

INTRODUCTION

The electric element of the heavy lift challenge has further evolved to present fresh challenges to teams competing in the 2011 competition.

This year's task can be considered as a humanitarian aid mission to ferry water supplies to drought stricken areas of the world.

The target is to transport as much water as possible around a prescribed flight course and deliver to the prescribed location within the allocated time.

Having designed a suitable airframe for this challenging task teams are required to submit drawings for their aircraft and conduct a presentation to a panel of judges that addresses the salient points of the design as well as outlining the thought processes and considerations involved.

For the flying element of the competition, teamwork, planning and a well-structured approach combined with a well designed and practical airframe will be key elements to success in this competition.

Please note that it is strongly recommended that the help of an experienced aero modeller is enlisted from the very start.

Local contacts are available from the BMFA office.

We look forward to receiving your team's entry for the 2011 Electric Lift Challenge.

FOREWORD

My career in aviation spans some 49 years, beginning with a 5 year apprenticeship at the Royal Aircraft Establishment, Farnborough and leading on to 37 years in the Royal Air Force until the present. In all that time I have found numerous instances amongst my contemporaries that lead me to conclude that a good grounding in aviation begins with a sound understanding of the principles of flight. And the best way to achieve that understanding is through the fascination of designing, building and flying model aircraft.

I can think of many famous names amongst the pioneers of aviation who began with a love of model aircraft but none more so than the man who was arguably the greatest innovator of modern aviation, Frank Whittle. It was Frank Whittle who invented the turbo jet engine without which aviation and air travel today would be a very different business. As a young man Whittle was forever experimenting with models, an interest that surely had something to do with his own quest to find ways of fundamentally overcoming the limitations of propeller driven power plants. His life and work as an aeronautical engineer of great distinction is reason enough to inspire anyone to at least take a leaf out of his book and learn from model aviation

Everyone needs a challenge. The Heavy Lift Challenges pose both intellectual and practical challenges. By any stretch of the imagination, designing a unique aircraft to meet the stringent specifications is a challenge to the intellect, to understand the aerodynamic principles, and to optimize the various performance characteristics to give the best result. And it is certainly a practical challenge to construct the aircraft with sufficient strength and reliability to perform the contest flights in any weather.

As a life long aeromodeller I can think of no better practical challenge than the two BMFA Heavy Lift Challenges to inspire understanding and innovation in the science of aeronautics.

Air Chief Marshal Sir Michael Alcock, GCB, KBE, DSc, FREng, FiMechE, FRAeS

**President,
British Model Flying Association**

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E.1 OBJECTIVES

Contestants are to research, design, build and prove an electric powered, radio controlled aircraft, to transport the greatest quantity of water around a predetermined triangular course in a prescribed 10 minute time slot utilising a standardised propulsion unit. The competing aircraft are permitted to make as many flights as possible during this set period. Competitors must arrive at a strategy that best utilises the characteristics of their design within the time available (i.e. the two extremes would be a very fast and agile aircraft that carries only a small quantity of liquid but may complete several cycles or a larger slow aircraft that will carry a large payload but may only complete one or two cycles). Teams are required to compile a technical report outlining their aircraft's design and construction together with design drawings. Teams are then required to give a verbal presentation in front of a panel of judges on their aircraft and finally take part in a flight competition to demonstrate the performance of their aircraft. The winners are the team who achieve the highest aggregate score for all the parts of the competition.

E.2 CONTEST ELIGIBILITY

The contest is open to all Further Education, University and 6th Form College students (applications outside of these criteria will be viewed on an individual basis). The pilot of the aircraft need not be a member of the group which has entered the competition as designers and builders, but must be a member of the BMFA and hold at least a 'B' Fixed Wing Power Achievement Scheme Certificate. The maximum number in a team will be five students plus a manager and a pilot. For the flying part of the contest a pilot can be supplied by the contest organisation.

E.3 AIRCRAFT CONFIGURATION

E3.1 Only fixed wing designs will be permitted to enter the competition. The maximum total wingspan is to be 1500mm.

E3.2 Propulsion unit is to consist of one E-flight Power 10 motor and one E-flight 40A speed controller (available at cost direct from the BMFA office). The battery must be a 3 cell Lithium Polymer with a capacity not to exceed 2500 mAH, the pack must have the manufacturers label with the capacity shown. A separate battery may be used to power the aircraft's radio receiver. No modification to the motor is permitted.

