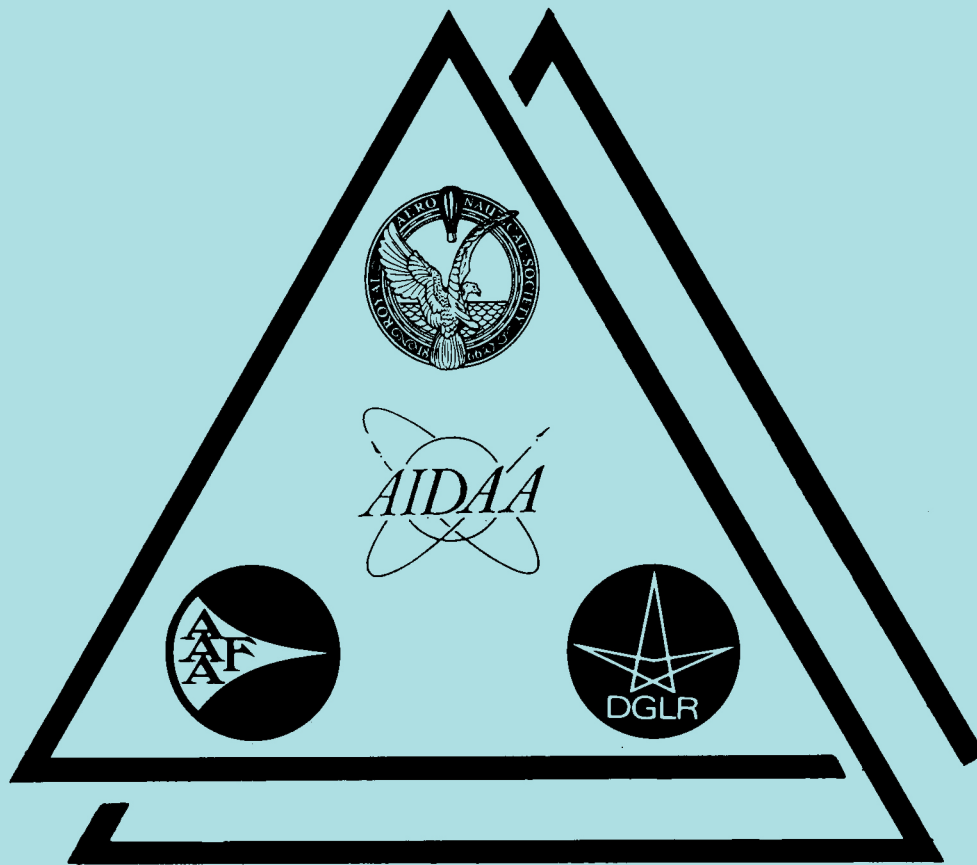


# The **AERONAUTICAL** Journal

EUROPEAN EDITION



Incorporating  
**The Aeronautical Quarterly**

Volume 96 Number 960 December 1992

# THE AERONAUTICAL JOURNAL

## Editorial Advisory Board

Dr E.W.E. Rogers, *Chairman*  
R. Ashford (airworthiness), *Civil Aviation Authority*  
D.E.H. Balmford (rotorcraft and structural dynamics), *Westland Helicopters*  
Professor P.W. Bearman (aerodynamics), *Department of Aeronautics, Imperial College*  
Professor E.G. Broadbent (noise, aeroelasticity and fluid mechanics), *Department of Mathematics, Imperial College*  
Professor R. Doganis (air transport), *Department of Air Transport, Cranfield Institute of Technology*  
R. Gibson (space), *Inmarsat*  
P.A. Hearne (avionics and systems), *GEC Avionics*  
Air Vice Marshal P. Howard (aerospace medicine), *formerly RAF Institute of Aviation Medicine*  
G.C. Howell (air traffic control and simulation), *formerly Civil Aviation Authority*  
Captain W.D. Lowe (flight testing, flight operations and air transport), *British Airways*  
Professor D. McLean (avionics and systems), *Department of Aeronautics & Astronautics, University of Southampton*  
G.B. Ratcliffe (maintenance and airworthiness), *RAeS Airworthiness and Maintenance Committee*  
T. Sharples (structures and materials), *Military Aircraft Division, BAe Defence*  
Professor P. Stow (computational fluid mechanics and propulsion), *Rolls-Royce*

## Aims and scope of The Aeronautical Journal

The aims and scope of The Aeronautical Journal are intended to reflect the objectives of the Society as expressed in the Charter of Incorporation. Briefly these are to encourage and foster the advancement of all aspects of aeronautical and space science. Thus the topics of the Journal include all those which are covered by the various Sections and Groups of the Society such as fluid mechanics and aerodynamics, propulsion, structures and materials, rotorcraft, astronautics and guided flight, dynamics and control, aeromarine technology, aviation medicine, air transport, test flying, flight simulation, air law, management studies, history of aviation and manpowered aircraft. Thus papers are solicited on all aspects of research, design and development, construction and operation of aircraft and space vehicles. Papers are also welcomed which review, comprehensively, the results of recent research developments in any of the above topics.

