TRANSLATION

NO. F-TS-672-RE

HISTORY AND EXPERIENCES OF HE-162

and

HE-162 REPORT No. 2
PERFORMANCES WITH JUMO-004
(Heinkel Report)

S. Günter and Hohbach

Release Date:
October 1946

HEADQUARTERS AIR MATERIEL COMMAND
WRIGHT FIELD, DAYTON, OHIO

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WF-O-7 OCT 46 800

HISTORY AND EXPERIENCES OF THE HE-162

Early in September 1944 it became evident that, with regard to the output of raw material factories, the manufacture of the Me-262 would be far behind the required number. The decisive factor was fuel production.

The Heinkel Corporation (Günter) suggested the manufacture of a fighter with reduced equipment, provided with only one power plant and attaining nearly the same performances as the Me-262 which was fitted with two engines of the same type. Calculations proved this possible, reducing fuel consumption one-half and making possible the operation of twice the number of aircraft, an important advantage in the long run.

On 15 September 1944 the Heinkel Corporation was given an order.

Projected Program.

1 October 1944 - Mock-up inspection.
10 December 1944 - Ready for take-off (First airplane).
January 1945 - Start of large quantity production.
April 1945 - Production output of 1000 airplanes.
Increased production up to 2000 per month.

Because of unused production capabilities, the BMW 003 power plant was proposed. Considering the very short time, structural parts of already existing airplanes (For example, the Me-109 landing gear) were used.

It was not possible to conduct wind tunnel tests, particularly in the DVL high speed tunnel, before the first flight. Eventual changes were to have been made on quantity production aircraft.

Flight Results.

The first test flight was made on 6 December 1944.

Flight Characteristics.

Very small rectilinear control forces, high maneuverability. Instability at high speeds corresponding to the angle of incidence. Stability corresponding in function to dynamic pressure was improved by the effect of the high-located thrust line.

High-speed tunnel tests (DVL) in January 1945 proved this result. Quite rectilinear moments only could be attained by a slight downward displacement of the wing or by drawing down the trailing edge of the landing flaps next to the fuselage. This latter was provided for quantity production because of its simplicity.

Moreover, the span of the control surfaces was increased by 10%. In order to keep control forces constant in spite of the decreasing effect due to acceleration when pulling out, the rearward tending weight of elevator operating rods was balanced. Within the load requirements for center of gravity position, stability of the airplane about the lateral axis with corresponding angle of incidence and dynamic pressure was obtained up to the highest flown speed of 960 km/h ($M = 0{,}86$) after the aforementioned changes.

Aileron forces were slightly increased by a small increase in rudder chord. By providing a spring in the controls the lateral control forces were increased and the rudder deflection reduced to half, There was some tendency to slip off on a wing when C_L was about 1,95. By fitting of a triangular outward rounded fillet (15 mm high by 35 cm long) on the leading edge next to the fuselage this difficulty was completely eliminated. (Longer fillet unfavorable.)

Among others the airplane was flown by six Air Force pilots who had flown trainers but not fighters and confirmed the easy landing characteristics of the 162. Experienced pilots judged the landing characteristics to be superior to those of the Me-109. Mr. Francke, Technical Director on the Heinkel Corporation, who has flown the 162 often, considered the wing area too small, but flight trials proved landing characteristics better than expected and the wing area sufficient. In my opinion correct power plant control and the elimination of idling thrust is of greater importance for good landing characteristics than a greater wing area.

The maneuverability of the Me-162 is by far greater than that of the Me 262. The damping of oscillations about the vertical axis was superior to all hitherto known airplane measurements in Germany. According to flight measurements on production airplanes the logarithmic decrement $\frac{T\psi}{t\psi} = 1.3$ at an indicated speed of 500 km/h at 2500 m, corresponding to a duration of oscillation of $T\psi = 2.S$ sec. and a decrement $\frac{1}{e} = 0.37$ times the value of $t\psi = 2.2$ sec. There is a normal coupling ratio of the amplitudes about longitudinal and vertical axis compared with other planes, the average value of $\frac{a_x}{a_z}$ being 1.3.

Flight Performances.

High speed tunnel (DVL) measurements on production type airplanes gave a $C_D = 0.198$ at small C_L values and a Mach Number of about 0.7. The corresponding value obtained by calculations was 0.21 which contained the additional rudder and flap drag that the model did not involve, The critical Mach Number of 0.75 on which calculations were based as well as the computed increase of drag above this value were sufficiently verified by the measurements.

Further reduction of drag on the order of about 8% could be attained according to tunnel tests by the improvement of wing to fuselage transition. Because of the difficulties expected by the application of such changes on production airplanes, this improvement was provisionally rejected.

According to wind tunnel measurements and assuming the same power plant and flight duration, the same performances as the Me-262 should be attained.

Although there had been considerable improvements made in the power plant since the trial installation under the fuselage of the He-219 twin engined night fighter in the summer of 1944, the lack of automatic nozzle needle control resulted in high thrust losses at high speeds as compared to BMW values which were used as a basis for computations. These thrust losses amounted to about 1/3 with a corresponding inadmissible speed loss of about 1/6. However, some of the values reached in flight corresponded to the calculated speeds. The automatic needle control, indispensable to the BMW 003, was completed in the spring of 1945, but installation was not made before occupation. It must be emphasized that when flying without automatic nozzle control, too small exits cause excessive temperatures which lead to a rapid destruction of the power plant.

In test flights, flight characteristics are more important than performances. It is advisable to have Mr. Bader test fly the three airplanes still available in the neighborhood of Landsberg. Mr. Bader can easily ascertain whether all changes have been made.

Status of Production and Projected Developments.

The start of quantity production was delayed from 1-2 months, more by the delay of production jigs than by structural changes. In May the first delivery of a large number of aircraft was to be made. In April 100 airplanes had been completed and parts for about 800 were ready for assembly. According to the delivery program the He-162 was the only airplane to be manufactured along with the Me-262.

Two He-162 airplanes equipped with the automatically controlled Jumo 004 power plant were destroyed by bombing at Vienna before having flown. New airplanes fitted with Jumo 004 power plants were not completed before the end of the war.

For the installation of the HeS 11 power plant a new wing and probably V tail, both with sweepback, were contemplated. This type of tail unit reaches higher critical speeds. There would have been sufficient time for wind tunnel tests since aircraft production changes were not anticipated before the beginning of 1946.

A new model with a 4.8 m span and two wing versions was about to be built for testing stalling conditions and to obtain essential data concerning lateral stability by test in the large Braunschweig wind tunnel. One wing was to have a 25° sweep-forward and the other a 35° sweep-back. If necessary, a third wing was to be built and the best model subjected to DVL high speed tests.

In order to reduce the large rolling moment caused by lateral rudder deflection, split control surfaces with a counter effect were proposed. Losses in lateral control effectiveness are of minor importance, the rudder efficiency being by far sufficient in spite of reduced maximum deflection to only $12\frac{1}{2}^{\circ}$. Flight tests of the 162 with straight wing and V tail were contemplated.

All trials were considered very urgent. The completion of drawings had been postponed in order that test results could be incorporated.

Landsberg, 6 July 1945.

APPENDAGE CONCERNING FLIGHT PERFORMANCES

It seems advisable to make some remarks concerning the BMW 003 power plant with regard to flight performances and its state of development.

The full-throttle values of thrust indicated by the BMW Co. with regard to the He-162 project assumed the thermal stress (Combustion chamber temperature) of the power plant to remain at the highest permissible value at all heights and speeds. To accomplish this the nozzle has to be varied accordingly. The BMW Co. had developed an automatic control which was in the process of being manufactured in Thuringia and was to be incorporated in the He-162 in the summer of 1945. In order to save the delicate power plant from excessive thermal stresses and to avoid hand regulation near the difficult best values, a large nozzle section was determined for normal flight conditions (Control position S, exit area = 1020 cm^2). However, this section resulted in high speed losses on the order of 16 to 20 % as compared to values obtained with best setting.

These results are shown in the attached graphs. The first graph takes the case where the height = 0 m with measurements of different speeds, exit sections and combustion chamber temperatures. It follows from this graph that at the highest permissible temperature of 750°C the thrust values warranted by BMW are attained with sufficient accuracy. The same graph reveals that with constant exit sections great thrust losses will occur at increased speeds as compared to best values. In the case of the usual position of the needle (S control setting area = 1020 cm^2, normal operating conditions) the loss amounts to 36 % at a speed of 800 km/h.

In the second graph are speed curves with ideal needle control and at constant nozzle area control positions F, S and H. At an altitude of 1 km and thrust position F two test flights were made in the month of April which established a verifying point.

Take-off and Landing. In order to verify take-off and landing runs to be within RLM (German Air Ministry) requirements, some test take-off and landing runs were made.

A take-off run of 750 m at a weight of 2.55 T satisfied requirements. Maximum power-plant speed was attained with locked wheels before starting the run. When maximum power-plant speed was attained as part of the run, run distance increased considerably.

Maximum lift coefficient measurements during landing runs reached values of 1.9 to 1.95, but was generally 1.6. The added leading-edge strip (to retard stalling tendencies) caused a C_L reduction of about 0.1 to 0.2 according to wind-tunnel data, hence a final $C_{L\,max}$ of 1.7. C_L mean will not decrease greatly when the possibility of landing with lift values nearer $C_{L\,max}$ is taken into consideration, due to improved stall characteristics. Hence, C_L mean is given as 1.5.

Taxiing Characteristics. Before testing there was some disagreement as to whether the airplane would have sufficient ground-maneuverability. Runway tests showed that with strong braking and power plant operation all requirements concerning curve radii for taxiing and turning and even figure 8s on the conventional runway were met.

