

A.M.S.R.  
(thru N.9).

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Future Airship Development.

In putting forward the views of the Airship Staff on the future development of Airships, we consider it advisable to state that the opinions expressed may have to be reconsidered when information obtained as the result of the technical investigations as to the cause of the accident to R.101 is available.

To obtain a true appreciation of the present position, it is necessary to briefly review:-

- (1) The scope of the 1924-1929 Airship Programme.
- (2) The results actually achieved with a consideration as how far these fall below the original aims, and the reasons for these shortcomings.

Airship Programme 1924 - 1929.

The purpose of the programme was to make a real advance in Airship development and thoroughly test the capacity of modern rigid Airships as a standard means of long-distance transport.

In general the programme consisted of a period of research and investigation, in preparation for two practical operations.

I The construction of two Airships of such improved speed range and loading capacity as would enable them to make long voyages overseas with a substantial margin of lifting power.

II The carrying out of successful flights to and from an Overseas Terminal in order to demonstrate that Airships were suitable for the work for which they were designed.

Results Achieved.

The results achieved are set out in the following table:-

	<u>R.101</u> <u>Anticipated</u> <u>1924-27.</u>	<u>R.101</u> <u>Actual</u> <u>1929.</u>	<u>R.101</u> <u>New Bay</u> <u>1930.</u>	<u>R.101</u> <u>New Bay</u> <u>with</u> <u>Improved</u> <u>Engines.</u>
Gross Lift (Tons)	153.5	148.6	167.2	167.2
Structural Weight	95.3	109.9	113.7	110.2
Disposable Lift	58.2	38.7	53.5	57.0
Full Speed, m.p.h.	82.0	68.0	74.0	80.0
Cruising Speed ( reckoned at 80% full speed).	65.6	54.4	59.2	64.0

\* Geared Tornado Engines, 5 at 700 H.P. = 3,500

	<u>R.100.</u> <u>Antici-</u> <u>ipated</u> <u>1924-</u> <u>1927.</u>	<u>R.100.</u> <u>Actual</u> <u>1929.</u>	<u>R.100.</u> <u>New Bay Estimated.</u>
Gross Lift (Tons)	153	156	172
Structural Weight	90	103	109
Disposable Lift	63	53	63
Full Speed, m.p.h.	85	81	78
Cruising Speed (Reckoned at 80% full speed).	68	64	62

Technical developments of the same order can therefore be reasonably contemplated in a new design during the next four years.

### Constructional.

The main constructional features developed in R.100 and R.101 are:-

1. Improved shape - aerodynamically more efficient than previous Airships.
2. Unbraced stiff transverse frame. (R.101).  
Tubular boom type girder (R.100).
3. Improved form of gasbag wiring.
4. New type of gas valve, permitting a rate of rise of 4,000 feet per minute. (R.101).
5. The development of the Compression Ignition Engine.
6. The application of steam cooling for the first time in an Aircraft Engine.
7. The production of stainless steel girders, suitable for the main hull structure.
8. Fabric suitable for weathering in the tropics.

A large amount of experimental fabric research including the production of a skin substitute is also available for future construction.

### Operational.

The further development of the high tower system of mooring. It should be noted that on all occasions R.100 and R.101 have landed to the Mooring Tower with the aid of 20 men, and not to a ground party of 500 men.

- R.101 has been moored out in winds of up to 83 miles per hour, including a wind shift 135° in one minute with a wind of 35 miles per hour.
- R.101 has landed in winds of 28 miles per hour.
- R.101 has carried out 11 flights, a total of 127 flying hours.

- R.100 has been moored out in winds up to 50 miles per hour.
- R.100 has landed at the Mooring Tower in winds of 25 miles per hour.
- R.100 has carried out 10 flights, a total of 296 flying hours, including the Canadian flight:
  - outward 78 hours.
  - homeward 57 hours.
- R.100 achieved a speed of 81 miles per hour, the highest speed so far recorded by any Airship.

As the Graf Zeppelin has been in commission during the period, it might be permissible evidence of the suitability of the Airship for long-distance flights, to quote her record:

(Total Flights ..... 124  
 (Total Flying Hours ..... 2177  
 See (Total distance covered ..... 132,654 m.  
 Encl. (World Flight from 7.8.29 to 4.9.29.  
 (Total flying time, 353 hours. Distance  
 ( covered, 24,989 miles.