## Notes on the preparation of papers

Acceptance of a submitted paper will depend on the results of rigorous technical review by at least two referees and on the judgement of the Editors as to the importance of the paper to readers of the Journal.

Three clear copies of the manuscript, each complete with illustrations, should be submitted. Papers should be typed in double spacing and should preferably not exceed 10 000 words. Handwritten manuscripts cannot be accepted.

A list of symbols used, both in the illustrations and in the text, should be given in alphabetical order at the beginning of the paper whether or not they are standard. All unfamiliar terms must be explained.

Symbols and formulae should be typewritten if possible. The use of dots, bars, and similar characters over symbols, or the use of dots as multiplication signs and bars for brackets, should be avoided. Suffixes (subscripts) and indices (superscripts) must be clearly indicated. Complicated suffixes and indices also should be avoided where possible.

References should be numbered in the text where they occur, and a complete list of references given at the end of the paper. The Aeronautical Journal uses the BSI Numeric System for references — e.g. author(s), title of contribution, title of periodical, year of publication, volume number, issue number, page numbers.

Illustrations should be kept to a minimum. When the paper is first submitted they can be clear prints or graphs, sketches or photographs. If the paper is accepted, authors are asked to provide the original drawings if possible, and clear, glossy, black and white photographs. All diagrams should be produced to the same scale.

Manuscripts should be read critically, for example by a colleague, before submission, in order to avoid small errors which might otherwise prolong the refereeing process.

## Conditions of publication

Authors must obtain consent, where necessary, to use any material in a paper which is copyright or the property of any other persons or of their employers.

Security clearance, if appropriate, must be obtained by the author before the paper is submitted.

The copyright of papers printed in The Aeronautical Journal is the property of The Royal Aeronautical Society. Permission to reprint or to use any paper will not be refused unreasonably.

Following the acceptance of a submitted paper, publication of the paper will not be unreasonably delayed.

Authors are entitled to 50 complimentary reprints of their papers. Authors may order any number of additional reprints at the time of printing and quotations can be provided.

## Technical Notes

The increasing flood of technical information makes it difficult to publish even abstracts of such information and it has become still more difficult to publish technical items of information which do not reach the status of full length papers.

Under this general heading of Technical Notes it is hoped that readers will help in providing just those very items of useful information which normally might not see the light of the printed page.

There will be no set form for these Notes. They may or may not be illustrated. They can be short papers of up to two thousand words; abstracts and comments upon unpublished papers or upon papers in publication with limited circulation; or notes of some interim results of research in hand and notes for further research; or in the form of a letter raising technical points or asking questions; or letters commenting on Notes published.

These pages are intended to be a technical forum where our readers can argue and discuss; where they can inform and be informed, and pass on their own experience, or air their technical difficulties. Contributions will be reviewed by a single referee and published as soon as possible.

No reader need ever say any particular subject does not receive the space it deserves as it can be brought to notice through these pages.

## Engineering Notes

Communicating solutions to practical problems on the shop floor or in the laboratory, Engineering Notes are a maximum of one page. The notes will be judged by the editors on their relevance and suitability and will be published in the next available issue. Appealing to both scientists and technologists alike, this is an opportunity to cross fertilise ideas.

# The AERONAUTICAL Journal

Volume 96 Number 960 December 1992

Incorporating the Aeronautical Quarterly



Editor  
J.M. Ramsden, CEng, FRAeS

Production Editor  
S.M. Penney, BEng, Grad RAeS

RAeS Director  
R.J. Kennett, FIMgt, AFAIAA, FRAeS

Published by  
The Royal Aeronautical Society  
4 Hamilton Place, London W1V 0BQ.  
Tel: 071-499 3515.  
Telex: 262826 RAESOC.  
Fax: 071-499 6230.

Reproduction of any of the papers published in this journal is not permitted without the written consent of the Editor.

None of the pages or paragraphs must be taken as expressing the opinion of the Council unless otherwise stated.