Landsberg, 17 July 1945

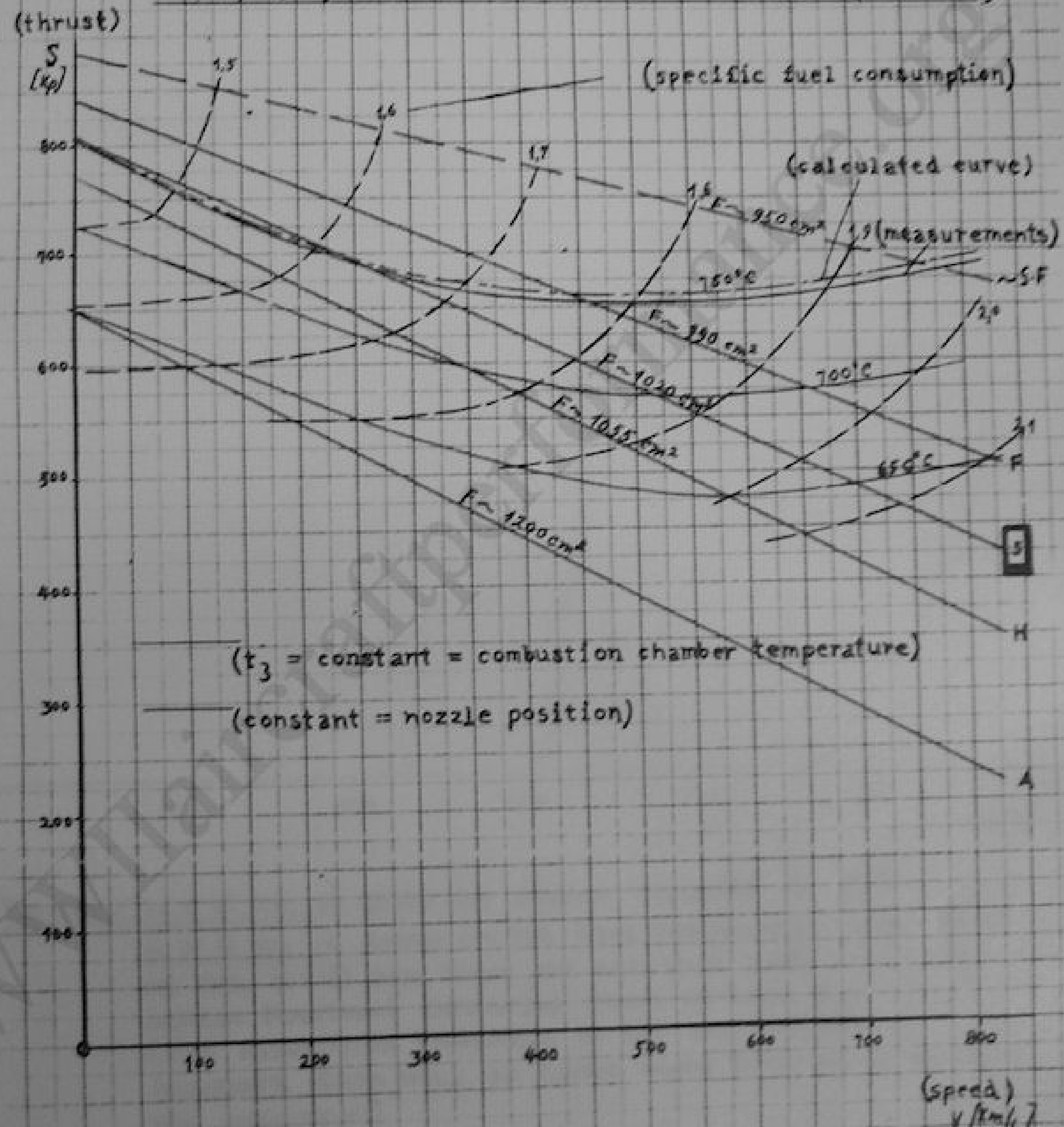
Hohbach.

(Measurements of BNW power plant type A0/05.)

BMW 003

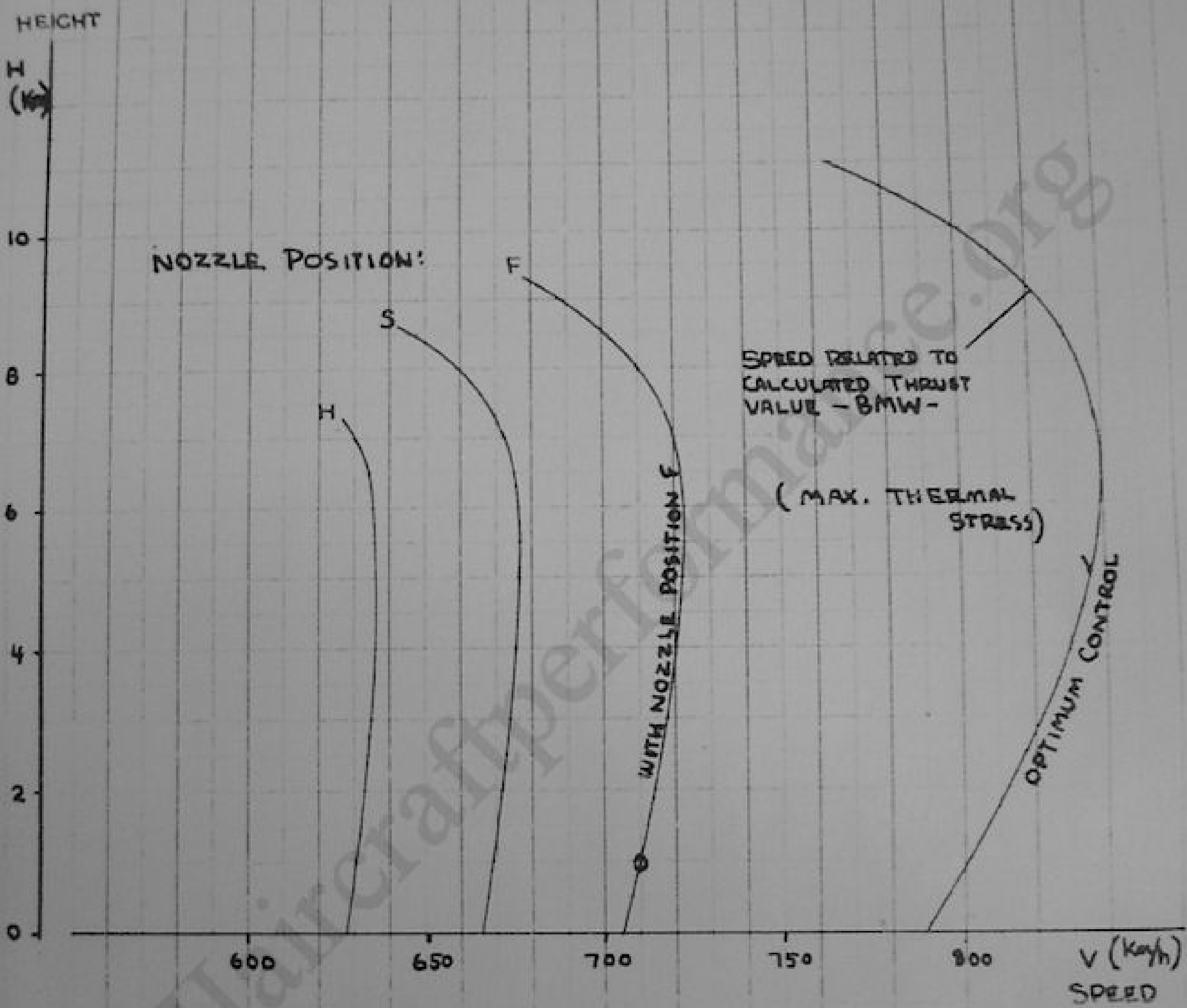
(height = 0 km) (speed = 9500 rpm)

(Thrust S as a function of the speed v, the nozzle section area A, H, S, and F and the combustion chamber temperature t_3.)

