HISTORY AND EXPERIENCES OF HE-162

and

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

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HISTORY AND EXPERIENCES OF HE-162

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PERFORMANCES WITH JUMO-004
(Heinkel Report)

S. Günter and Hohbach

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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 = 0.96) 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_d was about 1.95. By fitting of a triangular outward rounded fillet (15 cm high by 55 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 \( \frac{\Delta V}{V} \) = 1.3 at an indicated speed of 500 km/h at 2500 m, corresponding to a duration of oscillation of \( \Delta V \) = 2.5 sec. and a decrement \( \frac{\Delta V}{V} \) = 0.37 times the value of \( \frac{\Delta V}{V} \) = 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 \( \frac{\Delta V}{V} \) being 1.3.

Flight Performances.

High speed tunnel (DVL) measurements on production type airplanes gave a \( C_D \) = 0.158 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 Landberg. 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 $12\frac{1}{4}$°. 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.
APPENDICE 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 cm²). 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 cm², 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 BMW (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 Cl reduction of about 0.1 to 0.2 according to wind-tunnel data, hence a final Cl max of 1.7. Cl mean will not decrease greatly when the possibility of landing with lift values nearer Cl max is taken into consideration due to improved stall characteristics. Hence, Cl mean is given as 1.5.

F-TS-672-RE
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 BWJ power plant type A0/05.)

(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 t3

(specific fuel consumption)

(calculated curve)

(measurements)

(t3 = constant = combustion chamber temperature)

(constant = nozzle position)
SPEED WAS 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.)
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 575 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.
**Fighter He-162**

Power plant with supplementary injection.

<table>
<thead>
<tr>
<th>Dimensions:</th>
<th>m²</th>
<th>m</th>
<th>11.16</th>
<th>7.20</th>
<th>4.65</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Power plant: one BMW type 004 D/E (performances from January, 1945)</th>
<th>Normal</th>
<th>maximum</th>
<th>thrust</th>
<th>thrust</th>
<th>30 sec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>thrust power</td>
<td>kg</td>
<td>1000</td>
<td>1150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>thrust at ( v = 800 ) km/h at height = 11 km</td>
<td>kg</td>
<td>315</td>
<td>395</td>
<td></td>
<td></td>
</tr>
<tr>
<td>specific consumption</td>
<td>kg/kg.h</td>
<td>1.39</td>
<td>2.34</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Weights:</th>
<th>kg</th>
<th>157</th>
</tr>
</thead>
<tbody>
<tr>
<td>armor</td>
<td>kg</td>
<td>59</td>
</tr>
<tr>
<td>crew</td>
<td>kg</td>
<td>57</td>
</tr>
<tr>
<td>equipment (without armament and armored parts)</td>
<td>kg</td>
<td>95</td>
</tr>
<tr>
<td>military load</td>
<td>kg</td>
<td>100</td>
</tr>
<tr>
<td>structure (61 kg trimming ballast)</td>
<td>kg</td>
<td>467</td>
</tr>
<tr>
<td>power plant with tanks and cowlings</td>
<td>kg</td>
<td>983</td>
</tr>
<tr>
<td>fuel (except starting fuel)</td>
<td>kg</td>
<td>800</td>
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<tr>
<td>gross weight</td>
<td>kg</td>
<td>575</td>
</tr>
<tr>
<td>fuel for warming-up and take-off run</td>
<td>kg</td>
<td>2325</td>
</tr>
<tr>
<td>starting fuel</td>
<td>kg</td>
<td>80</td>
</tr>
<tr>
<td>gross weight during take-off run</td>
<td>kg</td>
<td>22</td>
</tr>
<tr>
<td>fuel for warming-up and take-off run</td>
<td>kg</td>
<td>3027</td>
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<table>
<thead>
<tr>
<th>Performances (calculated):</th>
<th>at 0 km</th>
<th>km/h</th>
<th>885</th>
<th>960</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum speed (medium gross weight 2.4 T)</td>
<td>at 6 km</td>
<td>km/h</td>
<td>889</td>
<td>925</td>
</tr>
<tr>
<td>at 11 km</td>
<td>km/h</td>
<td>823</td>
<td>865</td>
<td></td>
</tr>
<tr>
<td>duration of flight (full throttle, calculated)</td>
<td>at 0 km</td>
<td>min</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>at 6 km</td>
<td>min</td>
<td>33</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>at 11 km</td>
<td>min</td>
<td>59</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>range (full throttle, calculated)</td>
<td>at 0 km</td>
<td>km</td>
<td>320</td>
<td>300</td>
</tr>
<tr>
<td>at 6 km</td>
<td>km</td>
<td>530</td>
<td>505</td>
<td></td>
</tr>
<tr>
<td>at 11 km</td>
<td>km</td>
<td>750</td>
<td>720</td>
<td></td>
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<tr>
<td>climb (medium gross weight 2.4 T)</td>
<td>at 0 km</td>
<td>m/s</td>
<td>30.3</td>
<td>42.7</td>
</tr>
<tr>
<td>at 6 km</td>
<td>m/s</td>
<td>15.7</td>
<td>25.3</td>
<td></td>
</tr>
<tr>
<td>at 11 km</td>
<td>m/s</td>
<td>4.9</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td>take-off run without assisted take-off</td>
<td>m</td>
<td>760</td>
<td>660</td>
<td></td>
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</tbody>
</table>