Printed by  
Manor Park Press,  
Unit 7, Highfield Industrial Estate,  
Edison Road, Hampden Park,  
Eastbourne.

Subscriptions: £180 per annum,  
post free.

RAeS members: £20 a year.

Single copies, including back  
numbers: £20.

Non-member subscriptions from  
The Royal Aeronautical Society  
Publications Subscriptions  
Department, PO Box 139, Tonbridge,  
Kent TN9 1EW, UK.  
Tel: 0732 770823.  
Fax: 0732 361708.

ISSN: 0001-9240

The Royal Aeronautical Society is a  
registered charity.

**PUBLISHED MONTHLY  
EXCEPT JUNE AND AUGUST**

## EUROPEAN EDITION

### Contents

365

**Prof Dipl-Ing G. Madelung**

The inaugural Willy Messerschmitt Lecture

373

**M.B. Horner, E. Saliveros, R.A.McD. Galbraith**

An examination of vortex convection effects during blade-vortex interaction

380

**Dr-Ing U.L. Berkes**

Technology developments within the predesign phase of the Hermes spaceplane programme

387

**J-L. Lecordix, J-M. Gippet and J-L. Duparcq**

Design of an advanced nacelle for a very high bypass ratio engine

395

**Library reviews, additions and reports**

401

**Index to Volume 96**

Incorporating the Journals of The  
Institution of Aeronautical Engineers  
and The Helicopter Association of Great  
Britain.

**DIVISIONS AND BRANCHES OF  
THE ROYAL AERONAUTICAL SOCIETY**

**Australia Branches at:** Adelaide, Canberra, Melbourne and Sydney.

*President:* Air Vice-Marshal R. NOBLE, FRAeS. *Hon. Secretary:* R.D. BARKLA, CEng, MRAeS. PO Box 573, Mascot, NSW 2020.

**New Zealand Branches at:** Auckland, Blenheim, Canterbury, Hamilton, Otago, Palmerston North and Wellington.

*President:* Air Cdre S. MCINTYRE, FRAeS, RNZAF Retd. *Hon. Secretary:* J.H. MOUNCE, CEng, MRAeS. PO Box 3813, Wellington.

**Pakistan** *Chairman:* S. AJAZ ALI, CEng, FRAeS. *Hon. Secretary:* Dr S.A. HASAN, CEng, FRAeS, 4th Floor, IEP Building, 177/2 Liaquat Barracks, Karachi 75530. Tel: 92-7780233.

**Southern Africa** *President:* The Hon. Mr Justice C.S. MARGO, FRAeS. *Hon. Secretary:* N.A.H. BARRAUD, CEng, MRAeS. PO Box 630, Kelvin, 2054, Republic of South Africa.

**Zimbabwe** *President:* K.A. BOLT, IEng, FRAeS. *Hon. Secretary:* A.S. MATIKITI, IEng, AMRAeS. Engineering Dept., Air Zimbabwe, PO Box AP1, Harare International Airport, Zimbabwe.

**Bedford**

*President:* T.H. KERR, CEng, FRAeS.

*Chairman:* C. MARTIN, AMRAeS.

*Hon. Secretary:* R. BAILEY, MRAeS, College of Aeronautics, Cranfield, Bedford MK43 0AL. Tel: 0234 750111 Ex. 2171.

**Belfast**

*President:* M. I. WILD CEng, MRAeS.

*Chairman:* Professor D. NIXON, FRAeS.

*Hon. Secretary:* Dr S.T. McILWAIN, GradRAeS, Systems Department, Defence Systems Division, Short Brothers, Montgomery Road, Belfast Northern Ireland BT6 9HN. Tel: 0232 458444 Ex 5650.

**Birmingham and Wolverhampton**

*President:* C. I. HUGHES, CEng, MRAeS.

*Chairman:* G. P. HARRIS, CEng, MRAeS.

*Hon. Secretary:* A.R. BANBURY, CEng, MIProdE, 13 Gasmere Close Tettenhall, Wolverhampton WV6 9DP. Tel: 0902 745957.

**Boscombe Down**

*President:* Air Cdre D.L. BYWATER, FRAeS, RAF.

*Chairman:* Dr D.W. WILLIAMS, FRAeS.

*Hon. Secretary:* Wg Cdr P.L. WOOD, CEng, MRAeS, ATG, Armament Division, A&EE Boscombe Down, Salisbury SP4 0JF. Tel: 0980 623331 Ex. 2975.

