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FORTRESS I.

Summary of development work undertaken to 24th July, 1941.

1. These aircraft carried out their first sortie in their full operational role on 24th July, 1941, and in view of the apparently long period it is taking to make them operationally fit for this duty, it seems desirable to summarise the work we have had to do to make them fit, so that Air Staff may fully understand the problems which have arisen.

2. At the meeting at Boscombe Down on 28th April, 1941, D.O.R. stated that the role of the aircraft would be high altitude bombing by day and indicated that its normal altitude would be 35,000 feet. This decision was, I think, based on the fact that the rear defence of the aircraft is very inadequate to our standards and the fact that, with its turbo superchargers, the aircraft is unique in having a ceiling approaching 38,000 feet.

3. We originally intended to take the aircraft just as it stood and fit the necessary radio equipment to meet ordinary Command radio organisation.

4. As soon as high altitude flights were made, however, three major problems appeared and these had to be cleared before any progress could be made.

(a) Provision of adequate oxygen.

(b) The extreme cold encountered.

(c) Internal frosting of windscreens.

5. OXYGEN.

(a) Regulators.

(i) We were informed by the American representative at the Conference on 28th April, 1941, that there was adequate oxygen for full aircraft endurance.

(ii) The aircraft as received were fitted with U.S.Regulators Type A.8. R.A.E. tests showed that these produced an entirely insufficient flow for any operational use at altitudes above 25,000 feet. As a result of the R.A.E. report and discussion with R.D.Inst. we decided on 29.5.41 to cut our losses and fit Mark X oxygen system without further delay. At a general discussion on American oxygen equipment held on 30.5.41 with R.D.Inst. and R.A.E. it transpired that the American A.6 Regulators on Liberator I aircraft would give adequate flow, and the decision to fit Mark X was, therefore, cancelled and decided to fit Type A.6 Regulators ex Liberator aircraft in lieu, a very simple job as the A.6 and A.8 are interchangeable. This we did, but on the first flight with A.6 Regulators, two froze up and the remainder showed very considerable variations in flow. Aircraft was flown to R.A.E. who confirmed these points.

(iii) As a result, we held a meeting on 5.6.41 at the Unit with U.S. representatives, the Air Ministry (D.O.R. and D.B. Ops.) and ourselves which decided that the Mark X system was the only real solution to the problem, with Mark VIIIA* regulators fitted to one aircraft as an interim measure for training purposes (giving an endurance of approximately four hours). The Mark X system would give sufficient oxygen endurance for operations and would bring in its train "charging in situ", the provision of wire wound bottles, and economisers.

(iv) The Mark VIIIA* Regulators fitted to the one aircraft failed, due to manufacturing defects not previously met. This point has been dealt with by R.D.Inst. and serviceable Mark VIIIA* were fitted to four aircraft as a temporary measure pending receipt of aircraft with completed Mark X installations.

(v) The Mark X system as first issued required modification to provide two different rates of flow simultaneously as detailed at paragraph 5c(v) below.

(b) Masks.

(i) The aircraft as received was fitted with B.L.B. Masks. These were reported by R.A.E. to be unsatisfactory, having insufficient rates of flow and having no provision for microphone. It was therefore decided to fit Type E Masks to the American system.

(ii) The report on freezing of the oxygen regulator A.6 indicated the danger of freezing of collected moisture in Type E Mask connecting type. As a result, R.A.E. designed and quickly produced a modified Type E Mask with oxygen inlet through the microphone aperture, to enable flying training to proceed.

(iii) The use of a microphone in the mask is an essential operational requirement and R.A.E. consequently redesigned their modified Type E Mask to provide freeze-proof oxygen inlet and at the same time to give space for either carbon or electro magnetic microphones. These masks had to be manufactured by R.A.E. and have now been delivered to the Unit.

(c) Economisers.

(i) Oxygen flow requirements at 35,000 feet are nearly double those at 25,000 feet and to obtain adequate endurance without providing an undue number of oxygen bottles, economisers became essential.