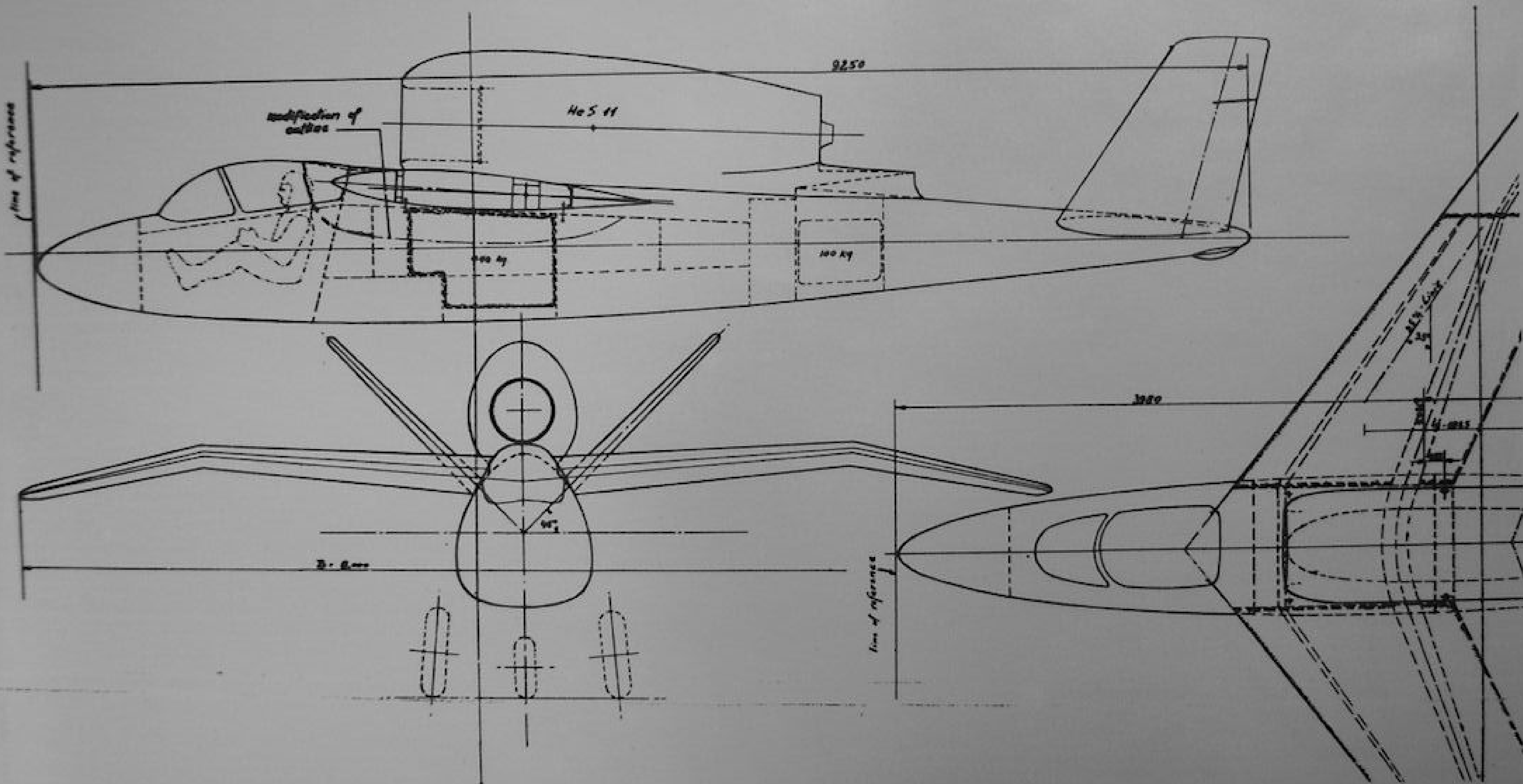


162 WITH BMW 003

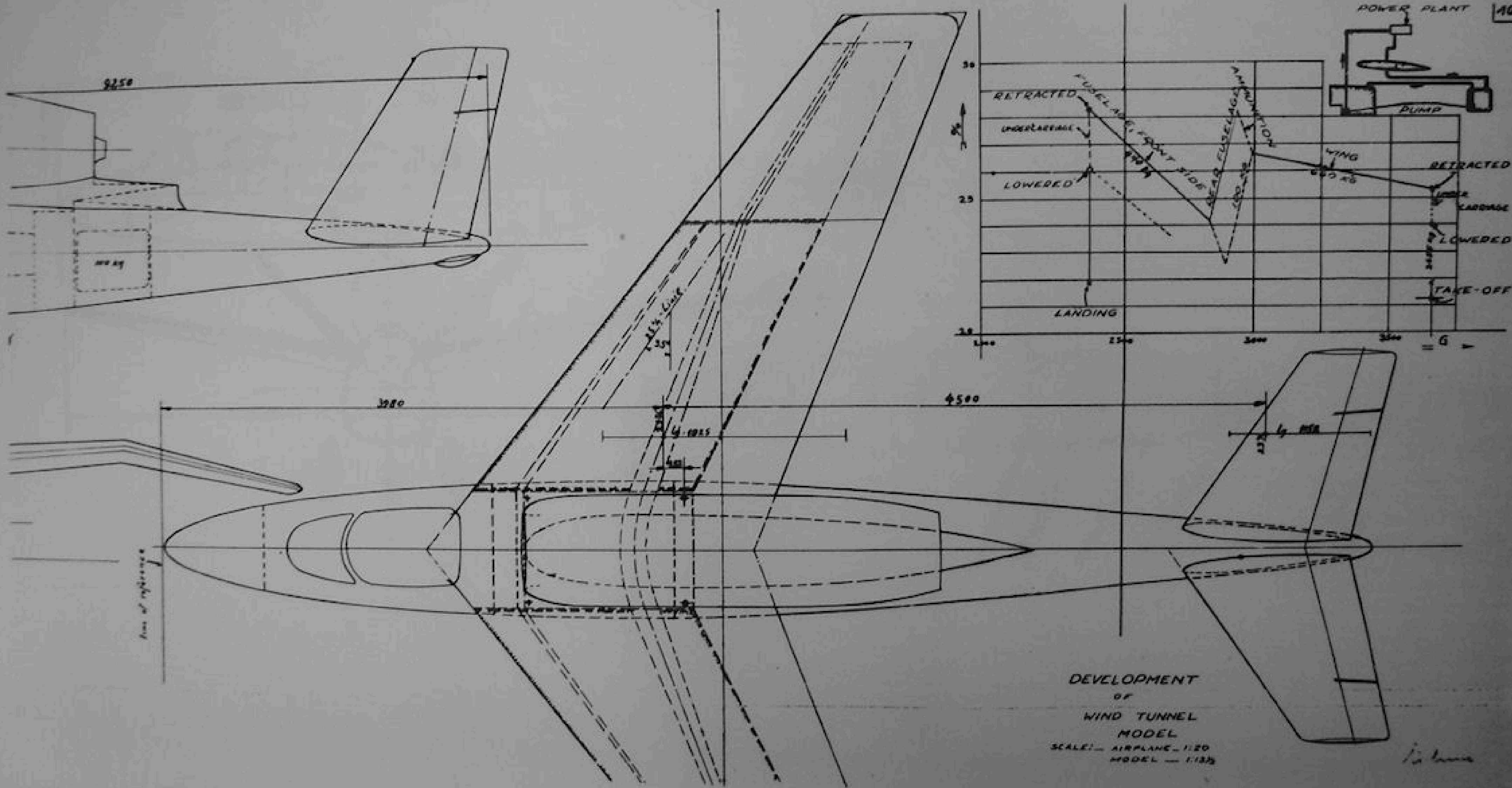
SPEED V AS A FUNCTION OF HEIGHT H AND NOZZLE POSITIONS F, S, AND H.

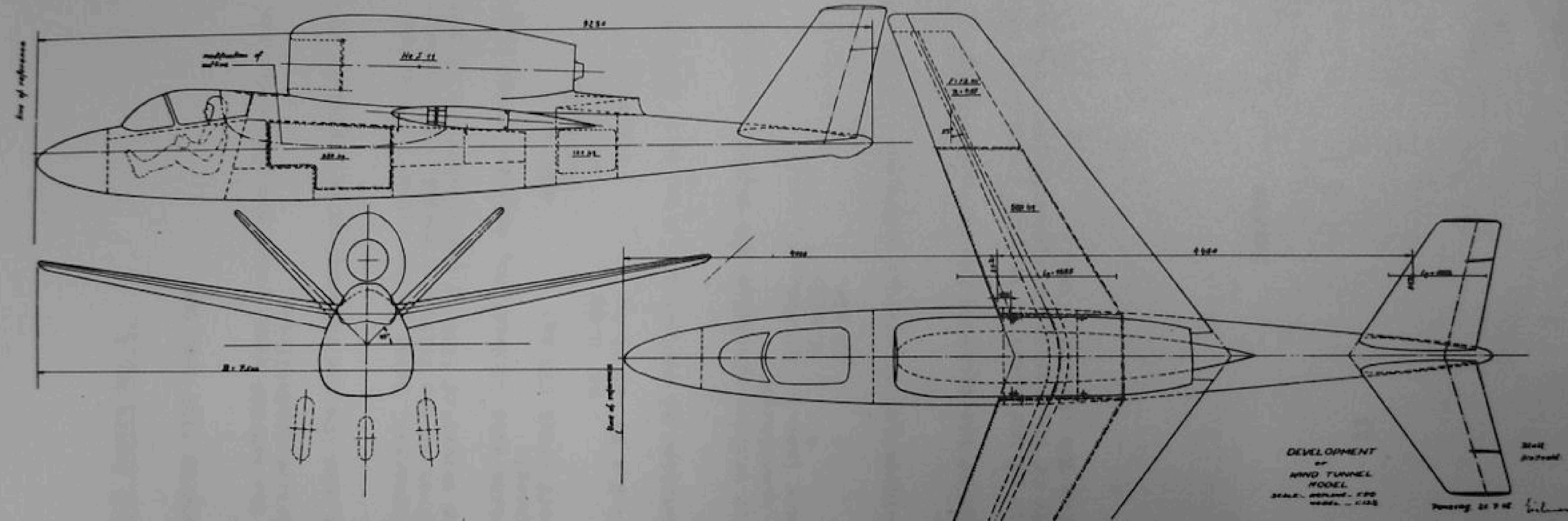


REMARK: H = 0 Km IS BASED ON VALUES MEASURED BY BMW.
H > 0 Km IS BASED ON THE SAME PERCENTAGE THRUST LOSSES AS FOR H = 0 FOR WANT OF ACCURATE DATA CONCERNING THE NOZZLE POSITIONS DEVIATING FROM OPTIMUM CONTROL. (THE ASSUMPTION PROBABLY IS TOO UNFAVOURABLE; ACCURATE DATA WILL BE GIVEN WHEN BMW MEASUREMENTS ARE AVAILABLE.)



9250
He S 11
modification of outline
line of reference
100 kg
100 kg
B = 8000
3980
line of reference


16
POWER PLANT
PUMP
RETRACTED
UNDERCARRAGE
LOWERED
FUSELAGE FRONT SIDE
REAR FUSELAGE
AMMUNITION
WING
RETRACTED
UNDER CARRIAGE
LOWERED
TAKE-OFF
LANDING
30
25
20
2500
3000
3500
= G
9250
3980
4500
DEVELOPMENT
OF
WIND TUNNEL
MODEL
SCALE:_ AIRPLANE _ 1:20
MODEL _ 1:13½


DEVELOPMENT
WIND TUNNEL
MODEL

He-162 Report No. 2

PERFORMANCES WITH JUMO 004

As previously mentioned, the BMW 003 power plant was chosen for the He-162 because of unused production capabilities.

