Joint Conference

The use of plastics and rubber in water and effluents

15 February to 17 February 1982

The Royal Lancaster Hotel
London

THE PLASTICS AND RUBBER INSTITUTE
11 HOBART PLACE · LONDON SW1W 0HL

International conference
THE USE OF PLASTICS AND RUBBER IN WATER AND EFFLUENTS
15-17 February 1982

at the Royal Lancaster Hotel, London

Sponsored by

Institute of Water Pollution Control
Institution of Public Health Engineers
Institution of Water Engineers and Scientists
Plastics and Rubber Institute
Water Research Centre

Organizing committee

G H Burke (Chairman)
J N Ratcliffe (Secretary)
J P Banbury MBE
G E Eden
H R Evans
C W M McDowell
I B Muirhead
D Papworth
D W R Price
R J Slater
Dr R F Stokes
R G Toms

The Plastics and Rubber Institute
11 Hobart Place
London SW1W OHL
Telephone 01-245 9555
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VENUE

The conference will take place in the Nine Kings Suite at the Royal Lancaster Hotel, Lancaster Terrace, London W2 2TY (telephone 01-262 6737, telex 24822). The hotel is above Lancaster Gate Underground Station, Central Line, facing Hyde Park.

SOCIAL FUNCTIONS

The conference dinner (dress informal) will be held at the Royal Lancaster Hotel on Tuesday evening, 16 February, at 1900 for 1930 in the Westbourne Suite, and the cost of this meal is included in the registration fee.

REGISTRATION

The conference registration desk in the foyer to the Nine Kings Suite will be open from 0900 on Monday 15 February. All participants are asked to call at the desk to collect a badge, list of delegates, and any other conference literature. They may leave messages or seek information there but it is regretted that it will not be possible to contact delegates other than by showing their names on the message board. Coin operated telephones are available at the hotel.

PROCEDURE AT SESSIONS

Speakers are asked not to exceed the time allocated to them on the program, bearing in mind that this should be used for highlighting the important points in their paper. Projection facilities will be available for 35mm slides and overhead projection. All slides should be in boxes clearly marked with the contributor's name. These should be handed to the projectionist before the start of the appropriate session and be collected after they have been shown.

Chairmen are responsible for keeping authors and discussion contributors to the correct timekeeping.

PUBLICATION OF PROCEEDINGS

It is hoped to prepare a general report on the conference for publication in a future issue of Plastics and Rubber International. The PRI claims the copyright for all the papers, and they must not be reproduced in part or in whole without written permission having first been obtained. All papers will be considered by the Journals Committee for publication in the Institute's quarterly 'Plastics and Rubber Processing and Applications'.

The texts in this booklet are compiled chiefly for the convenience of those attending the meeting. They have not been refereed; the length, form and content may not be appropriate for journal publication. The material contained in these papers may subsequently be published as a substantive publication elsewhere.

EXHIBITION

It is hoped to hold a small exhibition in the foyer.

ENQUIRIES

Enquiries prior to the conference should be addressed to:

Patricia Barham
The Plastics and Rubber Institute
11 Hobart Place
London SW1W OHL (telephone 01-245 9555, telex 912881)

THE PRI

The Plastics and Rubber Institute - an amalgamation of the Institution of the Rubber Industry, founded in 1921, and the Plastics Institute, founded in 1931 - is the oldest and largest international professional society in the world devoted exclusively to providing a service for personnel employed in the plastics and rubber and allied industries.

Over 11,300 individual members, of whom about 5,800 are resident overseas.

The PRI's membership qualifications are internationally recognized as the leading qualifications in the fields of polymer science and technology. Examinations for the higher grades of membership are conducted at various centres throughout the world and are open to members who have completed approved courses of study.

Publications include the two-monthly 'Plastics and Rubber International' issued free to members, and the research and development quarterly 'Plastics and Rubber Processing and Applications'. A range of over 80 books, pamphlets and study guides are also available at preferential rates to members.

