TECHNICAL REPORT ON THE TESTING AND MATCHING OF ASSEMBLIES OF ROCKETS ARISING FROM THE PROPOSAL FROM HERR LINDENBERG ON THE 28 AUGUST 1945.

Present:

Major	TARGETT, LR
Mr	WORTLEY
Lt	MEYER
Herr	LINDENBERG
Ing	ZANGL

Place of Meeting - British Technical Office, KRUPPS.

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1. Following discussions with Herr LINDENBERG and his suggestion outlined in copy of his letter of Aug 28, a meeting was held in order to clarify the position regarding the fundamental data relating to test eqpt and matching.

2. A preliminary survey of various assemblies and components was made in the workshops and stores. The purpose of this survey was to:-

(a) Allow ZANGL to get an appreciation of the condition of assemblies from the deterioration point of view.

(b) To endeavour to locate test sheets and data for individual assemblies.

3. The rockets on which work is proceeding have been damaged and exposed to adverse conditions. This necessitates the replacement of either components or assemblies which may be found defective on the elementary tests which are capable of being carried out at KRUPPS. This replacement raises the question of the characteristics of components and assemblies and whether the tolerances and specifications laid down are either fine or wide. Both LINDENBERG and ZANGL confirmed that the characteristics would vary considerably in some cases as much as + or - 10%, and therefore in order to match components accurately at KRUPPS special tables would be required, which may take any time from 2 to $2\frac{1}{2}$ years to compute. The following notes were taken in conference after examination outlined above.

4. LINDENBERG asked if ZANGL was in a position to give the matching values if one part of the rocket had to be removed and replaced by another, i.e. if the venturi was removed owing to damage and another venturi, of which the characteristics were unknown, was put in its place, whether ZANGL would be in a position to calculate the adjustments needed for matching purposes. The same would obviously apply to the turbine, pumps and steam unit. ZANGL answered that these values were obtained by means of tables and nomographs. These nomographs were composed from theoretical calculations and partly from practical deductions. From these nomographs a set of reference figures were evolved such that each individual piece of apparatus could be given a code number indicating its performance figures. This method of testing was also an indication that unskilled or semi-skilled inspection could be employed, and the tables were such that large tolerances in manufacture could be allowed. It is interesting to note that these individual values and tables are calculated from 25 variables.

5. ZANGL stated that each component was subjected to test and data sheets were made out giving the relative performance figures. These data sheets were placed in the assembly cases and should always have been with the particular unit concerned. An examination of the eqpt at KRUPPS had shown that few data sheets were available, mainly concerned with the steam units and the pumps. No data sheets have been found for the venturi and therefore owing to the lack of these figures, and what is more important the lack of the nomographs, no interchangeability values can be given for each separate assembly.

6. The practical conclusion was therefore as follows - that the firing of rockets from KRUPPS, from the manufacturing standpoint, must be dealt with under two headings:-

(a) The examination of complete but damaged rockets, requiring no interchangeing of combustion components.
(b) Rockets in which individual components must be interchanged.

7. The following notes were made on (a).

Complete rockets have obviously, before passing from works, had their assemblies and such assemblies matched; for instance the orifices needed to balance and match pumps and venturis and the setting of the reducing valve for these particular values would have been fitted. Therefore, if these rockets are stripped and subjected to pressure tests and they are found to require no further changing of components, the orifices installed could be replaced and the reducing valve set to the figures which are shown painted on the tail unit. It is most important that when these rockets are re-assembled and the orifice plates are replaced, the reducing valve must be set to the exact value stated.

8. The following notes were made on (b).

Small faults in the calibration of the components affect the trajectory of the rocket inasmuch as they alter the thrust and therefore the initial acceleration. In effect the rate of inclination during the initial trajectory may be influenced thus affecting height at point of cut-off for an equivalent duration of thrust.

9. Two other important factors arising from inaccurate matching are variation in fuel ratio and in steam unit pressure. The matching of orifices is made by initially installing one standard restricting throat in either the alcohol or oxygen pump delivery. Final matching is carried out by the insertion of a sharp edged orifice in whichever delivery pump is found to require reduction in pressure. The pre-determined value of this standard restricted throat was given by ZANGL as 125 mm. If the manufacture of the pumps were such that the performance could be kept within close limits, then standard throats could be pre-determined for both pumps.

10. Arising from notes on (b) above, it was agreed that in order to carry out Exercise BACKFIRE the inclusion of two standard restricting throats was thought to be the best arrangement in order to take the minimum amount of risk. It would also be proposed that in the case of (b) the reducing valve controlling pressure on the steam unit should be set at the average value of 32.5 atmospheres. It was disclosed that for each atmosphere dropped on the setting of the reducing valve the revolution of the turbine , and therefore pumps, is decreased by 100 per minute. The working revolutions of the turbine was stated to be approx 4,000 rpm. The theoretical revolutions required with matched units

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11. With regard to the cleaning of the venturi, ZANGL stated that wash through with water under pressure was the best method of clearing any foreign matter. The use of rust removing fluids is not advisable owing to the restrictions and corners which are inherent in the manufacture of this part. There was also the possibility of chemical reaction between the fluid and the fuels used.

12. LINDENBERG asked if by using the two standard restricting throats there would be a danger for the venturi to burn through. Basing his answer on experience, ZANGL stated that only trial would prove this point, and that there is a danger of burning through the venturi if this contains foreign matter, or if loosened foreign matter is passed through on to the jets, thus blocking them and upsetting the fuel ratio.

13. The attached Appendix gives some idea of the type of nomograph which the Germans evolved, and the general conclusion reached after this meeting was that no guarantee of matching and therefore fuel ratio can be given, that all components must be pressure tested, that as far as possible complete assemblies should be used since to introduce new components would upset the values, and that some method of flame pattern check may be necessary before actual firing is contemplated. It would therefore be noted that so far as Operation BACKFIRE is concerned, concentration will have to be made on the rockets that were recently chosen from CUXHAVEN railway yard, since from every outward appearance these are in a fair state of preservation.

30 Aug 45

(Sgd) LR TARGETT. Major

(Sgd) J. WORTLEY (C.T.A.)