Nevertheless the advanced Jumo 004 was intended to be installed in the He-162.

Power plant data and performances, based on the output of Jumo 004 (1000 kg static thrust), are given in the following graphs. This power plant is said to have a maximum thrust of 1150 kg permissible for 30 sec.

1. Sheet with the most important data (dimensions, weights, power plant characteristics, performances):

gross weight during take-off (fuel 675 kg)		2925 kg
maximum speed		890 km/hr
climb	at 0 km	30 m/sec.
(based on gross weight G = 2.4 T)	at 11 km	5 m/sec.

2. Values of thrust and consumption at various altitudes as a function of the speed.

3-5. Range, speed, endurance for various altitudes and throttle positions with regard to three fuel quantities:

a) 865 kg fuel	=	endurance (max.)	90 min.
b) 675 kg "	=	" "	70 min.
c) 475 kg "	=	" "	50 min.

6-7. Range and endurance (full-throttle) at various altitudes. Climb distances, rate of climb.

8. Rate of climb as a function of the altitude for various weights.

9. Rate of climb as a function of the speed at various altitudes. This graph shows the possibility of increasing considerably the speed during climb by moderately reducing the rate of climb.

Landsberg, 17 July 1945.

Hohbach.

Report
No. 2.

Fighter He-162

power plant with supplementary injection.

Dimensions:			
wing area (without sweep-back	m^2	11.16	
span	m	7.20	
aspect ratio		4.65	
Power plant: one BMW type 004 D/E (performances from January, 1945)		Normal thrust	maximum thrust 30 sec.
thrust power	kg	1000	1150
thrust at v = 800 km/h at height = 11 km	kg	315	395
specific consumption	kg/kg.h	1.89	2.34
Weights:			
armament (2 fixed forward firing MK 108)	kg	157	
ammunition (50 shells for each gun)	kg	58	
armored parts	kg	57	
equipment (without armament and armored parts)	kg	95	
crew	kg	100	
military load	kg	467	
structure (61 kg trimming ballast)	kg	983	
power plant with tanks and cowlings	kg	800	
fuel (except starting fuel)	kg	675	
gross weight	kg	2925	
fuel for warming-up and take-off run	kg	80	
starting fuel	kg	22	
gross weight during take-off run	kg	3027	
Performances (calculated):			
maximum speed (medium gross weight 2.4 T) at 0 km	km/h	885	960
at 6 km	km/h	889	925
at 11 km	km/h	823	865
duration of flight (full throttle, calculated) at 0 km	min	22	20
at 6 km	min	38	36
at 11 km	min	59	57
range (full throttle, calculated) at 0 km	km	320	300
at 6 km	km	530	505
at 11 km	km	750	720
climb (medium gross weight 2.4 T) at 0 km	m/s	30.3	42.7
at 6 km	m/s	15.7	25.3
at 11 km	m/s	4.9	10.7
take-off run without assisted take-off	m	760	660

* - Assumption is made that during one flight the permissible maximum thrust for 30 sec. will be used 6 times.

Fighter He-162 A-1

power plant with supplementary injection

Dimensions:			
wing area (without sweep-back)	m^2	11.16	
span	m	7.20	
aspect ratio		4.65	
Power plant:			
one BMW type 003 E		Normal thrust	maximum thrust 30 sec. +)
thrust power	kg	800	920
thrust at v = 800 km/h at height = 11 km	kg	265	332
specific consumption	kg/kg.h	1.61	1.96
Weights:			
armament (2 fixed forward-firing MK 108)	kg	157	
ammunition (50 shells for each gun)	kg	58	
armored parts	kg	57	
equipment (without armament and armored parts)	kg	95	
crew	kg	100	
military load	kg	467	
structure (61 kg trimming ballast)	kg	983	
power plant with tanks and cowling	kg	680	
fuel (except starting fuel)	kg	675	
gross weight	kg	2805	
fuel for warming-up and take-off run	kg	80	
starting fuel	kg	22	
Gross weight during take-off run	kg	2907	
Performances (calculated):			
maximum speed (medium gross weight 2.45 T) at 0 km	km/h	790	890
at 6 km	km/h	838	905
at 11 km	km/h	765	845
duration of flight (full throttle) (calculated) at 0 km	min	30	28 *
at 6 km	min	48	46
at 11 km	min	83	81
range (full throttle) (calculated) at 0 km	km	390	370 **
at 6 km	km	620	595
at 11 km	km	975	945

(continued on next page)

F i g h t e r He-162 A-1

power plant with supplementary injection.   (continued)

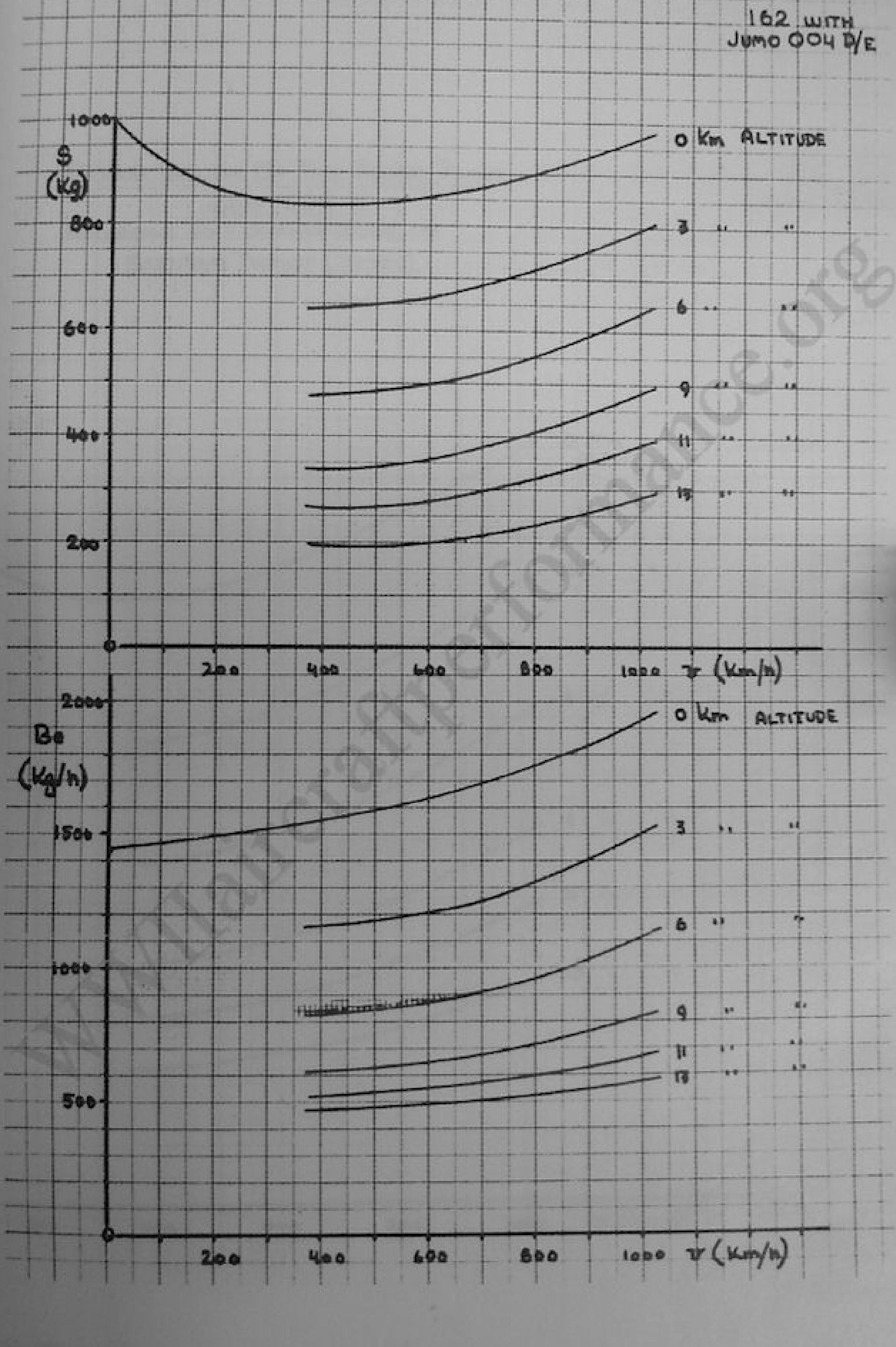
climb (medium gross weight 2.45 T)	at 0 km at 6 km at 11 km	m/s m/s m/s	19.2 9.9 1.6	26.5 16.0 5.8
take-off run without assisted take-off		m	850	740