**Bristol**

*President:* C.H. GREEN, CEng, FRAeS.

*Chairman:* P. CHRISTIE, CEng, FRAeS.

*Hon. Secretary:* J.G. MATTHEWS, GradRAeS, British Aerospace Airbus Ltd., C2 Technical Centre, PO BOX 77, Filton House, Filton, Bristol BS99 7AR. Tel: 0272 364018.

**Brough**

*President:* R.I. HARESCOUGH, CEng, FRAeS.

*Chairman:* G. CHISNALL, CEng, MRAeS.

*Hon. Secretary:* Mrs A.L. FERGUSON, CEng, MRAeS, 19 Drovers Rise, Elloughton, Brough, East Yorkshire, HU15 1LN. Tel: 0482 664217.

**Cambridge**

*President:* Professor M. GASTER, FRS, CEng, FRAeS.

*Chairman:* K. WESTLEY, AMRAeS.

*Hon. Secretary:* D.N. WHITEHEAD, CEng, MRAeS, Marshall of Cambridge (Aerospace) Ltd, Airport Works, Cambridge CB5 8RX. Tel: 0223 61133. Ex. 3541.

**Cardiff**

*President:* Vacant.

*Chairman:* J.A. STEELE, IEng, AMRAeS.

*Hon. Secretary:* Wg Cdr P. RAWSON, IEng, AMRAeS, Engineering Wing, RAF St Athan, Barry CF6 9WA. Tel: 0446 798798 Ex. 4054.

**Chester**

*President:* S.A.E. DYKE, MRAeS.

*Chairman:* Dr J.E.D. CHARLES-JONES, MRAeS.

*Hon. Secretary:* C.E. MANN, Technician RAeS, 3 Fir Tree Avenue, Westminster Park, Chester CH4 7QY. Tel: 0244 682607.

**Christchurch**

*President:* M.J. COBHAM, FRAeS.

*Chairman:* P.E. COURSE, MRAeS.

*Hon. Secretary:* R.W. SMILLIE, Associate RAeS, Penny & Giles Control Ltd, Somerford Road, Christchurch, Dorset BH23 3RS. Tel: 0425 278821 Ex. 210.

**Coventry**

*President:* J.B. ROBERTS CEng, FRAeS.

*Chairman:* Dr B.D. HOBSON, CEng, MRAeS.

*Hon. Secretary:* R.I. RATCLIFF, IEng, Technician RAeS, 6 Erithway Rd, Green Lane, Coventry CV3 6JT. Tel: 0203 413779.

**Cranwell**

*President:* Air Vice Marshal D. COUSINS, RAF.

*Chairman:* Wg Cdr M.S. TAYLOR, MRAeS, RAF.

*Hon. Secretary:* Sqn Ldr J.E. MORTON, CEng, MRAeS, RAF College Cranwell, Sleaford, Lincs NG34 8HB. Tel: 0400 61201 Ex. 6437.

**Derby**

*President:* J.O. KEIR, FRAeS.

*Chairman:* D.C. COOK, CEng, MRAeS.

*Hon. Secretary:* C.J. ROBINSON, CEng, MRAeS, c/o Compressor Technology, Rolls-Royce plc, PO Box 31, Derby DE24 8BJ. Tel: 0332 249017.

**Gatwick**

*President:* R. ASHFORD, CBE, CEng, FRAeS.

*Chairman:* A.G. SAYCE, CEng, MRAeS.

*Hon. Secretary:* S.A. WITTS, MRAeS, Civil Aviation Authority, Transport Aeroplane Group, Aviation House, Gatwick RH6 0YR. Tel: 0293 573285.

**Glasgow**

*President:* Dr A.W. BABISTER, CEng, MRAeS.

*Chairman:* F.J. MULLEN.

*Hon. Secretary:* J. ALLAN, Grad RAeS, 47 Somerville Drive, Murray 7, East Kilbride G75 0LU. Tel: 03552 63620.

**Gloucester and Cheltenham**

*President:* J.R. LIGHTFOOT, CEng, FRAeS.

*Chairman:* R.H. ASHFORTH, CEng, FRAeS.

*Hon. Secretary:* R.F.J. McCARTHY, CEng, FRAeS, Dowty Aerospace, Anson Business Park, Cheltenham Road, Gloucester GL2 9QH. Tel: 0452 711428.

**Halton**

*President:* Gp Capt R. BRUMPTON, MRAeS, RAF.

*Chairman:* Wg Cdr C.G.R. GREAVES, CEng, MRAeS.