(ii) In consequence, Economisers were provided at all crew stations.

(iii) The danger of freezing brought to light by the freezing of the A.6 oxygen regulator at 5(a)(ii) above, also brought to light the fact that economisers by reason of the resulting stiffening of diaphragm fabric cannot be considered safe at temperatures below -50°. In consequence it became necessary to design heater muffs containing Everhot bags for economisers with a heater coil for the oxygen lead inside the muff. These were designed and have been manufactured by R.A.E., and are being issued to the Unit.

(iv) Just before the Mark X oxygen system was completed on the first aircraft, R.A.E. tests proved that the use of economisers at gun stations would not provide sufficient oxygen for manual effort (gun loading etc.) at a height of 35,000. It became necessary, therefore, to delete economisers at gun stations. This deletion in turn raised the query as to the necessity for retaining heater muffs at other crew stations where cabin heating was available but it was decided to retain these against failure of the cabin heating for any reason. (See paras. 6 and 7 below).

(v) The deletion of economisers at gun stations introduced the necessity for providing two different rates of flow in the Mark X system, one for economisers, one for direct feeds. This was achieved by introducing special jets in distribution manifolds for those stations with direct flow and this modification is now being carried out at the Unit by working party. Further, flow tests of the modified Mark X system showed that when the two beam gun oxygen leads were simultaneously in use, the oxygen flow to the wireless operator's economiser was considerably reduced and it therefore became necessary to delete one beam gun oxygen point. This

the oxygen endurance from 11 hours (with economisers at all stations) to 6½ hours at 35,000 feet and 10¾ at 25,000 feet in its final form.

(d) Oxygen Bottles.

(i) When fitting Mark X system, it was originally intended to fit British wire wound bottles and provide a clean, "grouped" installation with bottles stowed behind existing armour. However, the job proved too big and we were forced to retain the dispersed U.S. bottles and connect them in parallel by extensive high pressure pipes.

(ii) The U.S. bottles retained required to be wire wound. This was arranged by R.D.Inst. without difficulty, although the process necessarily interferes with the production of wire wound British bottles.

(iii) Before the bottles can be wound, it is necessary to remove the stop valve. These are apparently cemented in during initial assembly and it took two days to devise a scheme and to remove the valve from the first bottle. This was ultimately achieved by 8 men levering on an 8' wooden beam, the bottle being held in a vice and the bench being held down by 3 further men. British Oxygen Company and Projectiles Ltd. both refused responsibility for carrying out this work and this is being done by Burtonwood.

(iv) The necessarily clumsy method of removing the valves has resulted in damage to approximately 20 per cent bottles. Losses are made up from bottles ex Liberator I and it is necessary to obtain the Liberator bottles from Scottish Aviation and send them to Burtonwood to have the valves removed.

(v) Wire winding is being done by Projectiles Ltd., in a similar manner to British bottles. The bottles are then sent to British Oxygen Company for drying, re-assembly of valve and re-charging.

(vi) The use of wire wound bottles has necessitated alterations to existing bottle stowages to provide for their increased size.

(vii) American stowages do not conform to our requirement of 1,000 lb. load in each direction to prevent "rocketing" when punctured. Where possible we are doing this but the provision of strong mountings is limited and it will be impossible to meet this requirement in the majority of cases without strengthening the aircraft structure in the immediate locality of the mounting. We are modifying the weakest stowages first.

(e) Portable Oxygen.

(i) In view of early oxygen failures, provision of portable oxygen sets became imperative. These were issued by D. of E. but have had to be modified by R.A.E. to provide adequate flow for use at 35,000 feet and in consequence the endurance of each bottle has fallen to 6 minutes and it has been necessary to provide two bottles for each crew member. Three now

6. COLD.

(i) At high altitudes, external air temperatures of -60° and lower can be expected.