E3.3 Only one flight battery may be used per flying round.

E3.4 A propeller spinner or rounded safety nut must be fitted on forward facing motors.

E.4 RADIO RESTRICTIONS

4.1 Radio control will be used to fly and manoeuvre the aircraft. No electronic or gyroscopic stabilisation assistance of any kind is allowed. All radio equipment may be scrutinised by the organisers and must be deemed fit for the intended application. Contestants must satisfy themselves that servos and linkages are capable of handling the anticipated air loads. All on-board radio equipment must be protected from the elements since the flight competition may take place in adverse weather conditions.

4.2 Where a separate battery is utilised to power the radio control system a five-hundred (500) mAH pack is the minimum required size for the competition.

4.3 Computer transmitters are permitted, however any extra functions, mixing or advanced programming must be explained and demonstrated during the presentation to the judges.

4.4 Equipment on the 2.4GHz band only.

4.5 All radio equipment must be UK compliant.

E.5 COMPETITION PROCEDURES

5.1 There will be two elements to the competition in which all participants are required to compete. The first, the design competition, will enable the contestants to present their designs and demonstrate their calculations to a panel of expert judges.

5.2 The second, the flight competition, will determine which aircraft is able to transfer the greatest quantity of water from the “in tank” to the “out tank” via the prescribed course in the fixed time period. We will supply water for the task on the day.

Please note; each team must display a sign with team name of at least A3 size in the pits area.

E.6 DESIGN COMPETITION

DRAWINGS: Each team must submit detailed drawings for the aircraft which is to be flown. The drawings must contain fully dimensioned front, side, and top views. These must all be drawn to scale and with the scale shown. Drawing files must be of sufficient resolution to permit all detail to be clearly noted. Materials and sizes are to be indicated. Detail drawings, which are deemed necessary to explain structure of the aircraft are also to be included. Each drawing sheet will include the name of the team in the Title box. For the 2011 competition teams should submit the drawing set by Email in PDF format only.

The judges will evaluate the drawings based on a professional standard format. Areas of evaluation will include.

- Detail
- Completeness
- Explanation of structures
- Readability
- Graphical standards

A maximum of three sheets of drawings is required. The drawings will be worth 25 points.

REPORT: It is intended that that the written report will be less academically rigorous when compared to the Heavy Lift Challenge. Each team must submit a report which outlines the design philosophy of the aircraft, team roles and responsibilities, choice of configuration, payload distribution, manufacturing techniques and any practical testing undertaken. No prediction of the total payload to be transported is required. Any original or innovative ideas should be described, together with the use of unique or advanced structural techniques and materials. The report is worth 25 points and should comprise no more than six double-spaced, typewritten pages of A4 paper, including any appendices and diagrams. Minimum type size to be 12 point. Where an institution enters more than one team, the designs, reports and drawings are to be produced by each team independently. Each page of the report will include the name of the team in the footer or header. If a report exceeds six pages, only the first six pages will be marked. As per the drawings, the report should be submitted in PDF format.

Drawings and reports are to be submitted by Email to both judges at least 30 days prior to the start of the flight competition. Late submissions will be penalised and competitors are advised that, in these circumstances, the judges' comments may be less carefully considered. The organisers are not responsible for lost/misdirected drawings/reports, please ensure that you request an acknowledgement Email when you submit your team's information and do not assume that your Email has arrived if you do not receive this.

Although normal course tuition and guidance is expected, the reports, drawings and the building of the aircraft are to be treated as though they are examination submissions and are to be the sole work of the students.

PRESENTATION: Prior to the first competition flight, each team will present their aircraft design before a panel of professional engineers. Order of presentation will be decided by drawing lots. Each team will be allocated seven minutes in which to describe their design.

Other than the project report and the aircraft (including transmitter if appropriate), no visual aids will be available or allowed. The aircraft must be available for the presentation.

Two points will be deducted for each ten-second-time period or part thereof over the seven minutes allowed for the presentation. The presentation is worth 50 points. Judging criteria for the presentation will include:

- Balance and continuity
- Articulation
- Technical highlights

Experience has show that teams do not make the best use of the opportunity to gain addition points that the presentation offers, remember, your teams presentation should aim for a professional standard and “sell” the benefits of your particular design to the maximum.

Subsequent to each team’s presentation, aircraft details will be recorded, this will include a physical check that the total wingspan does not exceed 1500mm. A safety and airworthiness inspection will also be conducted at this time to enable teams to address any item requiring attention before flight.