Over 150 meetings are organized each year. Coming major events:

1982

2-3 Mar	Injection moulding of thermosets
29 Mar-1 Apr	Deformation, yield and fracture of polymers V
12-13 May	Polymer extrusion
2-10 Sep	Plastics pipes V
15-17 Sep	Plastics in telecommunications III

1983

8-10 Jun	Polyethylenes 1933-83: Past, present and future

PROGRAM AND TIMETABLE

MONDAY 15 FEBRUARY 1982

0945 Registration and coffee

1025 Opening remarks by the Chairman of the Organizing Committee, Mr G H Burke

1030 1 Use of plastics and rubber in water and effluents
R Y Bromell (Severn-Trent Water Authority)

SESSION A PROBLEMS AND ANSWERS WITH PIPELINE SYSTEMS

Chairman E C Reed (President, Institution of Water Engineers and Scientists)

Structural

1050 2 The problems, advantages and disadvantages of plastics for water mains and services
H D M Speed (Newcastle and Gateshead Water Co)

1105 3 Plastics in effluent pipelines - gravity and pressure
K I M Henry (Babtie Shaw and Morton)

1120 Discussion on papers 1-3

Joints

1135 4 Rubber ring joints for pipe joints
D Brister and D Papworth (The Victaulic Co Ltd)

1147 5 Plastics and rubber in flexible joints for pipelines
J B Glover (Hepworth Iron Co Ltd)

1200 6 Recent developments in rubber joint rings for water mains
P C Kirby (WRC Engineering Centre) and J W Ridgeway (WRC Environmental Protection Laboratory)

1212 Discussion on papers 4-6

1230 Lunch

Water quality

Chairman G E Eden (President, Institute of Water Pollution Control)

1415 7 Effects of rubber materials on water quality
Jenny S Colbourne (Thames Water Authority)

1427 8 Effects of plastics materials on drinking water quality
J K Fawell and R F Packham (WRC Environmental Protection Laboratory)

1440 Discussion on papers 7 and 8

1500 Tea

Maintenance and renovation

Chairman C W M McDowell (Vice-President, Institution of Public Health Engineers)

1530 9 Renovation and renewal of water mains
R W Parkinson (WRC Engineering Centre)

1542 10 Renovation of sewers: extending the active life
G C Cox (Thames Water Authority)

1554 11 Structural tests on renovated sewer sections
G M A Jones, E B Glennie and I Cooper (WRC Engineering Centre)

1606 12 Use of polyethylene pipes to reline sewers
J Harwood (Du Pont (UK) Ltd)

1618 Discussion on papers 9-12

Evening No arrangements made

TUESDAY 16 FEBRUARY 1982

SESSION B MATERIALS AND EQUIPMENT

Chairman L Mullins (President, Plastics and Rubber Institute)

General review

0900 13 Plastics and rubber for the water industry: their nature and properties
M M Hall (Rubber and Plastics Research Association)

0915 14 Design criteria for plastics pipes
J G Williams (Imperial College)

0927 15 Polyethylene piping systems
W J Allwood, J M Cann and M J Cawood (BP Chemicals Ltd)

0939 16 Polypropylene piping systems
R M Webber (ICI Petrochemicals and Plastics Division)

0951 17 PVC piping systems for water distribution
D Walton (Wavin Plastics Ltd)

1003 18 Glass-reinforced plastics piping systems
P N Paul (John Taylor and Sons)

1015 Discussion on papers 13-18

1045 Coffee

Costs and economics

1115 19 A contractor's view
Speaker to be announced

1127 20 Pipe selection - an operational view
D B Johnson (Anglian Water Authority, Lower Ouse Water Division)

1139 21 Water distribution mains: a comparison of costs for various types of materials and layout
A Pilling (North West Water Authority)

1151 22 Comparison of resin costs for plastics pipes, compared with other materials
D C Harget (Du Pont (UK) Ltd)

1203 Discussion on papers 19-22

1230 Lunch

Testing, standards and regulations

Chairman D G Jones (British Standards Institution)

1415 23 Impact of standards on plastics pipes
D E Burgess (Yorkshire Water Authority)

1427 24 A critique of standards for the assessment of pipe properties
G P Marshall (Manchester Polytechnic)

1439 25 Specification of new materials for use in the water industry
R F Stokes (WRC Engineering Centre)