* - 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**

<table>
<thead>
<tr>
<th>Dimensions:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>wing area (without sweep-back)</td>
<td>m²</td>
</tr>
<tr>
<td>span</td>
<td>m</td>
</tr>
<tr>
<td>aspect ratio</td>
<td></td>
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<table>
<thead>
<tr>
<th>Power plant:</th>
<th>Normal thrust</th>
<th>maximum thrust 30 sec. +</th>
</tr>
</thead>
<tbody>
<tr>
<td>one BMW type 003 E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>thrust power kg</td>
<td>800</td>
<td>920</td>
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<tr>
<td>thrust at v = 800 km/h at height = 11 km kg</td>
<td>285</td>
<td>332</td>
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<tr>
<td>specific consumption kg/kg.h</td>
<td>1.51</td>
<td>1.96</td>
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<table>
<thead>
<tr>
<th>Weights:</th>
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<tbody>
<tr>
<td>armament (2 fixed forward-firing MK 108) kg</td>
<td>157</td>
</tr>
<tr>
<td>ammunition (50 shells for each gun) kg</td>
<td>58</td>
</tr>
<tr>
<td>armored parts kg</td>
<td>57</td>
</tr>
<tr>
<td>equipment (without armament and armored parts) kg</td>
<td>95</td>
</tr>
<tr>
<td>crew kg</td>
<td>100</td>
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<tr>
<td>military load kg</td>
<td>467</td>
</tr>
<tr>
<td>structure (61 kg trimming ballast) kg</td>
<td>933</td>
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<tr>
<td>power plant with tanks and cowling kg</td>
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<tr>
<td>fuel (except starting fuel) kg</td>
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<tr>
<td>gross weight kg</td>
<td>2905</td>
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<tr>
<td>fuel for warming-up and take-off run kg</td>
<td>80</td>
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<td>starting fuel kg</td>
<td>22</td>
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<tr>
<td>Gross weight during take-off run kg</td>
<td>2907</td>
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<table>
<thead>
<tr>
<th>Performances (calculated):</th>
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<tbody>
<tr>
<td>Maximum speed (medium gross weight 2.45 T)</td>
<td></td>
</tr>
<tr>
<td>at 0 km km/h</td>
<td>790</td>
</tr>
<tr>
<td>at 6 km km/h</td>
<td>838</td>
</tr>
<tr>
<td>at 11 km km/h</td>
<td>765</td>
</tr>
<tr>
<td>duration of flight (full throttle) (calculated)</td>
<td></td>
</tr>
<tr>
<td>at 0 km min</td>
<td>30</td>
</tr>
<tr>
<td>at 6 km min</td>
<td>48</td>
</tr>
<tr>
<td>at 11 km min</td>
<td>33</td>
</tr>
<tr>
<td>range (full throttle) (calculated)</td>
<td></td>
</tr>
<tr>
<td>at 0 km km</td>
<td>390</td>
</tr>
<tr>
<td>at 6 km km</td>
<td>620</td>
</tr>
<tr>
<td>at 11 km km</td>
<td>975</td>
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</tbody>
</table>

(continued on next page)
**Fighter He-162 A-1**

Power plant with supplementary injection.  (continued)

<table>
<thead>
<tr>
<th>Climb (medium gross weight 2.45 T)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>at 0 km m/s</td>
<td>19.2</td>
<td>26.5</td>
</tr>
<tr>
<td>at 6 km m/s</td>
<td>9.9</td>
<td>16.0</td>
</tr>
<tr>
<td>at 11 km m/s</td>
<td>1.6</td>
<td>5.8</td>
</tr>
</tbody>
</table>

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.
Thrust Values Of The Power Plant