Correct Failsafe operation must also be demonstrated at this time if appropriate.

NOTE: This competition is as much a test of your organisational skills as of your engineering flair. You may well have a world-beating design....on paper. Each year several teams fail to complete their projects by the date of the Flight Competition.

E.7 THE FLIGHT COMPETITION

E7.1 Each aircraft must transfer the maximum amount of water from an “out tank” to an “in tank” following the prescribed course during the allocated time slot.

E.7.2 Any number of flights may be made during the allocated time slot.

E.7.3 The aircraft must take off from a standing start (no pushing) utilising it’s own undercarriage.

E.7.4 The payload may be carried on or in the airframe in whatever manner is deemed appropriate, removable module(s) are permitted (see note 1); however there must be no duplication in order to permit loading before the aircraft lands. It should be borne in mind that the payload will need to be transferred to the scoring receptacle in the shortest possible time in order to maximise the overall scoring opportunity.

E7.5 At the start of the prescribed time the model should be without load, on being given the start signal the team must load the aircraft from the “out tank” with an appropriate quantity of water. The model must then be carried to the take off line and set down facing predominantly into wind. Take off must be completed within 61 metres to avoid penalty deductions. The model must proceed to pylon number one whereupon a flag will be raised immediately the model has passed the pylon. The aircraft will then proceed to pylon two where the same process will apply. The aircraft is then flown on a path that most

effectively lines up for a landing in the prescribed area. Should a successful take-off not be made, teams may retrieve the model for further attempts

E7.6 Touch down must be completed within 61 metres of the take off line with the landing roll not to exceed a further 61 metres. The aircraft must touch down and remain on the far side of a marked 10 metre line and the motor must be fully stopped as soon as all landing wheels are deemed to be firmly on the ground (no taxiing). Only when the aircraft has come to a complete standstill (see note 2) may a team member then retrieve the aircraft and return it to the loading bay where the water must be transferred to the “in tank”. Further flights within the time slot will commence immediately with loading from the “out tank” followed by a repeat of the previously outlined process.

E7.7 At the end of the time slot the “in tank” will be closed and the contents checked and recorded by the CD.

E7.8 No transfer of payload will take place after the end of the time slot has been reached.

E7.9 No transfer of payload may take place outside of the designated area.

E7.10 Removable parts of the airframe are permitted provided no duplicate components are used (no pre loading permitted).

E7.11 The original design of the aircraft as presented in the Design Competition may not be altered during the course of the competition and must finish the slot with the original parts. The only exception being the propeller and undercarriage components.

E7.12 The aim is for each team to fly two, ten minute slots, however, a final decision will be announced at the morning briefing to reflect the time available, the number of teams competing and the expected weather conditions.

E7.13 The distances indicated on the flight plan sheet are for guidance purposes only, these will be set and announced at the morning briefing to reflect the prevailing wind conditions and location on the airfield.

E7.14 Time for trimming flights will not be available on the day of the competition. Entrants should test fly their aircraft with a full load prior to the weekend of the competition.

E7.15 Any protest must be filed in writing to the Contest Director by the faculty advisor or team captain. Any protest must be filed no more than 10 minutes after the Flight Competition is announced as being completed. In order to have a protest considered a team must be willing to put up 20 points, which may be forfeit, if their protest is rejected. The Contest Director may call upon a jury of interested parties to help with his decision. This decision is final.

NOTES

- 1) It is important that the payload is distributed and “damped” (no pun intended) in such a manner that it cannot significantly alter the centre of gravity of the airframe in flight.
- 2) Note this rule will be strictly enforced in the interests of safety and fairness, teams should note that there are no limits on the number of functions utilised therefore a “braking system” (for example) could be considered as a compliant addition to the airframe.

E7.16 SCORING

Overall score = Drawings + Report score (max. 50)
+ Presentation score (max. 50) - Penalties + Flight score

Penalty points are assessed as follows:

- **2 points deducted for each day or part day late in delivery of plans or reports**
- **2 points deducted for each ten second time period or part thereof by which the presentation overruns the allotted 7 minutes**
- **5 points deducted for a take off overrunning the designated 61metres**

THE FLIGHT SCORE WILL BE NORMALISED, 100 POINTS WILL BE AWARDED TO THE TEAM WHO TRANSPORT THE LARGEST QUANTITY OF WATER OVER THE TWO FLIGHT ROUNDS AND ALL OTHER SCORES WILL BE CALCULATED AS A PERCENTAGE OF THIS FIGURE (THIS HAS BEEN IMPLEMENTED IN ORDER TO MAINTAIN A VALID BALANCE BETWEEN THE POINTS AVAILABLE FOR THE DRAWINGS, PRESENTATIONS AND FLIGHT SCORE).