1451 Discussion on papers 23-25

1510 Tea

1540 Film on plastics pipes with comments by W Müller (Hoechst AG, F R Germany)

1600 Open forum

1900 for 1930 Conference dinner

WEDNESDAY 17 FEBRUARY 1982

SESSION C OTHER USES AND NEW DEVELOPMENTS

Chairman M J Rouse (Water Research Centre)

0930	26	Use of flexible membranes and fabricated structures for fluid containment J O Alexander (Lined Environmental Constructions Ltd)
0942	27	Stabilization of soil in coastal and waterway structures J E Templeman and D B Sweetland (Netlon Ltd)
0954	28	Sealants for the water industry B W Gill (WRC Engineering Centre)
1006	29	Use of coatings in the protection of steel and concrete structures B S Jackson and E A Wells (Evode Holdings Ltd)
1018	30	New developments in the building field which might influence the water and effluent industry A F E Wise (Building Research Establishment)
1030		Discussion on papers 26-30
1050		Coffee
1115	31	Fusion welding of polyethylene pipe using an inductive heating method J M Stuart, B Phelps (Cranfield Institute of Technology) and N L Rice (Haxey Engineering Ltd)
1127	32	A new development in uPVC pipe technology M J Littlewood (IMI Yorkshire Imperial Plastics Ltd)
1139	33	Hot water plastics - progress to standardization J A Denning (Stewarts and Lloyds Plastics)
1151		Discussion on papers 31-33
1205	34	A look ahead B C Lindley (Dunlop Ltd)
1225		Concluding remarks by G H Burke, Chairman of the Organizing Committee
1230		Lunch

BIOGRAPHICAL NOTES OF CONTRIBUTORS

J O Alexander is Director of Lined Environmental Constructions Ltd.

W J Allwood graduated in General Science from London University and after National Service joined British Resin Products, a DCL Company in 1960. Initially he was concerned with HDPE Technical Service and Development and in 1969 was concerned with thermoplastic materials development. In 1975 he was made responsible for Technical Service and Applications, HDPE and PS. He is a member of several UK and international pipe and materials committees involving BPF, BSI and ISO. In 1980 he was appointed Assistant Coordinator, T S & D Plastics, BP Chemicals.

D Brister ANCRT APRI is Technical Services Manager of the Rubber Division of The Victaulic Co Ltd at Huntingdon and has been involved in the development of rubber compounds for pipe joints since 1970, first with TBA Industrial Products Ltd, and since 1977 with Victaulic.

R Y Bromell studied engineering at the Royal Naval Engineering College, Manadon, during the war subsequently serving in the Fleet Air Arm. In 1947 he joined Coventry Water Undertaking, becoming Chief Assistant Engineer in 1953. He moved to the Mid-Northamptonshire Water Board as Deputy Water Engineer in 1960 returning to Coventry as Water Engineer and Manager in 1967. Following the reorganization of the water industry in 1974 he became Assistant Director and in 1977 Director of Operations to the Severn-Trent Water Authority.

D E Burgess graduated with an honours degree in Civil Engineering at the University of Birmingham in 1963. He then joined the South Staffordshire Waterworks Co where he was involved in the design and construction of treatment works and pipeline projects followed by a period devoted to forward planning. In 1947 he moved to the East Worcestershire Waterworks Co to take up the post of Deputy Engineer and Manager in 1975. In 1979 he joined the Yorkshire Water Authority, North Central Division, as Works Manager. He represents the National Water Council on the British Standards Plastics Pipes Committees and in 1980 became Chairman PLC/9.

J M Cann BSc FPRI studied Physics at Bristol University. He joined British Resin Products, a DCL company in 1960 to work on the physical and mechanical properties of rubber and plastics. After BRP was acquired by BP the work broadened in 1970 to include polymer processibility and materials development. For many years he has been a member of various RAPRA and SRC committees, representing industry views. In 1980 particle technology was added to his responsibilities and he was appointed Manager Polymer Sciences Branch, BP Chemicals Ltd.

Dr M J Cawood graduated in Physics at Leeds University in 1962 and obtained MSc and PhD degrees by research in soil physics also at Leeds. He joined BP Chemicals Ltd in 1967 to work on the development of physical testing methods for plastics and now leads the Group concerned with physical performance of plastics products.