*Hon. Secretary:* Flt Lt D. CURWEN, RAF, O/C Aerodynamics Flight, AES, RAF Halton, Aylesbury, Bucks HP22 5PG. Tel: 0296 623535 Ex. 5014.

**Hatfield**

*President:* C.B.G. MASEFIELD, CEng, FRAeS.

*Chairman:* F.B. OGILVIE, AMRAeS.

*Hon. Secretary:* J. SAUNDERS, CEng, MRAeS, Aerodynamics Dept — H160, BAE Corporate Jets, Hatfield, Herts AL10 9TL. Tel: 0707 255098.

**Heathrow**

*President:* LORD KING of WARTNABY, CompRAeS.

*Chairman:* Capt. P. READ, MRAeS.

*Hon. Secretary:* R.A. KENNEDY, IEng, AMRAeS, British Airways (S.1) PO Box 10, Heathrow Airport, Hounslow, Middx TW6 2JA. Tel: 081-562 3366.

**Isle of Wight**

*President:* Vacant.

*Chairman:* R.L. WHEELER, CEng, FRAeS.

*Hon. Secretary:* P.J. CHIVERS, CEng, MRAeS, Westland Aerospace, Castle Street, East Cowes, Isle of Wight PO32 6RH. Tel: 0983 294101 Ex. 2016.

**Loughborough**

*President:* Professor G.L. WILDE, OBE, CEng, FRAeS.

*Chairman:* Vacant.

*Hon. Secretary:* Professor S.J. STEVENS, CEng, MRAeS, Transport Technology Dept, Loughborough University of Technology, Leics. LE11 3TU. Tel: 0509 223403.

**Luton**

*President:* J. M. RAINBOW, OBE, CEng, FRAeS.

*Chairman:* C. TURNER, CEng, FRAeS.

*Hon. Secretary:* N.G. TOOMEY, IEng, MRAeS, c/o Monarch Aircraft Engineering Ltd (Planning Dept.) Luton International Airport, Luton, Beds LU2 9LX. Tel: Work—0582 398542. Home—0234 54185.

**Manchester**

*President:* Professor J.B. SCOTT-WILSON, FRAeS.

*Chairman:* D.F.S. BOXALL, AMRAeS.

*Hon. Secretary:* I.R. FORD, Student RAeS, British Aerospace Regional Aircraft, Woodford, Cheshire SK7 1QR. Tel: 061-439 5050 Ex 4287.

**Marham**

*President:* Gp Capt. G.E. STIRRUP, FRAeS.

*Chairman:* Sqn Ldr R.B. ECKERSLEY, MRAeS.

*Hon. Secretary:* Flt Sgt N.P. KING, AMRAeS, 617 Squadron, RAF Marham, Kings Lynn, Norfolk PE33 9NP. Tel: 0760 337261 Ex. 6423.

**Medway**

*President:* P.A. HEARNE, Hon. FRAeS.

*Chairman:* G.R. SLEIGHT, CEng, FRAeS.

*Hon. Secretary:* R.T. TWINE, MRAeS, c/o GEC Avionics Ltd, Airport Works, Rochester, Kent ME1 2XX. Tel: 0634 844400 Ex. 3534.

**Middle Wallop**

*President:* Col W. G. HARRISON.

*Chairman:* Vacant.

*Secretary:* Major D. R. WALKER, CEng, FRAeS, Validation Section, School of Aeronautical Engineering, Army Air Corps Centre, Middle Wallop, Stockbridge, Hampshire, SO20 8DY. Tel: 0264 384305.

**Preston**

*President:* D. GARDNER, CEng, FRAeS.

*Chairman:* M. MANSSELL, FRAeS.

*Hon. Secretary:* M. CHRISTIE, Student RAeS, Aerodynamics Dept (W310P), British Aerospace Defence, Warton Aerodrome, Preston, Lancs PR4 1AX. Tel: 0772 853244.

**Prestwick**

*President:* P. BERRY, MRAeS.

*Chairman:* J. THOMAS, AMRAeS.

*Hon. Secretary:* A.R. FROST, AMRAeS, 21 Fullerton Road, Prestwick KA9 2BU. Tel: 0292 78204.

**Sherborne**

*President:* Air Marshal Sir ERIC DUNN, KBE, CEng, FRAeS.

*Chairman:* C.A. FRY, FRAeS.

*Hon. Secretary:* G.R. RUSSELL, GradRAeS, 18 Berkely Court, Hermes Place, Ilchester, Somerset BA22 8JU. Tel: 0935 704231.