THE FINAL FLIGHT SCORE WILL BE THE ACCUMULATED TOTAL OF THE TWO FLIGHT SLOTS WHERE TWO SLOTS ARE POSSIBLE.

E.8 GENERAL CONDUCT AND SAFETY

E.8.1 NOTE: THE WORD OF THE CONTEST DIRECTOR IS FINAL IN ALL MATTERS.

E.8.2 It is important that all team members including the pilot attend the morning briefing; this will consist of safety information as well as other information pertinent to the day’s activities. The time for this briefing will be announced on the Saturday after presentations to the judges have taken place.

E.8.3 In the event of unsportsmanlike conduct, the team will receive a warning from the Contest Director. A second violation will result in expulsion of the team from the competition.

E.8.4 Safety rules, as defined in the BMFA Handbook will be used during the flight competition. They will be explained to all team members prior to the flight competition.

E.8.5 Deliberate violation of safety rules will result in the team's expulsion from the competition.

E.8.6 The CAA document CAP 658 requires that model aircraft with a dry weight in excess of seven kilograms, be fitted with a device which brings the throttle to idle in the event that radio contact is lost (a failsafe device). If you expect the dry weight of your model including its cargo, to exceed seven kilograms, you should fit an on-board failsafe (note: in the case of electric powered aircraft this should be motor stopped)

E.8.7 Also CAP 658 requires that any model fitted with radio control equipment that has a failsafe capability must at the least have the throttle set to idle on loss of signal. Equipment with this facility must not be left in the "hold last position" setting which is often the default setting supplied when purchased new (note: in the case of electric powered aircraft this should be motor stopped).

E.8.8 The Competition Director reserves the right to ground any aircraft if in his opinion, or that of his appointee, the aircraft does not meet a safe standard of construction or radio installation.

RADIO CONTROL SYSTEMS AND MOTOR SAFETY

It is most important, for safety reasons, that your power train and radio are installed correctly and the competition director reserves the right to ground any model if it is considered that the installation does not meet a satisfactory standard. It is strongly advised that a modeller with experience in radio control model flying should make periodic checks on models during construction and advise on airworthiness matters.

E.9. OPERATIONAL SAFETY MATTERS

The equipment used in this competition is potentially dangerous. Great care should be taken when operating electric powered aircraft the motor must be treated as "live" at all times that a battery is connected. the characteristics of out-runner type motors provide very high torque and the ability to draw large amounts of current in order to keep turning even when obstructed (by fingers for example).

Lithium polymer batteries should be charged and used directly in accordance with the manufactures instructions.

Ensure that the correct charger and settings are used at all times, do not charge packs in the airframe. Should your teams aircraft be involved in an impact resulting in suspected damage to the battery pack this must be reported to the flight-line director immediately.

Take great care to ensure that no direct short of the battery pack occurs, packs exhibiting unusual symptoms such as swelling should be removed to a safe area and reported to the event organisers.

The pilot of the aircraft should satisfy himself before flight that all systems are functioning correctly and that all controls have full and free movement as well as operating in the correct sense.

The extent of the flying area will be announced during the morning briefing, any pilot flying within the briefed “no fly” area’s will be directed to land immediately.

Safety is of paramount importance and pilots must be prepared to “ditch” their aircraft on the order of the flight-line director should he deem it necessary on safety grounds.

E.10. USEFUL BIBLIOGRAPHY

Aerodynamics and Performance

- **Model Aircraft Aerodynamics** **Martin Simons**
- **Theory of Wing Sections** **I.G.Abbott and A.E. Doenhoff**
- **Airplane Aerodynamics** **D.O.Domasch, S.S.Sherby and T.F.Connolly**
- **Aerodynamics for Engineering Students and N.E.Carruthers** **E.L.Houghton**

The above references are recommended for general purposes.

