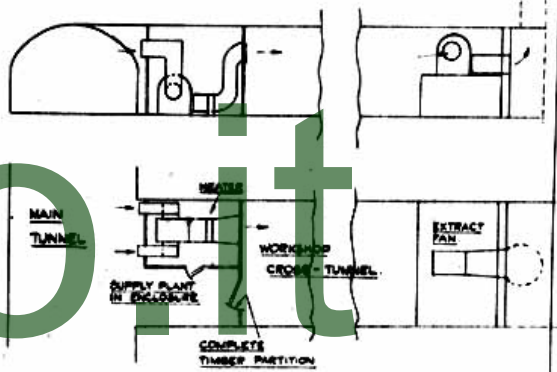
200' 250' 300' 350' 400' 450' 500' 550'
 F e e t



SECTION
 SECTION THRU MAIN TUNNEL LOOKING SW SHOWING COVER AS MEASURED BY ABNEY LEVEL



TEMPORARY PARTITION
 U.S. 67-147 624
 MAIN TUNNEL
 LOCKED BY
 BRICKS AND ANCHORS REVEALED
 SECTION THRU MAIN TUNNEL
 SECTION THRU CROSS TUNNEL
 SECTION THRU WORKSHOP
 SECTION THRU CROSS TUNNEL
 SECTION THRU WORKSHOP
 SECTION THRU CROSS TUNNEL
 SECTION THRU WORKSHOP



PLAN & ELEVATION OF WORKSHOP CROSS TUNNEL
 SHOWING ARRANGEMENT OF VENTILATION PLANT

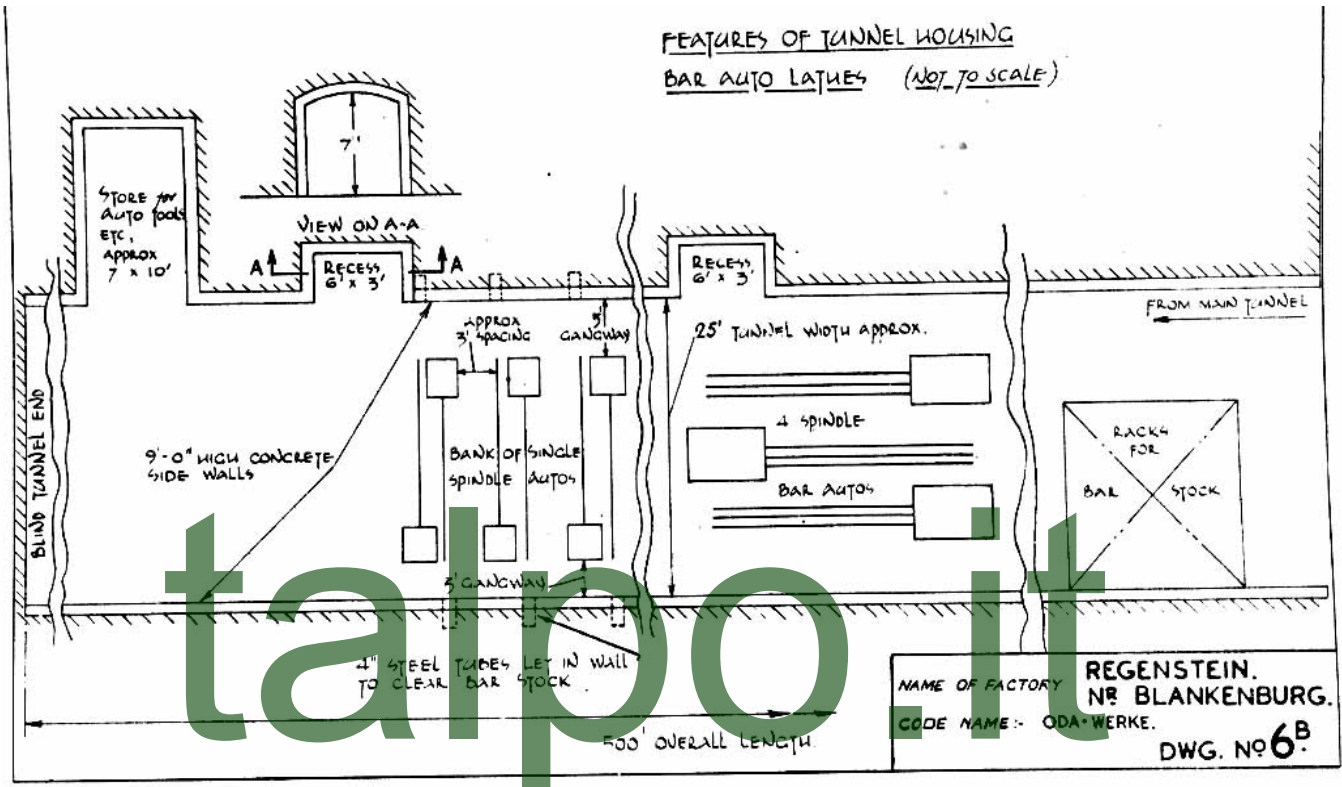
LINED IN SITU CONCRETE TO SPRING AT 134' HIGH. THEN PRECAST CONCRETE SLAB ARCH RINGS AT INTERVALS. CLEAR WIDTH AT FLOOR = 27 FT APPROX.
 THIS IS TUNNEL REFERRED TO IN PRODUCTION REPORT AS HAVING MC TOOLS INSTALLED