Causes for difference in Design

Performance than that actually attained.

The hull structure weights of R.100 and R.101 are both in excess of the original estimate.

The weight of Passenger Accommodation - approximately 12 tons in either ship, was more than anticipated, owing to provision being made for too many passengers on an elaborate scale.

The increased weight of the engine units. In the case of R.101, the weight per horse-power being  $8\frac{1}{2}$  lbs. against the original design figure of  $4\frac{1}{2}$  lbs.

Although the results obtained were below those anticipated it must be remembered that the largest ship previously constructed was 2,475,000 cubic feet capacity (75 tons) whereas both R.100 and R.101 are over 5,000,000 cubic feet capacity (150 tons).

A certain amount of criticism has also been made in regard to the delay in the completion of the programme, but it should be observed that although the work was sanctioned in the middle of 1924, staffs had to be collected, and the start on the design and ground organization was not made until early 1925.

In this connection it is interesting to note that the design of the D.O.X. flying boat was commenced in 1924, but its trials were not undertaken until after the launch of R.101 in 1929. Radical developments in the Airship and the large flying boat have therefore more or less coincided from the point of view of time.

Such technical progress in Lighter-than-Aircraft design as the result of the construction of two Airships would appear to compare favourably with similar progress in Heavier-than-Aircraft and justify further efforts to achieve the aims outlined in 1924.

In formulating the following proposals it is assumed that, apart from any technical consideration, the financial stringency will indicate that the most economical proposals consistent with real development will only receive consideration. The question of new construction is therefore only noted for further consideration, if desired.

The following modifications which have already received tentative approval prior to the accident to R.101, are considered necessary, and should be carried out before a further flying programme is approved.

1931.  
R.100. The addition of one new section.  
New outer cover.  
New set of gasbags.  
Repair of old gasbags as spares, if considered practical after thorough examination.  
Restress hull structure and strengthen for mechanical handling, if found necessary.  
New Electrical system.  
New fuel and water tanks and bags.  
Modification of gasbag wiring nets.  
Modification to Passenger Accommodation.

1932.  
R.100. To install one complete Diesel Engine unit in place of a Rolls-Royce Engine, for thorough air test under actual flying conditions. The unit to complete 400 hours flying before any long Overseas flight is attempted.

It should be mentioned that, as there appears to be some doubt as to the suitability of the R.101 type of outer cover for R.100, the relative merits of the two designs should again be investigated before a final decision is taken as to the system to be adopted.

The object of these proposals can be summarised as follow:

#### Constructional.

1. To improve the performance of R.100.
2. The further development of the Compression Ignition Engine. Geared and reversible Tornado, Dieselised Condor, and other engines suitable for Airship purposes that are in the development stage. Test Bench trials of 400 hours with air tests of similar duration before any proposals are considered to re-engine R.100 with complete Diesel machinery installation.

#### Operational.

##### 1931.

1. To develop mechanical handling of Airships. (The Americans have already carried out satisfactory trials).

Operational.

1931.

2. To continue to develop the technique of landing Airships to a Mooring Tower.

Landings up to the present have only been made in winds up to 28-30 miles per hour, but no reason is seen why landing should not be made in winds of 35-40 miles per hour, as soon as reliable power units are available which will give an adequate reserve of astern thrust.

Flying.

During 1931 it is proposed that flights should be confined to the vicinity of the British Isles, with a view to obtaining:

1. Training of Airship Crews. - It is considered that sufficient time should be allowed in the first series of flights to allow the officers and crew to become perfectly acquainted with the general handling of the ship before special tests and trials are carried out.
2. Speed trials.
3. Measurement of drag by deceleration of the Airship.
4. Measurement of turning circle, controllability and stability of Airship.
5. Full scale pressure plotting experiments.
6. Measurements of strains and stresses in structure members by special electrically recording strain gauges.
7. Gas valve tests (including automatic release of gas at pressure height).
8. Tests of the pressure control system and the ventilation of the interior of the hull as a whole.

1932.