Dr Jenny S Colbourne graduated with an honours degree in Microbiology from the University of Surrey in 1973. She joined Beecham Products Ltd in 1973, transferring to the Directorate of Scientific Services, Thames Water in 1974, as Assistant Microbiologist with special responsibilities for the evaluation of materials and their effect on water quality. In 1979 she was awarded the degree of Doctor of Philosophy by the University of Surrey for research undertaken in collaboration with Thames Water and in 1981 she was appointed Scientific Adviser to the National Water Council Fittings Scheme Technical Committee.

I Cooper was a research worker at University of Newcastle upon Tyne before joining Northumbrian Water Authority in 1974, where he was involved in the design and construction of capital works. He joined Water Research Centre in 1980 and is now Manager of the Engineering Services Group.

G C Cox graduated with a 1st degree in civil engineering from Imperial College, London University in 1954 and a Masters degree in public health engineering in 1971. The first part of his career was spent in heavy civil engineering contracting until his appointment as Resident Engineer to the London Borough of Croydon in 1965. He was then transferred into the GLC Department of Public Health Engineering before joining the Thames Water Authority on its inception in 1974. He has recently been appointed Manager, Operational Standards and Maintenance for the Thames Water Authority and is Chairman of the Metropolitan District Centre of the Institution of Public Health Engineers.

J A Denning graduated with a BSc in Chemistry from the University of Aston in Birmingham. Joined British Steel Corporation Tubes Division Research Centre as a Research Analyst involved in plastics and environmental studies. In 1979 transferred to Stewarts and Lloyds Plastics as Technical Services Manager and is currently Works Manager.

G E Eden BSc CChem FRSC FIWES FIWPC, President IWPC 1981-82. Born 1922. On leaving Harrow County School in 1940 he joined the newly-created Water Pollution Research Laboratory at Watford and became involved in various war-time projects and industrial effluent problems. In 1946 he graduated at London University and in 1949 was put in charge of the radiochemical laboratory built for WPRL in the grounds of the Building Research Station at Garston. Though the work was principally concerned with civil defence and with the disposal of radioactive waste, the unit soon turned its attention to pioneering the use of radioactive tracers for the measurement of flow and retention periods. Following this interest in radioactive matters, he moved to the Radiochemical Centre at Amersham, where he was involved in the separation of fission products and the production of radioactive sources. In 1955 he returned to WPRL, by now at Stevenage, and took charge of more work on radioactive pollution, this time largely in support of the civil nuclear power program. Other developments from this period were the use of neutron scattering for the study of percolating filters, the vacuum sampler, and the use of lithium as a non-radioactive tracer. Subsequently he became involved in the detergent problem and with the reclamation of water from sewage effluents. He moved into administration and

became Assistant Director. In 1974 when WPRL became part of the Water Research Centre he took charge of the laboratory and was designated Director in 1978. In 1980 he opted for early retirement and joined Binnie & Partners as an in-house consultant. He has taken an active interest in the IWPC's affairs, was Chairman of the Metropolitan and Southern Branch, and has served on Council for three terms. He was also an active member of the former Society for Water Treatment and Examination and was their President in 1972-73, coincidentally holding his Annual Conference at the Old Swan Hotel Harrogate.

J K Fawell: please see page v.

B W Gill is a graduate chemist and polymer technologist with many years experience in the formulation and application of sealants, adhesives and water proofing compounds for the building construction industry. He joined the Central Laboratory of George Wimpey & Co Ltd in 1968, transferring to Expandite Ltd in 1970 becoming Senior Development Chemist. In 1980 he joined the Water Research Centre as the Section Head responsible for polymeric materials and is now associated with a wide range of polymer-based products used in the water industry.

Dr E B Glennie joined the British Gas Engineering Research Station in 1972 after studying mathematics at Cambridge. He joined the Water Research Centre in 1979 and leads the Structures and Construction Section at the Engineering Centre, Swindon.