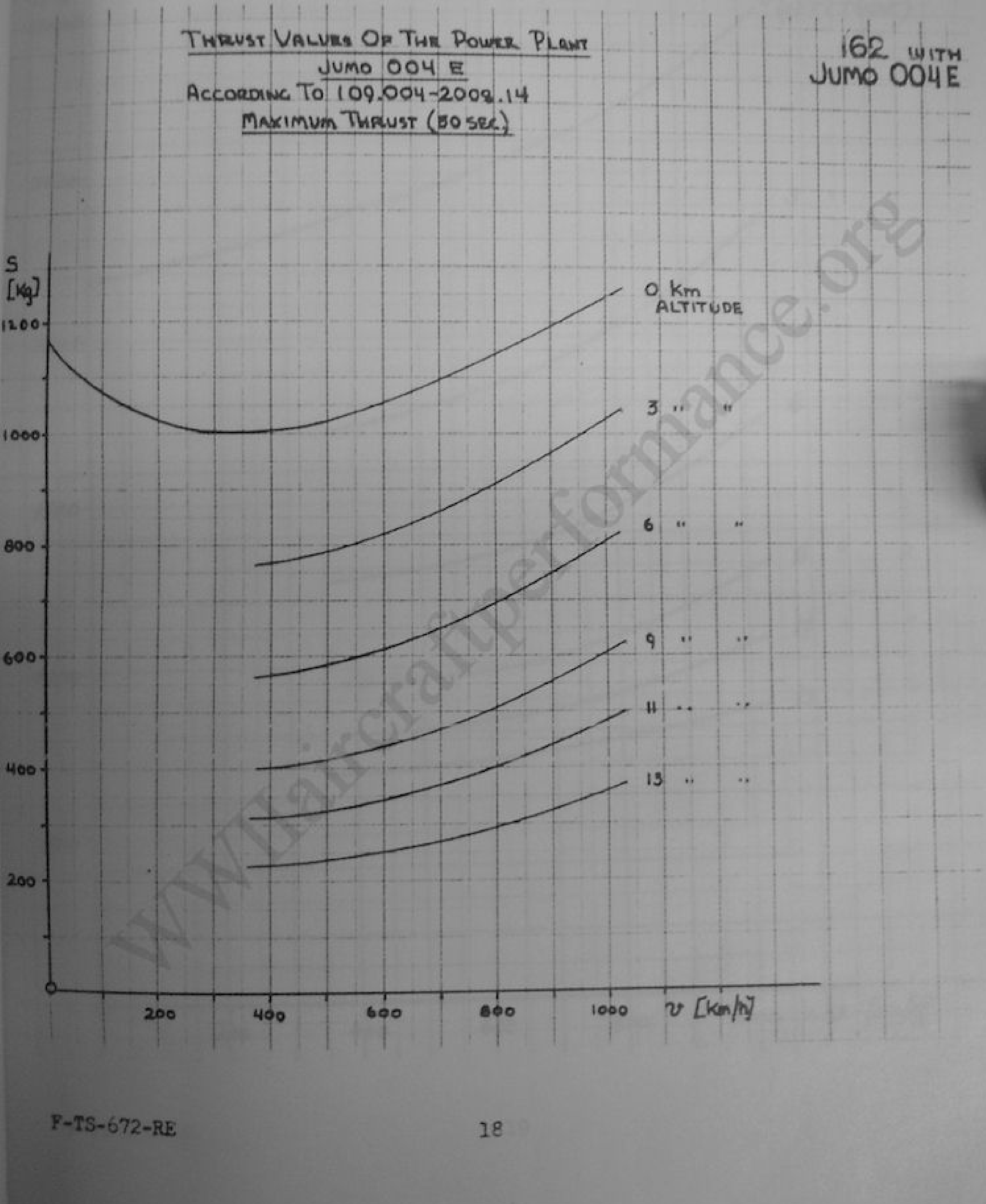
* - Assumption is made that during one flight the permissible maximum thrust for 30 seconds will be used 6 times.

** - Changes in thrust and consumption corresponding to data for Jumo 004 D/E, issued by the Junkers Aviation Corp., January 45.

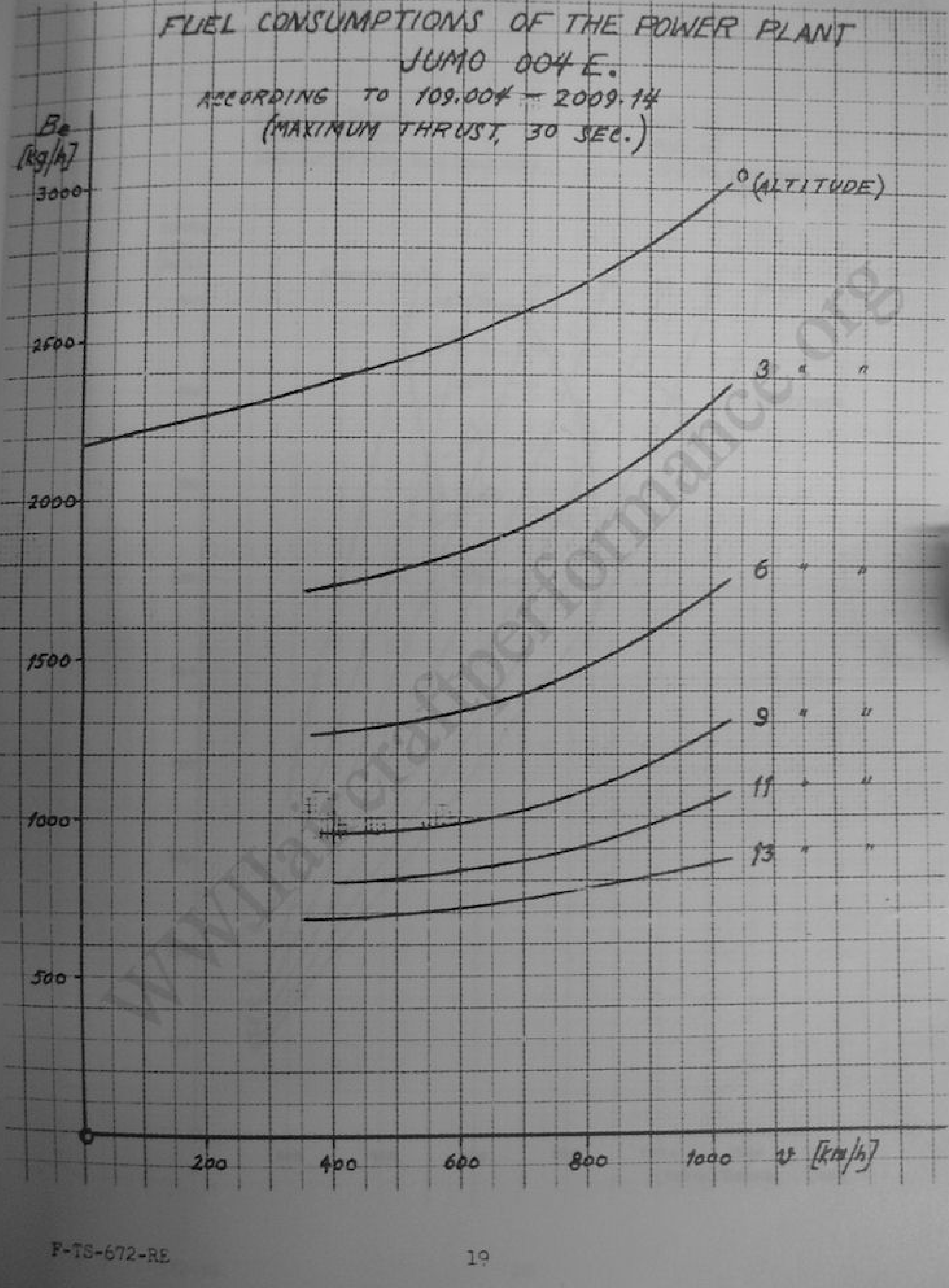
Vienna, March 15th 1945.

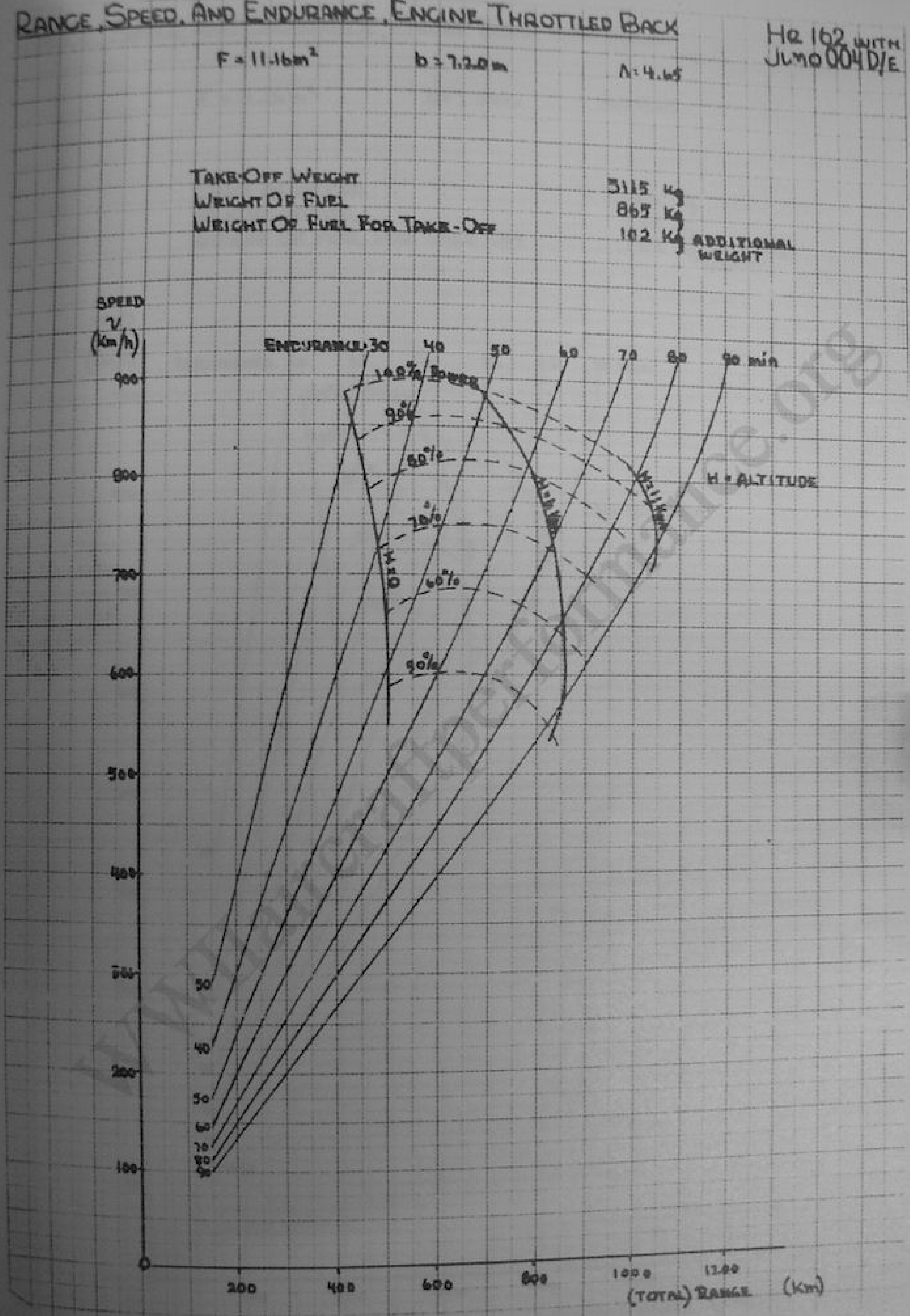
THRUSTS AND FUEL CONSUMPTION OF THE POWER PLANT
JUMO 004 D/E
ACCORDING TO 109.004-2006.14 AND 109.004-2007.14
JANUARY 1945