(ii) The pilot's cabin is well heated, but in the event of failure of heating or breakage of the canopy or the necessity to reduce temperature detailed under 7 (i) below, it was necessary to provide electrically heated clothing for the pilots compartment and for the navigator's compartment.

(iii) The design of gun station aperture covers is such that their removal and stowage in the air is a difficult and somewhat lengthy

process. In consequence, it is necessary on operations to fly with the aperture open all the time. Standard electrically heated clothing (boots, gloves and waistcoat) for gunners and wireless operator is, therefore, of vital importance and standard heated clothing had to be provided for. The "Taylor" suit also is undergoing trials with the unit.

(iv) The same problems arise with the camera, which is exposed to the outer air, and camera heating is essential and has been provided.

7. INTERNAL FROSTING.

(i) With the efficient cabin heating, moisture from the warm air condenses on inside surfaces of windscreens and panels, where it freezes solid by virtue of the very low outside air temperature. In the absence of any preventative, it is necessary to reduce cabin temperature to outside air temperature before the frost can be cleared. This is most desirable and we have tried to eliminate the necessity as detailed below.

(ii) Originally, a Glycol sponge was provided to prevent internal frosting. The degree of cold, however, is so great that the Glycol freezes and completely obscures visibility through the window, even after the moisture itself has thawed.

(iii) As a temporary palliative, we have provided "Gnomist" but this cannot be regarded as more than a very temporary, limited and unsatisfactory measure.

(iv) A dry air sandwich based on the Boeing Company's Laboratory experiments on this problem, details of which were provided by U.S. representatives, has been fitted to pilots and bomb aimers windscreens in aircraft now being issued to the Service. It is now evident, however, that the 'mechanics' of the design of this sandwich is unsatisfactory and must be put right. Failure of seals is the first trouble encountered. Action to this end is in hand with A.D/D.A.(N.A) but it is clear that we are some way from a satisfactory solution.

8. RADIO.

(i) As Radio equipment originally provided in the aircraft was to U.S. Army Air Corps requirements in respect of frequencies etc. and did not meet Bomber Command frequency requirements, after discussion with Command, Signals and D.C.D. it was decided to replace this throughout with standard British equipment, and this work was put in hand on the first aircraft.

(ii) Bomber Command, however, later revised their decision and agreed to accept certain frequency limitations and to retain U.S. equipment modified by R.A.E. to an approximation of the Commands' full requirements. These modifications were done at R.A.E. on the equipment from the first aircraft and now all aircraft are fitted with modified U.S. equipment. Where modification proved impossible we have been forced to retain certain British equipment as a temporary measure, pending receipt from U.S. of items covering these essential wave bands. These are on order and are expected by mid-September.

(iii) U.S. "Command" set which provides intercommunication and R/T is arranged for carbon microphones. These fail progressively from 25,000 feet upwards and British electro-magnetic microphones and amplifier A.1134 have been connected to the set in lieu. These have been tested and found to be a considerable improvement and are now being fitted to all aircraft.

9. It will be seen from the foregoing that the problem of meeting the apparently simple operational role of the aircraft has taken us right away from ordinary conditions and has plunged us into a process of concentrated research into the special problems of very high altitude flying in unpressurised exposed conditions (and involving abnormal muscular effort for the gunners). Each of these has had to be tackled as soon as encountered and a solution found and put into practice with the greatest urgency. To this end it has been

the Research Departments concerned and ourselves. This, in turn, has taken us right away from the normal channels of routine and has necessarily forced us, as the central co-ordinating department, to cut across the normal procedure of D.T.D. and D.P.C.A. and to usurp a degree of authority not officially our prerogative.

10. It is by no means certain that our problems are solved, and we must be prepared to meet a continued succession of troubles which in turn are most likely to cause interruptions to the operational functioning of the Unit. It seems reasonable, therefore, that the Unit should not be regarded as a normal operational unit, but as a High Altitude development unit with a special operational function.

(Sgd) W.H. G.Ewing. W/C.

R.D.Q.B.
28.7.41.