J B Glover CEng MICE MIMunE MInstHE trained as a Municipal Engineer with Leicester City Council starting in 1949. Qualified as a Chartered Civil Engineer in 1959. Served with several City Authorities until 1965 on civil and public health engineering work. National Service in Cyprus as an officer in the Royal Engineers 1953/55. Joined the Hepworth Iron Co in 1965 as Product Development Manager and now Director, responsible for Product Development. Also a Director of Ketch Couplings Ltd. Author of several papers including 'The main drainage of Leyton' (The Chartered Municipal Engineer), 'Drainage in the seventies - a new look' (Municipal Engineering). Member of a number of BSI Standard and Code of Practice Committees. Also participant on ISO and DIN Committee. Member of the Pipe Associations Liaison Committee of NWC/DOE Standing Committee on Sewers and Water Mains.

Malcolm Hall has been at the Rubber and Plastics Research Association since December 1970 in the successive posts of manager - engineering physics, manager - engineering and now Director of Technology Development. Prior to joining RAPRA he was a research fellow and then lecturer at the Cranfield Institute of Technology (1963-1970), in R&D at Dunlop Ltd (1961-1963) and a lab. assistant at Bakelite Ltd (1955-1959). He has BSc degrees in mathematics and physics from London (external, 1959) and Birmingham (1961) and a PhD from London (external, 1967). He is a Fellow of the PRI and Institute of Physics and is currently a member of the PRI Council.

Dr D C Harget is with Du Pont (UK) Ltd.

J Harwood is with Du Pont (UK) Ltd.

K I M Henry obtained BSc degree at Harriott Watt University in 1958. Has since worked with the Consultant Contractor and Local Authority. Has been with the consultant Babtie Shaw and Morton since 1967.

Dr B S Jackson is with Allweather Evode Paints Ltd.

D B Johnson was articled to Cyril Cooper and attained Chartered status in 1965. A period in the design and construction of new waterworks projects in South Humberside preceded his appointment in 1975 as Operations Controller with the Lower Ouse Water Division of the Anglian Water Authority.

Dr G M A Jones studied and carried out research at Swansea University before joining Sir William Halcrow and Partners in 1976. He joined the Water Research Centre in 1980 and is presently involved with structural aspects of sewer assessment and renovation.

P C Kirby is an honours graduate in Metallurgy of London University with an MPhil in Materials Science from the same university. After working for several companies in the marine and automobile industries carrying out research and development on materials and products he joined the Water Research Centre in 1974 to take charge of the Materials Section there. He is now responsible for the management of External Research and Development work sponsored by the WRC Engineering Centre.

Dr B C Lindley is with Dunlop Ltd Technology Division at Birmingham. (Further details at end of these notes)

M J Littlewood gained the Associateship of the Plastics Institute by examination at Newton Heath Technical College in 1959 after part-time study. In 1958 he joined his present company (now IMI Yorkshire Imperial Plastics Ltd) as Laboratory Supervisor, and for the past 14 years has been Technical Liaison Manager. Following his work in the field of national and international standardisation for plastics pipes he was awarded the Fellowship in 1971. He is at present Chairman of the BSI Steering Committee for International Plastics Pipes and leader of the UK delegation to ISO Technical Committee 138, and is also Chairman of the Yorkshire Section of the PRI.

Phil Marshall graduated from Imperial College, London, with an honours degree in Mechanical Engineering in 1966. He undertook a PhD with Prof Gordon Williams on the Fracture Behaviour of Polymers which was completed in 1971. After working on post-doctoral research at Imperial for a further two years, he left to work as a full-time consultant on failure problems with polymers in engineering applications. He felt the call of the wild in 1976 and returned to his homelands in Manchester in 1976 to establish a research group in the Polymer Technology Department at Manchester Polytechnic, where he is now Principal Lecturer in Polymer Engineering. Current research interests include properties of composites, diffusion of noxious environments into thermoplastics and composites, failure behaviour of PVC and PE pressure pipes, effects of processing on properties of polymers, high impact responses of polymers for crash helmets. Many of

his present activities are involved with re-designing tests for applications standards and establishing the criteria for new standards for both thermoplastics and composites.

C W M McDowell 1951-53 Public Works Department, Tanzania - Senior Engineer. 1953-56 Howard Humphreys & Sons - Resident Engineer. 1956-58 London County Council - Deputy Resident Engineer. 1958-63 Howard Humphreys & Sons - 4 years as Senior Engineer, one year as second in charge Motorway and Highway Section. 1963 to date: Founded M McDowell & Partners, dealing with many schemes involving public health, highways, infra-structure. Has appeared as a professional witness in nearly 200 planning appeals, public enquiries and High Court cases and has arbitrated in many cases involving civil and building disputes of varying size and complexity.