THRUST VALUES OF THE POWER PLANT
JUMO 004 E
ACCORDING TO 109.004-2008.14
MAXIMUM THRUST (30 SEC.)
162 WITH
JUMO 004E
S
[Kg]
1200
1000
800
600
400
200
0 Km
ALTITUDE
3 " "
6 " "
9 " "
11 " "
13 " "
200
400
600
800
1000
v [Km/h]


FUEL CONSUMPTIONS OF THE POWER PLANT
JUMO 004 E.
ACCORDING TO 109.004 – 2009.14
(MAXIMUM THRUST, 30 SEC.)
Be [kg/h]
3000
2500
2000
1500
1000
500
0 (ALTITUDE)
3 " "
6 " "
9 " "
11 " "
13 " "
200
400
600
800
1000
v [km/h]

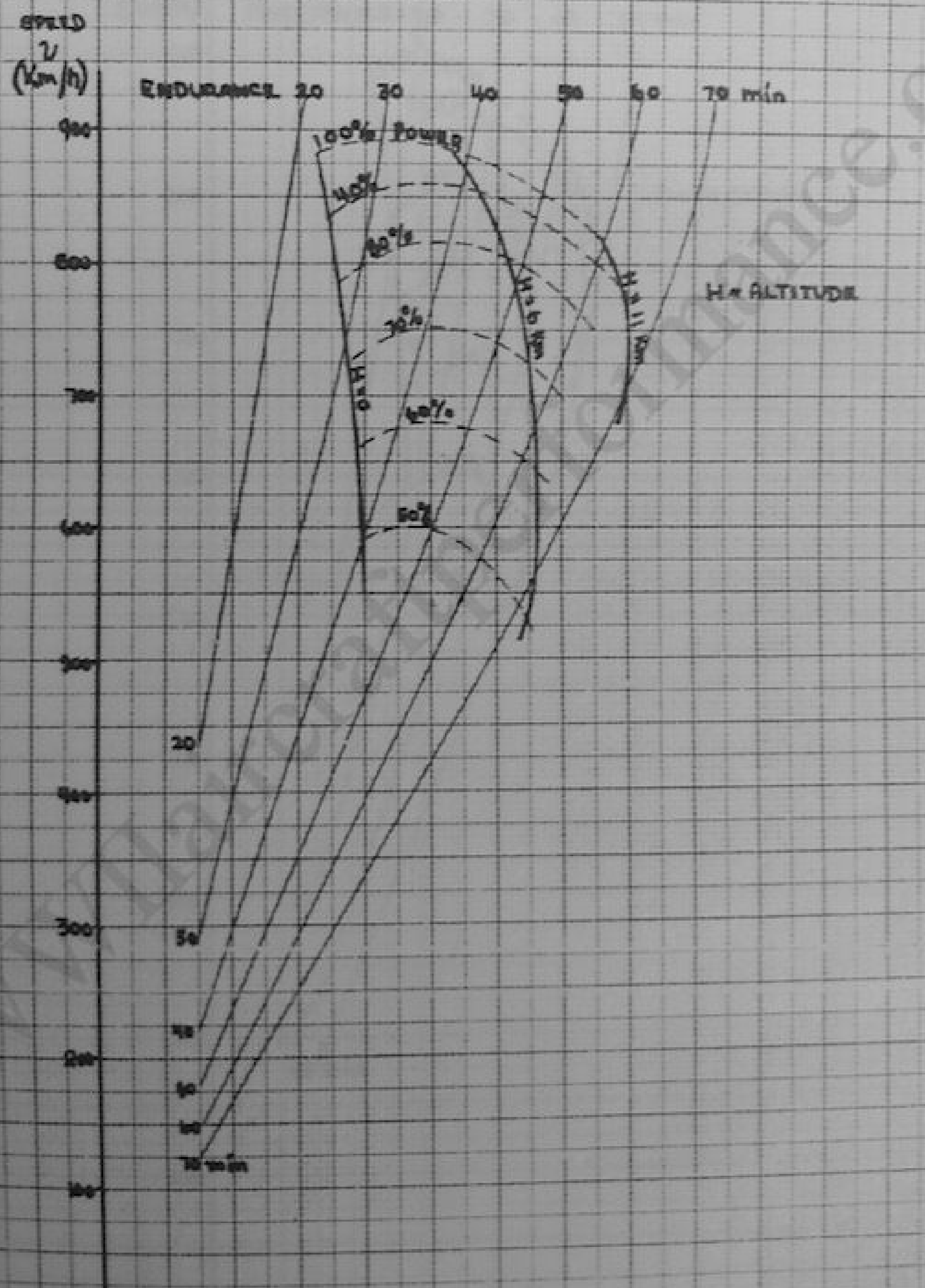

RANGE, SPEED, AND ENDURANCE, ENGINE THROTTLED BACK
He 162 WITH JUMO 004 D/E
F = 11.16m²
b = 7.20 m
Λ = 4.65
TAKE-OFF WEIGHT 3115 kg
WEIGHT OF FUEL 865 kg
WEIGHT OF FUEL FOR TAKE-OFF 102 kg ADDITIONAL WEIGHT
SPEED v (km/h)
ENDURANCE 30 40 50 60 70 80 90 min
100% POWER
90%
80%
70%
60%
50%
H = 0
H = 6 km
H = 11 km
H = ALTITUDE
900
800
700
600
500
400
300
200
100
0
200
400
600
800
1000
1200
(TOTAL) RANGE (km)

