APPENDIX F

COLMORE REPORT ON R.101'S LIFT

NOVEMBER 1929

This document was prepared by Reginald Colmore at the request of Sir John Higgins, the Air Member for Supply and Research (AMSR). Colmore was the Acting Director of Airship Development and so in charge of the Royal Airship Works; Higgins was the highest-ranking civil servant in charge of airship development programs at the Air Ministry and reported directly to the Secretary of State for Air, Lord Thomson. Although the report was signed by Colmore, it was written most likely by Richmond with assistance from Rope.

This document was written after R.101's lift and trim trials in late September 1930. R.101's lift was so deficient that "it would be impossible to attempt to operate the ship on the Indian route even for demonstration flights with only this disposable lift available." The document contains two parts: a memo to Higgins outlining the problems with R.101's lift and possible modifications to increase it, and an appendix, labeled "1A," that details the proposed modifications.

The report to Higgins describes how the high atmospheric temperatures in Egypt and India would reduce R.101's already substandard lift to the point where the airship could not carry enough fuel to make the journey safely. The report mentions modifications to R.101 to gain six tons of lift: just enough to travel to India with ten passengers. It then outlines lengthening R.101 to gain nine tons of lift to enable the ship to operate the United

Kingdom–Egypt route throughout the year with what they carefully described as a "useful load" and to also operate a "number of months of the year" from Egypt to India. The report notes that, "it could not, of course, be carried out in time for the first flight as now proposed."

The appendix lists twenty items that could be modified or removed from the ship to gain lift. It reveals the desperation of the Works' team to lighten R.101's load: even a voice pipe that adds thirty pounds to the airship's weight is not too small to consider. The reader curious about how Colmore arrives at his "grand total" of 13,506 lbs for the weight saved should note that under item 11 Colmore chose to use the more conservative 150 lbs shaved instead of the possible 250 lbs.

This document was extracted from item NO. 35 "A M File Flight to India, 522039" in the supplement materials assembled for the Simon Inquiry. The Abbreviation "A M" indicates "Air Ministry." The document is at the National Archives, Kew, Reference AIR 5/904. I have inserted notes in brackets to help clarify any ambiguities.

In accordance with AMSR's instructions the following report on the lift of R.101 in submitted.

The lift and trim test was carried out in the NO. 1 shed at RAW at 6 p.m on September 30th, 1929. The purity of the gas at the time of the test was ninety-seven percent, but the air density was low and the gross lift under the conditions at the time of the test worked out at 146.8 tons. Had the air density been the normal standard, sea level figure, the gross lift would have been 151.6 tons with the same gas purity.

The actual weighed weight of the structure at the time of the test was 110.1 tons, and this figure must be regarded as reliable. The difference between this and the gross lift at the time of the test is 38.5 tons, whereas, the disposable weight actually on board only amounted to 35 tons. There is thus a discrepancy of 3.5 tons which can only be accounted for by the accumulation of dust

and dirt on the ship and by the limits of error of the experiment.

We have no further data at present to justify taking any credit for this discrepancy, and it is proposed to work on a disposable lift of thirty-eight tons under standard conditions, with a purity of ninety-seven percent, which it should be practicable to maintain.

It would be impossible to attempt to operate the ship on the Indian route even for demonstration flights with only this disposable lift available. At Karachi during the midsummer months the air density is such that there would be a loss of about seven percent of the gross lift of the airship, or say eleven tons, which would reduce the disposable lift to twenty-seven tons. Even if crew, ballast, etc. were reduced to a minimum, the ship could not leave the ground with more than say seven tons of fuel and even then it would be necessary to leave at the best time of the day.

A number of suggestions have been put before AMSR verbally for improving the lift of the ship, and a statement—1A—is attached for our proposals in detail.

In regard to cost. The labor involved for the modifications to the wiring will cost approximately £1,700, and the material will amount to approximately £200.

The removal of the reefing girders, involving a part renewal of the outer cover forward and aft, will cost approximately £350 labor and £650 material. These are the two largest individual items. It is not possible at the moment to give a firm estimate for the other work proposed, but the total labor and material cost of all the items shown on the attached statement should not exceed £6,000, excluding cost of gas for re-inflation and any work done by crew.

This money can be found without exceeding the total airship estimate for 1929.

You will note that if this work in approved, the disposable lift of the ship will be increased by about six tons, bringing the figure up to forty-four tons.

Considering now the lift which would be available for fuel for a demonstration flight on the Indian route, The disposable lift of forty-four tons might be divided as follows:

Crew & Effects	3½ tons
Moveable furniture not included in fixed weights	1 ton
Emergency ballast	8 tons
Ordinary ballast	2 tons
Spare parts and fittings to be carried in flight	½ ton
Allowance for flying height	5 tons
	20 tons

It is not proposed to carry parachutes for this flight.