**Southampton**

*President:* Professor G.M. LILLEY, CEng, FRAeS.

*Chairman:* C. WISE, MRAeS.

*Hon. Secretary:* D.R.J. BAXTER, CEng, MRAeS, Dept of Aeronautics and Astronautics, The University, Southampton, Hants SO9 5NH. Tel: 0703 592326.

**Southend**

*President:* BARONESS PLATT of WRITTLE, CBE, FEng, FRAeS.

*Chairman:* M. NICOLINI, MRAeS.

*Hon. Secretary:* D.R.J. BAXTER, Associate RAeS, 21 Sandleigh Road, Leigh-on-Sea, Essex SS9 1JT. Tel: 0702 713365.

**Stevenage**

*President:* J.A. HOLT FEng, FRAeS.

*Chairman:* Dr J.M. YOUNG, FRAeS.

*Hon. Secretary:* D. MURPHY, British Aerospace Space Systems, Gunned Wood Road, Stevenage, Herts SG1 2AS. Tel: 0438 736737.

**Swindon**

*President:* Professor M.G. FARLEY, CEng, FRAeS.

*Chairman:* Wg Cdr G.S. EVANS, MRAeS.

*Hon. Secretary:* V.A. SIMON, 20 Hawkswood, Covingham Park, Swindon, Wilts. Tel: 0793 525350.

**Weybridge**

*President:* Professor I.R. YATES, CBE, FEng, FRAeS.

*Chairman:* Miss J.M. GULLAND CEng, MRAeS.

*Hon. Secretary:* K.J. DAVIES, CEng, MRAeS, 65 Stringers Avenue, Jacobs Well, Guildford, Surrey GU4 7NN. Tel: 0483 31529.

**Yeovil**

*President:* V.A.B. ROGERS, CBE, FEng, FRAeS.

*Chairman:* R.I. CASE, CEng, FRAeS.

*Hon. Secretary:* F.N.R. BALLAM, CEng, MRAeS, Box 285, Westland Helicopters, Yeovil, Somerset BA20 2YB. Tel: 0935 703779.

**OVERSEAS BRANCHES**

**Cyprus**

*President:* Air Vice-Marshal G. A. WHITE, CB, AFC, FRAeS.

*Chairman:* D. PANTAZIS, FRAeS.

*Hon. Secretary:* C. PERICLEOUS, MRAeS, 8 Georgiou Christodoulou, Acropolis, Nicosia, Cyprus. Tel: 357-2-310430.

**Hong Kong**

*Chairman:* S.M. JOHN, OBE, FRAeS.

*Hon. Secretary:* M.J. POMFRET, MRAeS, MME Dept HK Polytechnic, Kowloon, Hong Kong. Tel: Office 3-7666647. Home: 3-7213732.

**Malaysia**

*Chairman:* Dato R. SINGH, FRAeS.

*Hon. Secretary:* Lt Col A. LATIF B. TAHA, AMRAeS MRAF, Dept of the Air Force, Ministry of Defence, Jalan Padang Tembak, 50634 Kuala Lumpur, Malaysia. Tel: 03-2354358.

**Munich**

*President:* Professor Dipl. Ing G. MADELUNG, FEng, HonFRAeS.

*Chairman:* J. VINCENT, FRAeS.

*Hon. Secretary:* D. CHINN, Student RAeS, c/o NEFMA, Arabellastrasse 16, 8000 Munich 81, Germany. Tel: 89-92803597.

**Northern Germany**

*Chairman:* Flt Lt M.R. GILBERT, IEng, AMRAeS, Electrical

Engineering Squadron, RAF Gutersloh, BFPO 47, Germany. Tel: (49) 52 4184 2414

*Hon. Secretary:* Vacant.

**Republic of Ireland**

*President:* R.W. O'SULLIVAN, CEng, FRAeS.

*Chairman:* J. TOWERS, CEng, MRAeS.

*Hon. Secretary:* J. CONERNEY, Technician RAeS, Eng. Wing, Air Corps, Baldonnel, Co. Dublin. Tel: 592493. Ex. 6633.

**Toulouse**

*President:* R.M. MCKINLEY, CEng, FRAeS.

*Chairman:* A.S. McCLYMONT, FRAeS.

*Hon. Secretary:* W.A.N. FORD, CEng, FRAeS, Chrestias, Avenue du Bouconne, Levisgnac 31530, France. Tel: Work — (33) 61 93 35 60. Home — (33) 61 85 42 58.