RANGE, SPEED, AND ENDURANCE, ENGINE THROTTLED BACK

He 162 WITH JUMO 004 D/E

F = 11.16 m² b = 7.20 m Λ = 4.65

TAKE OF WEIGHT 2925 Kg
WEIGHT OF FUEL 675 Kg
WEIGHT OF FUEL FOR TAKE-OFF 102 Kg ADDITIONAL WEIGHT

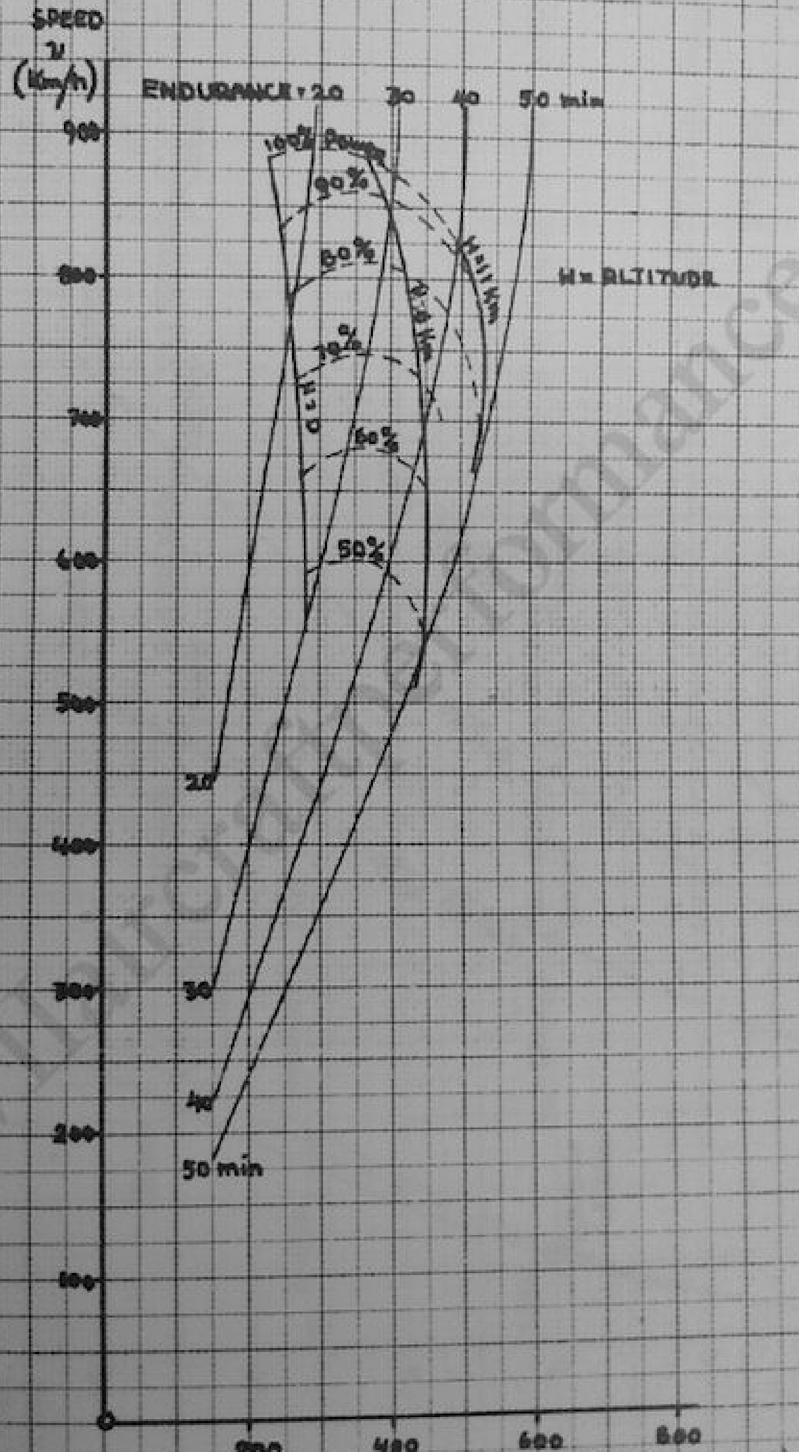


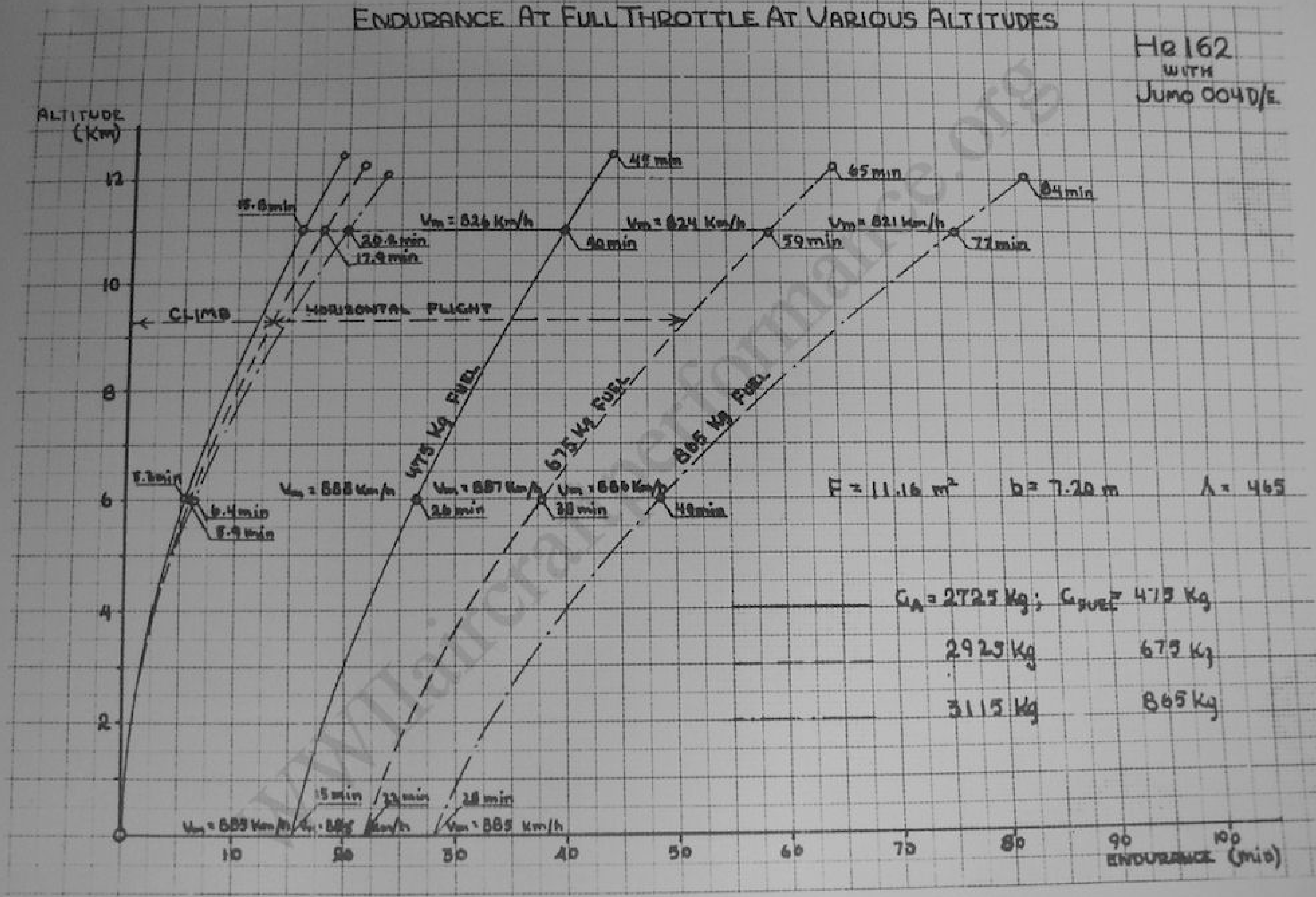
RANGE, SPEED, AND ENDURANCE, ENGINE THROTTLED BACK