This would leave twenty-four tons for fuel and freight.

It would appear sufficient if an allowance was made of one ton per ten passengers for such a flight (including food, luggage etc.). If this is accepted there would be available twenty-three tons for fuel under standard conditions, with ten passengers on board.

Cardington

It is considered it can be assumed that standard conditions or very little worse will be obtainable at Cardington for the commencement of the flight, and that the ship would get away with about twenty-three tons of fuel.

Egypt

The loss of lift owing to the generally lower air density in Egypt may amount to as much as seven-and-a-half tons during the summer months (May to October). Excluding May to October inclusive the loss of lift should not exceed three tons provided the best time of the day is chosen for leaving. Except during the summer months, therefore, the ship should be able to leave Egypt with about twenty tons of fuel.

Karachi

The loss of lift owing to the generally lower air density at Karachi may amount to as much as ten tons during May, June and July. From November to March inclusive the loss of lift should not exceed five to seven tons, and the ship, therefore, should be able to get away from Karachi with say seventeen tons of fuel during these months,

The improvements recommended might be completed by the middle of

February if work can commence on the ship in the course of the next ten days or so, but a certain amount of overtime will be necessary. Also, as I have recently reported, the calls on the Drawing Office staff in connection with the trials of R.101 have proved more than anticipated, and probably Drawing Office work will arise on R.100 after that ship's trials, if not before. If found necessary, therefore, it is hoped that immediate approval would be given to the engagement of additional Drawing Office staff.

If the improvements can be completed by the middle or February, the ship might be ready for the first demonstration flight to India by say the first or second week in March. It should be pointed out, however, that although an intensive effort will be necessary to keep such a date, it is thought we should endeavor to work to this program.

It is proposed to consider now the performance of R.101 on the Indian route with the lift available after the improvements have been completed.

England/Egypt section

Based on our present ideas of fuel consumption and speed, there should be a sufficient margin of fuel to fly the ship to Egypt throughout the year. Between Egypt and England, however, as pointed out above, the lift available for fuel is considerably less, and it is considered an intermediate landing will be necessary on a number of occasions between the months of April and October. Between November and March it should be possible to carry more fuel, but the margin appears small. If the first demonstration flight was carried out in March, it would probably be sufficient if emergency arrangements were made for a landing at Marseilles or Friedrichshafen, in connection with the return journey.

Ismailia/Karachi section

The fuel required on this section is far more difficult to estimate, but a further investigation to endeavour to ascertain more definitely a safe margin for a flight in March is now in hand.

It may be necessary to consider intermediate emergency facilities for refueling and gassing, but I will report further in the course of a few days when the above investigation has been completed, and when further information should be available on fuel consumption as a result of the present endurance flight.

The performance of R.101, even with the improvements proposed, is, unfortunately, still far from satisfactory, and the following possible improvements

in connection with the engine installation are therefore put forward.

Astern power

A suggestion has been made that the Meteor engine should be used in place or a Tornado for the astern power of the ship, which would effect a saving of approximately one-half ton. [The Meteor engine, like the Tornado, was built by Beardsmore. Rolls-Royce also offered an engine named Meteor, but this engine was not produced until the 1940s.] It is not clear yet whether the Meteor can be modified to prevent the water pump fouling the suspension struts of the power car. If this can be done the suggestion appears a practical one.

In considering this suggestion it should be mentioned that a saving of approximately one-and-a-half tons could be obtained if a [Rolls-Royce] Condor was fitted in place of a Tornado. The petrol for this engine could be limited to about three times the amount which is already carried in each power car for the Ricardo starting engines, and it could be arranged for the whole of this petrol also to be carried in the car. I do not know whether this would be considered as contrary cxhy120380.0o the decision in regard to the use of petrol engines in hot climates, but there is no technical objection, and we do not think there would be any more risk of fire than from the existing petrol tanks in the power cars.

If it is decided that petrol carried outside the hull of the ship is permissible as a temporary measure, then there is the still more attractive proposition of making use of two Maybach engines which we should like to examine.

Any of the above alterations in addition to saving weight have the merit of providing additional spare Tornados at an earlier date than those at present on order.

In relation to the future operation of the ship as distinct from the first demonstration flight, an important improvement could be obtained by inserting an additional bay in the structure. We do not see any design or operational objection to this.

It is considered that a net gain in lift of nine tons could be obtained by this means, the whole of which would be available for fuel or freight. This would enable the ship to operate on the England/Egypt section throughout the year carrying a useful load, which would also be possible during a number of months of the year on the Egypt/India section.

If it is decided to adopt this proposal, although it could not, of course, be carried out in time for the first flight as now proposed, it would appear desir-

able to incorporate the new section in the ship as soon as possible afterwards. The earliest date at which the material could be provided and the components got ready for the assembly of the ship, is considered to be June 1930, but to do this it will be necessary to provide additional staff almost immediately. If all components are ready beforehand, it would not be necessary to lay the ship up for more than eight weeks.