It is reasonably certain that in spite of the loss of R.101, the Canadian Government will expect one or two flights to be carried out to Montreal in the year 1932 with a view to further investigating the Atlantic route - more especially as the new American ship N.R.4. (6½ million cubic feet) is due for completion by May of 1931, and after trials is almost sure to attempt the Atlantic passage. The experience gained during 1931 should have thoroughly tried out R.100 and enabled the officers and crew to become thoroughly acquainted with handling and manoeuvring. Overseas flights could then be started with a reasonable certainty of success.

Experience is also required in flying over the desert, and it is therefore desirable that a certain number of flights should be carried out to Egypt, the ship to be based on Ismailia for, say, a fortnight at a time, and local flights of 24-48 hours being made. Until this experience has been obtained it is not proposed that an extended flight to India should be carried out.

## Meteorological Investigations.

The investigation work that has been in progress during the last 4 years is considered to be of vital importance in connection with the flying of long range aircraft - not only Airships but the large flying boat and the large aeroplane as well on the Empire air routes.

The conditions experienced by R.100 in the St. Lawrence Valley on the Canadian flight indicate how little is known of the magnitude of these vertical currents. The extent of the danger to large aircraft it is felt has not been fully appreciated and it is therefore highly desirable that the scope of this research work should be extended by co-operation with other Dominion and Colonial Meteorological Services.

## Practical Research.

1. Investigations into the design of improved type of girders and other component parts of the new design (R.102).
2. Further tests of gasbag outer cover fabrics with full scale exposure tests in India. This has already been carried out on sample test pieces in conjunction with the Indian Government.
3. Investigations into points arising out of the Inquiry as to the loss of R.101.
4. Development of the Compression Ignition Engine and machinery units in general.

## New Design.

A considerable amount of very general work has been carried out on the new design, R.102, and if any continuity of development is to be aimed at, it is important that this should proceed. If, however, as the result of the investigations on R.101, a decision is given in regard to the use of helium, the general dimensions will have to be increased to counteract the loss of lift amounting to about 12% of the total gross lift.

From inquiries made, it appears that Foreign Airship development is likely to continue, and it appears very important, therefore, that new design work should proceed without interruption, as the American ship Z.R.4. (6½ million cubic feet of helium) is due for completion in May next, and the new German ship L.Z.128 will be ready for tests in the Spring of 1932.

Dr. Eckener has definitely stated that they intend to proceed with their programme of development.

## Helium Policy.

Although it is fully appreciated that any future Airship development policy may be dependent on the use of helium as the lifting medium, the reduction in disposable lift (approximately one-third) is a very serious disadvantage, amounting as it does to a large proportion of the fuel reserve in R.100.

The flying personnel are of the opinion that, on an overseas route like the Atlantic, where very severe weather prevails at times, ~~that~~ a large reserve of fuel is more likely to provide adequate safety than the use of helium. It should, however, be stated that the provision of emergency Mooring Towers say in Ireland, Bermuda, the Azores or Newfoundland, would overcome this objection.

It is well known that the U.S.A. Naval technical staff have felt that the ban on the use of hydrogen in America was a very severe handicap when comparing the performance of their Airships with those constructed in this country and Germany.

#### Conclusions.

It is considered that the actual results obtained during the last five years justify full consideration of a further Airship development programme, as the Airship at present appears to be the only type of Aircraft sufficiently developed to fill the role of long distance transport carriers on the main overseas air routes of the Empire. If a decision to stop all development is taken it seems highly probably that, in view of the progress made in other countries a fresh start may have to be made in three or four years' time with all the consequent delays and further development necessary before we should be in a position to make up the lost ground in the development which would then probably have been achieved by both Germany and America.

In this connection Dr. Eckener's remarks quoted in 'The Times' 13/10/30 are of considerable interest:

"The British contribution to the development of Airships had been extremely valuable, especially in the matter of construction, and in the perfection of new means of handling Airships at the Mooring Masts and on the ground. The latter was an English invention and Airship travel could not be developed without it".

Dr. Eckener is in close collaboration with the Goodyear Zeppelin Corporation in connection with his plans for developing Airship lines to the American Continent. Mr. Hunsaker, a Vice-President of the Goodyear Zeppelin Corporation, is at present in this country and will shortly be proceeding to Germany to meet Dr. Eckener to formulate their proposals.

A. D(O).  
for D.A.D.

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