He 162 with Jumo 004 D/E

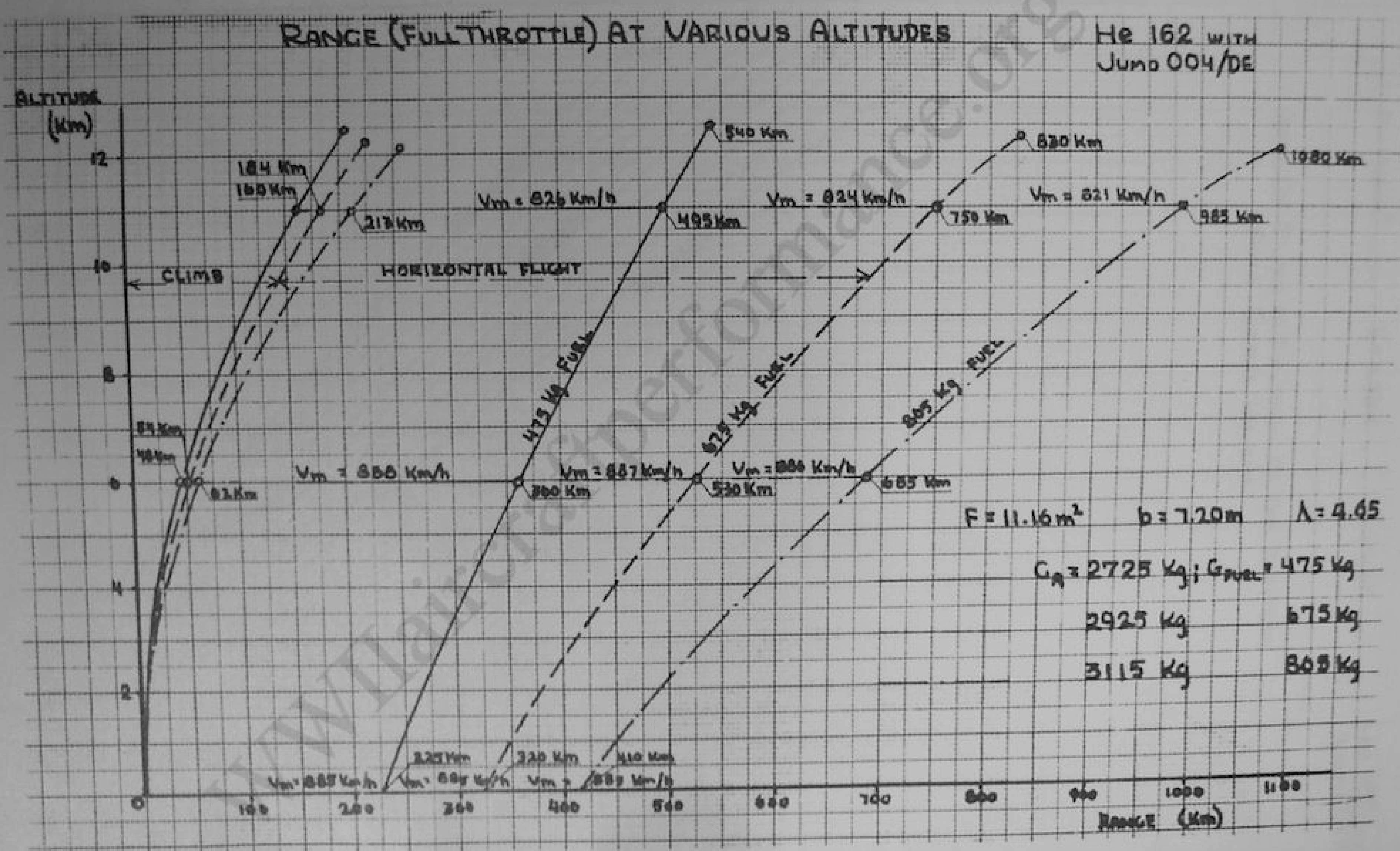
F = 11.16 m²   b = 7.20 m   λ = 4.65

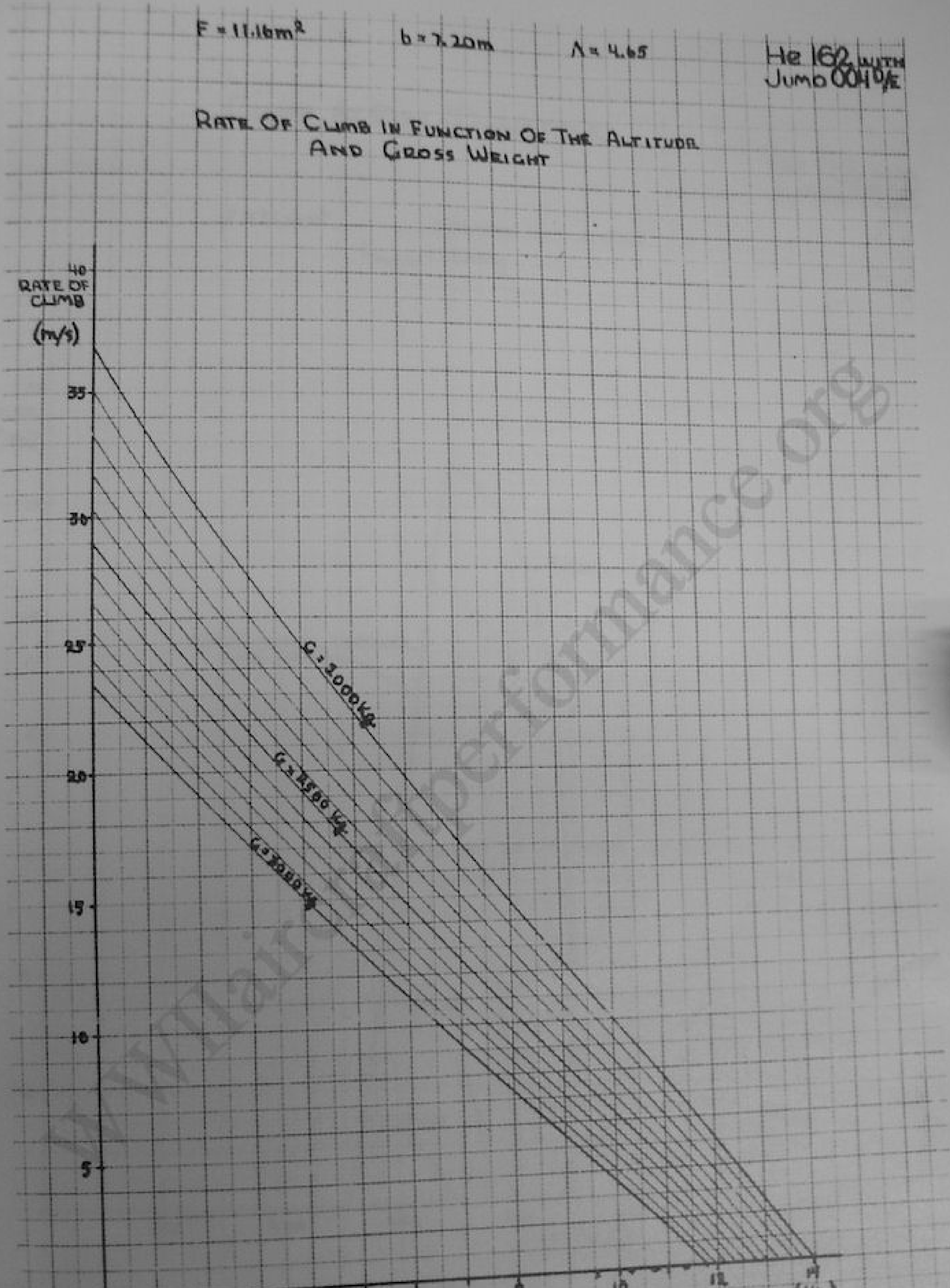
TAKE-OFF WEIGHT	2725 Kg
FUEL WEIGHT	475 Kg
FUEL WEIGHT FOR TAKE-OFF	102 Kg ADDITIONAL WEIGHT

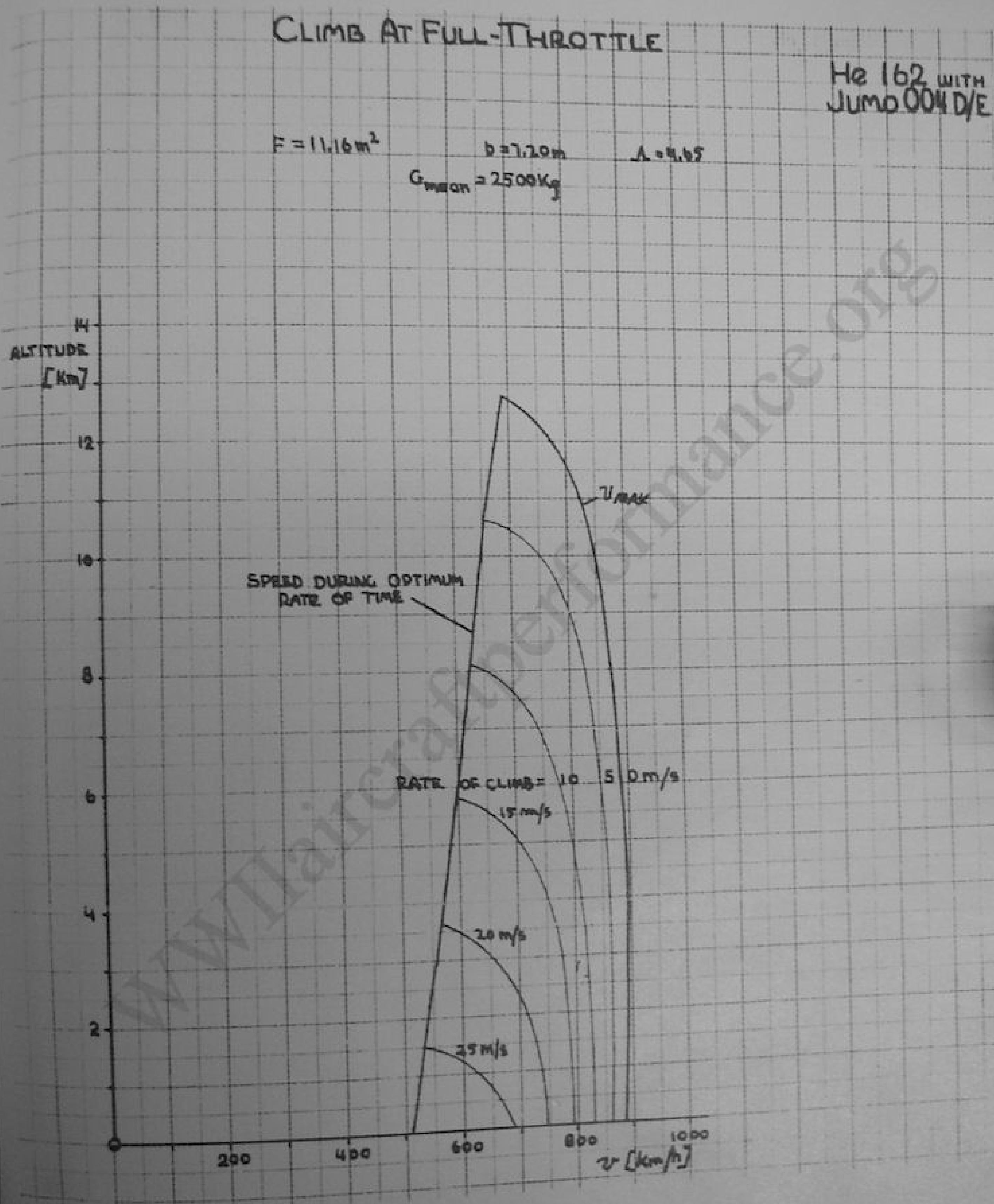



ENDURANCE AT FULL THROTTLE AT VARIOUS ALTITUDES
He 162
WITH
JUMO 004 D/E.
ALTITUDE (Km)
ENDURANCE (min)
CLIMB
HORIZONTAL FLIGHT
475 Kg FUEL
675 Kg FUEL
865 Kg FUEL
Vm = 826 Km/h
Vm = 824 Km/h
Vm = 821 Km/h
Vm = 888 Km/h
Vm = 887 Km/h
Vm = 886 Km/h
Vm = 885 Km/h
15.6 min
20.8 min
17.9 min
45 min
65 min
84 min
40 min
59 min
72 min
5.3 min
6.4 min
5.9 min
26 min
38 min
49 min
15 min
22 min
28 min
F = 11.16 m²
b = 7.20 m
λ = 4.65
GA = 2725 Kg; GFUEL = 475 Kg
2925 Kg
675 Kg
3115 Kg
865 Kg

F-TS-672-RE


RANGE (FULL THROTTLE) AT VARIOUS ALTITUDES
He 162 WITH
JUMO 004/DE
ALTITUDE
(Km)
12
10
8
6
4
2
0
184 Km
160 Km
213 Km
540 Km
830 Km
1080 Km
Vm = 826 Km/h
495 Km
Vm = 824 Km/h
750 Km
Vm = 821 Km/h
985 Km
CLIMB
HORIZONTAL FLIGHT
475 Kg FUEL
675 Kg FUEL
805 Kg FUEL
54 Km
48 Km
63 Km
Vm = 888 Km/h
380 Km
Vm = 887 Km/h
530 Km
Vm = 886 Km/h
685 Km
F = 11.16 m²
b = 7.20 m
Λ = 4.65
G = 2725 Kg; G FUEL = 475 Kg
2925 Kg 675 Kg
3115 Kg 805 Kg
225 Km
320 Km
410 Km
100
200
300
400
500
600
700
800
900
1000
1100
RANGE (Km)


F = 11.16m²
b = 7.20m
Λ = 4.65
He 162 with Jumo 004 B/E
Rate Of Climb In Function Of The Altitude And Gross Weight
Rate of climb (m/s)
G = 2000 Kg
G = 2500 Kg
G = 3000 Kg
Altitude (Km)
40
35
30
25
20
15
10
5
0
2
4
6
8
10
12
14



CLIMB AT FULL-THROTTLE
He 162 WITH JUMO 004 D/E
F = 11.16 m²
b = 7.20 m
Λ = 4.65
G_mean = 2500 Kg
ALTITUDE [Km]
14
12
10
8
6
4
2
V_MAX
SPEED DURING OPTIMUM RATE OF TIME
RATE OF CLIMB = 10 5 0 m/s
15 m/s
20 m/s
25 m/s
200
400
600
800
1000
v [km/h]