R. B. B. Colmore

RAW for DAD [Royal Airship Works for Director of Airship Development]

18.11.1929

Statement 1A

Refit of R.101

Modifications proposed

The following items of work to be carried out on the re-fit of R.101 are suggested principally with the object of reducing the fixed weights. In some cases, however, the experience gained in the operation of the ship up-to-date shows that the changes proposed would lead to greater simplicity and reliability of operation. The modifications to the gasbag wiring, Item 17, will necessitate deflating each bag of the ship in turn. In view of this and the fact that it may be found desirable to remove some or all of the power cars in turn from the ship, it is definitely recommended that on coming into the shed, the ship should be slung on cradles and completely deflated. This would also permit of a close inspection of the structure to see what have been the effects, if any, of the flying which the ship has so far carried out.

It is not considered that complete deflation need cause any additional delay if, as far as possible, work is completed in the various bays consecutively so that re-inflation does not have to wait necessary until all work is done.

Item 1 Removal of access to the top of Frame 5. The work on the look-out at Frame 5 has never been completed, and to do so would mean additional weight. The Flying Staff now consider that this position can be dispensed with. All ladders and platforms above the D longitudinal port side would be removed, and also the voice pipe.

Weight saving:

On ladders and platforms **170 lbs**

On voice pipe **84 lbs**

Item 2 The covers to the engine cylinders are at present somewhat heavy, being made in thick-cast aluminum and are not easy to remove; an operation which

must be carried out before every flight. AD/RDE has agreed to their abolition. A light sheet aluminum cover which could be easily removed will be substituted to keep rain from the engine.

Weight saving **145 lbs**

Item 3 The Triplex glass provided in the windows of the promenade has not been found to provide a very good outlook as the glass is not sufficiently uniform; on the other hand, the Cellon windows appear quite effective. It is proposed to substitute Cellon windows in the place of the glass.

Weight saving **417 lbs**

Item 4 Remove two WCs [water closets]. The present number is considered unnecessarily large, and it is proposed to remove two with their partitions, etc.

Weight saving **130 lbs**

Item 5 Reduction in amount of fuel stowage. It is now evident that the ship even when modified cannot have sufficient lift to take fuel in all the storage tanks which have been provided. The absolute maximum storage which can be contemplated as ever able to be carried is twenty-seven tons. Working to this figure, it is possible to remove tanks equivalent to the storage of eight-and-a-half tons of fuel.

Weight savings on tanks and slings **800 lbs**

Item 6 The lubricating oil for the engines is at present carried in somewhat awkward shape tanks in the bottom of the power cars. These tanks in the present gauge of material have given a certain amount of trouble. They also lead to a somewhat complicated piping system. It is proposed to substitute a single tank in each car which is practically cylindrical in shape placed on the deck at the side of the engine. The deck which will be built above these tanks gives the engineers better access to the engines and the existing deck. The oil piping system will also be simplified.

Weight saving **190 lbs**

Item 7 The present transfer system relies on the use of two compressors, a compressed air main throughout the ship and certain high pressure transfer tanks. It is thought that considerable amount of weight could be saved by substituting a system of electrically driven pumps. It is probable also that these would be easier to operate. Quotations for the necessary electric motors promise delivery in six to seven weeks. Difficulties have been experienced in obtaining a quotation for suitable pump, but it is thought that this might be made at RAW.

Weight saving **500 lbs**

Item 8: Piping Supports It is considered that the number of these may be slightly reduced, and also a lighter design of support may be employed.

Weight saving **50 lbs**

Item 9 The oil temperatures on the Tornado engines have been found to be quite low in flight at full power even when half the oil cooling surface at present provided has been out of action. It is considered that by a re-arrangement of the oil system, the amount of cooling surface and also of oil piping could be reduced which, together with the new oil tank referred to above, would provide a considerably simplified arrangement.

Weight saving **150 lbs**

Item 10: Modification to steam radiators The operation of the engine cooling system as at present designed, has not proved very suitable. The radiators are mounted a considerable way above the engine, but the original reason for this no longer holds. The design of a radiator itself has given trouble partly owing to the manner in which it is mounted and also due to the arrangement of [the] relief valve. It is proposed to move the radiators down to positions immediately above the engine oars and to sling them in a different manner. The drain from the radiators would run direct to the separators in the power cars and not through the reserve water tank.

Considering first the radiators at Frames 4 and 11, although the weight saving would not be great, the reliability would be very materially increased.