Up-to-date information on aerofoils, which are particularly suited to this competition, is available from the research work of Selig, Wortmann, Hollinger and Eppler. See the online database:

<http://www.ae.uiuc.edu/m-selig/ads.html>

Some initial guidance specific to model may also be given by online resources as follows:

<http://www.rrcc.org/downloads.htm>

<http://www.b2streamlines.com/plotters.html>

<http://www.winfoil.com>

http://www.aa.nps.navy.mil/~jones/online_tools/panel2/

E10 Bibliography cont'd.....

Information specific to designing and building model aircraft may be found in the following publications

Model Aeroplane Building: Sketch by Sketch (Paperback)

by [Peter Holland](#) (Author)

- **Publisher:** Special Interest Model Books; 2Rev Ed edition (31 Dec 1998)
- **ISBN-10:** 1854861484
- **ISBN-13:** 978-1854861481

Designing Model Aircraft (Paperback)

by [Peter Miller](#) (Author)

- **Publisher:** Traplet Publications (Aug 1995)
- **Language** English
- **ISBN-10:** 0951058967
- **ISBN-13:** 978-0951058961

Radio Controlled Sports Aircraft from Scratch (Remote Control Handbook) (Paperback)

by [Alex Weiss](#) (Author)

- **Publisher:** Special Interest Model Books (31 Dec 1998)
- **ISBN-10:** 1854861409
- **ISBN-13:** 978-1854861405

Building and Flying Radio Controlled Model Aircraft (Radio Control Handbooks) (Paperback)

by [David Boddington](#) (Author)

- **Publisher:** Special Interest Model Books; 3Rev Ed edition (31 Dec 1998)
- **ISBN-10:** 1854861352
- **ISBN-13:** 978-1854861351

Basic Aeronautics for Modellers (Paperback)

by [Alasdair Sutherland](#) (Author),

- **Publisher:** Traplet Publications Ltd (Jun 1995)
- **ISBN-10:** 0951058940
- **ISBN-13:** 978-0951058947

Model Flight (Paperback)

by [Martin Simons](#) (Author)

- **Publisher:** Special Interest Model Books (31 Dec 1998)
- **ISBN-10:** 085242938X
- **ISBN-13:** 978-0852429389

E.11. Entry form for 2011 Electric Lift Challenge

Note: Please copy this form and complete one form per team entered

Name of university or school: _____

Names of team: _____

Names and contact addresses of:

Team manager (include e-mail addresses and telephone numbers, please): _____

All correspondence relating to the 2011 Challenge will be conducted through the addresses and numbers given on this form.

**Do you require technical assistance from local aeromodellers?
YES/NO**

Do you require pilots? YES/NO

**PLEASE SEND COMPLETED ENTRY FORMS TO THE
CHALLENGE CO-ORDINATOR AT:**

**The British Model Flying Association
The Development Officer
Chacksfield House
31 St Andrews Road
Leicester
LE2 8RE**

**Or by E mail marked for the attention of the Development Officer (Manny
Williamson) on admin@bmfa.org**

**To facilitate planning, we must receive, by January 30th 2011, a
formal notification of your intent to enter the 2011 competition.**

REPORTS AND DRAWINGS

**All reports and drawings must be submitted at least 30 days prior to
the day of the flying competition, late submission will be penalised as
described previously. Material should be sent to by email to both
judges:**

Andrew.white@baesystems.com and Nigel.revill@baesystems.com

E.12. PRIZE AND AWARD DETAILS

The 2011 Electric Lift Challenge will reward the winning teams with the following.

The Jetex Trophy (an impressive piece of silverware, awarded annually)*

£350.00 Cash prize, paid to university department or school.

£50.00 Cash prize, paid individually to each team member (up to a limit of seven persons).

*** Note: the Jetex Trophy is presented to the winning team on an annual basis and remains the property of the British Model Flying Association. The trophy must be returned 28 days prior to the competition of the following year in order that it is available to present at the event.**

E.13 POWERTRAIN NOTES.

The specified motor for the Electric Lift competition is the Eflight Power 10 1100kv Brushless Outrunner (one of).

This is to be coupled to an Eflight 40amp speed controller (one of).

Only aircraft utilising the specified powertrain will be eligible to compete in the challenge.

Horizon Hobbies who are the UK importer of the Eflight range have kindly agreed to supply these units at a much reduced cost to teams competing in the challenge. These are available directly from the BMFA office (one set per team entered) at a cost of:

Eflight Power 10 motor £22.07 (rrp £49.00)

Eflight 40amp speed controller £32.19 (rrp £72.00)

Flight Pattern Subject To Wind Direction