Jumo 004 E

According To: 109.004-2009.14

Maximum Thrust (50 sec)

0 km altitude

S [N]

1200

1000

800

600

400

200

0

0  200  400  600  800  1000  u [km/h]

3

6

9

11

13
FUEL CONSUMPTIONS OF THE POWER PLANT
JUMO 004 E.
ACCORDING TO 109.00$ - 2009.14
(MAXIMUM THRUST, 30 SEC.)

(ALTITUDE)

P-78-672-RE. 19
Range, Speed, and Endurance, Engine Throttled Back

\[ F = 11.46 \text{m}^3 \quad \theta = 7.2 \text{rpm} \quad N = 4.16 \text{ps} \]

Take-Off Weight

- Weight of Fuel: 511.5 kg
- Weight of Fuel for Take-Off: 863 kg
- Additional Weight: 102 kg

Graph showing speed (\(\nu\), km/h) vs. range (km) for different endurance times and altitude (H).

- Endurance: 30, 40, 50, 60, 70, 90 min
- Speeds: 140 mph, 90 mph, 80 mph
- Altitude (H) ranges from 0 to 13,000 ft.
RANGE, SPEED, AND ENDURANCE, ENGINE THROTTLED BACK

$F = 11.18 \, \text{m}^2$  
$b = 7.20 \, \text{m}$  
$\Lambda = 4.49$

TAKE OFF WEIGHT  
WEIGHT OF FUEL  
WEIGHT OF FUEL FOR TAKE OFF  
ADDITIONAL WEIGHT

2925 Kg  
675 Kg  
102 Kg

<table>
<thead>
<tr>
<th>SPEED (km/h)</th>
<th>ENDURANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>60</td>
<td>70 min</td>
</tr>
</tbody>
</table>

TOTAL RANGE (km)
RANGE, SPEED, AND ENDURANCE, ENGINE THROTTLED BACK

\[ P = 11.18 \text{m}^3 \]
\[ b = 7.20 \text{m} \]
\[ \lambda = 4.45 \]

He 182 with Jumo 004 D/E

TAKE-OFF WEIGHT
FUEL WEIGHT
FUEL WEIGHT FOR TAKE-OFF

2725 Kg
478 Kg
102 Kg

ADDITIONAL WEIGHT

SPEED \( v \) (160 km/h)

ENDURANCE: 20 30 40 50 min

TOTAL RANGE (km)

P-762-RE 22
ENDURANCE AT FULL THROTTLE AT VARIOUS ALTITUDES

He 162
WITH
JUMBO 004/D/E.

\[ E = \frac{11.16}{m^2} \quad b = 7.78 \, m \quad \lambda = 465 \]

\[ g_a = 2725 \, Kg; \quad g_{sue} = 475 \, Kg \]

2.925 Kg
2.925 Kg
675 Kg
3.115 Kg
865 Kg
**Range (Full-throttle) at Various Altitudes**

**He 162 with Jumo 004/DE**

- **Altitude (km):**
  - 0 km
  - 2 km
  - 4 km
  - 6 km
  - 8 km
  - 10 km
  - 12 km

- **Horizontal Flight:**
  - 493 km
  - 620 km
  - 770 km
  - 885 km
  - 1020 km

- **Climb:**
  - 104 km
  - 165 km
  - 216 km

- **Symbols and Values:**
  - \( F = 11.16 \text{ m}^2 \)
  - \( b = 7.20 \text{ m} \)
  - \( \lambda = 4.85 \)

- **Weights:**
  - \( C_g = 2725 \text{ kg} \)
  - \( C_{\text{fuel}} = 1475 \text{ kg} \)
  - 2925 kg
  - 175 kg
  - 3115 kg
  - 805 kg
RATE OF CLIMB IN FUNCTION OF THE ALTITUDE AND GROSS WEIGHT

$F = 11.16 \text{ m}^2$  
$b = 3.20 \text{ m}$  
$\lambda = 4.65$  
He 162 with jump 004112
CLIMB AT FULL-THROTTLE

He 162 with
Jumo 004 D/E

\[ F = 11.6 \text{ m}^2 \]
\[ b = 7.2 \text{ m} \]
\[ \alpha = 9.45 \]
\[ C_{\text{mean}} = 2500 \text{ Kg} \]

Altitude [Km]

Speed during optimum rate of climb

Rate of climb: 10.5 m/s

25 m/s

20 m/s

15 m/s

\( V \) [Km/h]

\( h \) [Km]

200
400
600
800
1000