Weight saving **80 lbs**

Considering next the radiator at Frame 8 which is used for passenger car heating, certain modifications are discussed below under the heading of "ventilation." It is strongly recommended, however, that, at any rate for the flight to India, any question of passenger car heating should be abolished. At present, it necessitates the radiator being below the level of the engines and in consequence, the condensed water being pumped back. The engines in question are both thrown out of action if there is any failure in the pumping system, and to a certain extent this has proved a source of unreliability so far. The radiator and pump are difficult to get at as at present mounted, although a certain amount could be done to simplify this in the alteration to the ventilating system referred to below. If the heating is abolished, however, it is proposed to substitute triangular radiators over the power cars in question exactly similar to the radiators employed in the other cars.

Weight saving **200 lbs**

Item 11: Ventilating system The present system of combined ventilating and heating for the passenger quarters entails the use of an electric fan, and a considerable amount of power to drive it. It is thought that the same degree of ventilation could be attained by the use of air scoops. If the heating is retained (vide the above paragraph) and therefore no weight saving is claimed under that heading, the weight saving on the new system would be 250 lbs. If the above saving is claimed, however, the weight saving may be taken as 150 lbs.
Item 12 So far there has been no opportunity to test the controls of the ship in rough weather, although it is hoped to gain further experience on this point before the ship goes into the shed. The indications so far in ordinary weather show the steering without the operation of the servo gear to be remarkably easy and it is hoped therefore that it will be possible to decide to remove the servo gear.

Weight saving **400 lbs**

Item 13: Reefing Girders It is now considered that the cover from the bow to Frame 1 and between Frames 13 and 15 is adequately supported without the use of reefing boom girders and that they could therefore be removed.

Weight saving **1,280 lbs**

This would entail making new covers for the portions of the hull referred to.
Item 14 It is now considered unnecessary to have engine room telegraphs in the control room as well as in the control car. It is proposed therefore to remove the former.

Weight saving **30 lbs**

Item 15 It is proposed to incorporate the voice pipe leading forward to the bow in the passengers handrail along the corridor.

Weight saving **30 lbs**

Item 16: Simplifications to fuel system The use of pumps for trimming fuel instead of air compressors will lead to considerable simplifications in the arrangement of the fuel system and a reduction in the number of cocks and valves involved. The operation of the system in flight will be greatly simplified thereby. It is not possible to forecast, however, at present what the actual weight saving will be.
Item 17 When the present gasbag wiring system was designed, it was considered a matter of [a] certain amount of speculation as to whether the bag would take up precisely the shape predicted. It was therefore thought desirable to so design the wiring system as to leave ample clearance between the wires and the girders of the hull. It has now been found that the shape taken up agrees extremely

closely with the predicted and it is therefore possible to reduce the clearances referred to. This will mean lengthening a certain number of the wires but not all. No new fittings will be required.

Additional lift **6,720 lbs**

Item 18 The platforms on the D longitudinal for access to the valves, as at present constructed, are unnecessarily heavy, and it is proposed to replace them with a new type, a sample of which has already been made.

Weight saving **150 lbs**

Item 19 For early demonstration flights until it has been possible to estimate more closely the margin of fuel required, it is considered justifiable to remove some of the passenger sleeping cabins from the upper deck in Bay 6–7. As these are in self-contained units, this could be done without damage to the passenger accommodation or the decorations etc. If twelve cabins are removed, fourteen double-berth cabins will be left, providing sleeping accommodation for twenty-eight persons. It would be proposed to remove the wooden decking as well as the cabins and to partition off the blank space thus left.

Weight saving **1,200 lbs**

Item 20 It is considered that some economies might be effected in the electrical system. If the servo gear and the ventilating fan are removed as suggested above, no power will be required in the ship except for the electric pumps, which it is proposed to install in place of the compressed air trimming system. The pumps will require a relatively small amount of power and could be connected to the generator which at present serves for cooking. This would enable the power generator to be removed from the ship with all its switches, cable, connectors etc. It is also proposed to remove from the galley the vegetable steamer and hot cupboard, as it is considered that for the number of persons carried on the early long demonstration flights, all the necessary cooking could be carried out on the range.

It is also proposed to remove the tank for hot water in the toilet room. Supplies of hot water could be obtained in lieu from the galley.

Weight saving **630** lbs

The grand total of the weight savings referred to above = **13,506 lbs**

In addition to the above items, there is a certain amount of work found necessary as the result of the flying trials to date. It is not proposed to enumerate all the items, many of them being comparatively small. Amongst the more important may be mentioned:

- Improvements to the rate of discharge of the ordinary water ballast.
- Improvements to the base hose feeding of bags to allow more rapid filling.
- Improvement to the sealing of the outer cover to prevent the leakage of rain and padding of certain girders where there is a tendency to chafe the gasbags when the ship rolls at the Mooring Tower.
- The above improvements may mean a small amount of additional weight which cannot be estimated at present, but which is very unlikely to exceed 500 lbs.

The net gain therefore is approximately six tons.

RAW

Cardington

18th November 1929