BRICK SURROUND WITH DOUBLE SWING DOORS ERECTED BY U.S. ARMY. NO EVIDENCE OF GERMAN DOORS

NOTE:-- ASSUMED THICKNESS OF OVERHEAD COVER (FEET) SHOWN THIS - (118)

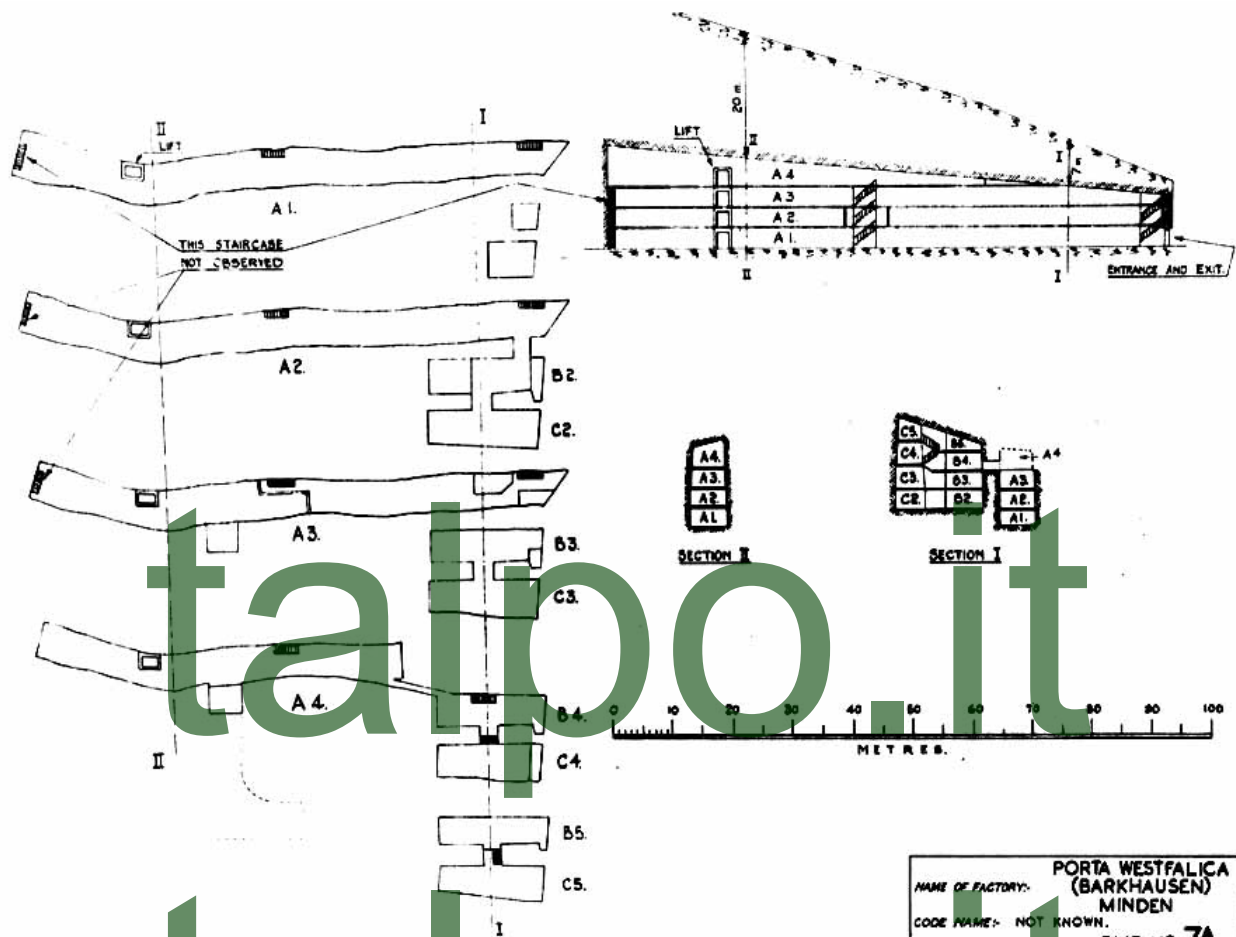
PLAN
 APPROXIMATE LAYOUT OF TUNNELS FROM DIMENSIONS TAKEN ON SITE

NAME OF FACTORY - **REGENSTEIN NR BLANKENBURG**
 CODE NAME - ODA-WERKE. **LA**



talpo.it

talpo.it



NAME OF FACTORY: PORTA WESTFALICA
 (BARKHAUSEN)
 MINDEN
 CODE NAME: NOT KNOWN.
 DWG. NO 7^A

talpo.it

talpo.it

talpo.it