Dr R F Packham graduated with an honours degree in chemistry from London University in 1951 and was awarded a PhD in 1954 for research in the field of electrochemistry. On completing his postgraduate research he joined Electronic Instruments Ltd as chief chemist transferring to the newly formed Water Research Association in 1956. Following the incorporation of WRA into the Water Research Centre in 1974 he became involved with health aspects of drinking water quality. He currently holds the post of Assistant Director with responsibility for research into the identification of water constituents, their biodegradability, toxicity and significance to public health. He is a member of the DOE/DHSS Committee on Medical Aspects of Water Quality and the DOE Committee on New Chemicals and Materials of Construction for use in Public Water Supply and Swimming Pools.

J K Fawell is a graduate in applied biology specialising in animal physiology. He has had ten years practical experience in various aspects of mammalian toxicology with Huntingdon Research Centre, Inveresk Research International and the Department of Nutrition and Toxicology of RHM Research before joining the Water Research Centre in 1979. His experience in the water industry includes earlier work on fish toxicology at the Water Pollution Research Laboratory and on pesticide residues in fish with the Avon and Dorset River Authority.

D Papworth is General Manager and a Director of The Victaulic Co Ltd and Stewarts and Lloyds Plastics. He has been in the rubber and plastics industry since 1944, and has had responsibilities for rubber joint rings and polyethylene pipes since 1959. He is Chairman of the BSI Rubber Ring Committee, and leads the UK delegation to the ISO task group on rubber rings for pipes.

Dr R W Parkinson 1967-70 BSc Metallurgy, University of Leeds. 1970-73 PhD Wear of plastics, University of Leeds. 1973-75 Fulmer Research Institute. 1975- WRC, Project Leader, Water Main Renovation Studies.

P N Paul is with John Taylor and Sons.

Dr B Phelps graduated in metallurgy from Sheffield University in 1955 and subsequently undertook research for a Masters Degree from Toronto University and a Doctorate from Sheffield University.

He has worked in the field of welding for 20 years with Murex Welding Processes, C A Parsons, British Gas and GKN. He is now engaged at Cranfield in establishing a Joining Technology Centre to provide education, training, research and information in all aspects of joining technology.

John Pickford MSc(Eng) ACGI FICE FIPHE. Leader of the Water and waste engineering for developing countries (WEDC) Group in the Department of Civil Engineering at Loughborough University of Technology. Went to City and Guilds College (part of Imperial College) where he obtained a war-time BSc when only 18 years old. Four years' Army service finishing as Captain was followed by 7 years in UK local government. Then he went to Ghana (at that time Gold Coast) where he was Town Engineer of Sekondi-Takoradi, population about 120,000, for 6 years. Although the work was varied, he was particularly interested in improving village water supply and in sanitation, and was responsible for the construction of a large number of communal latrines.

Returning from Ghana in 1960 he went to Loughborough, obtained a London MSc by research, wrote a book on 'Analysis of surge', and introduced an undergraduate course in public health engineering. From 1967-77 he organized 10 public health conferences. During the 1970s he has build up Loughborough's work for developing countries, with courses, consultancy, research and conferences. The WEDC Group now offers a 12-month MSc course, an annual 3-month course for Senior Professionals and Managers and short specialist courses. A 2-week program in Kathmandu, Nepal, will be run in August and a 5-month program in Sri Lanka starts in October. WEDC conferences have been held since 1973, the 6th in 1980 was in Nigeria: the 8th next February will be in India. John frequently visits Africa and Asia and is particularly concerned with unsewered sanitation and the factors which determine the appropriateness of water supply and sanitation in developing countries. He is the author of more than 30 papers and articles.

A Pilling graduated with a degree in Civil Engineering from UMIST in 1969. He joined Tarmac Construction Ltd and worked as a site engineer on two major pipeline projects for Liverpool Corporation Water Works. In 1972 he joined the former St Helens CWD as an engineering assistant in the New Works Office, before transferring to Distribution as assistant engineer in 1974. At reorganization he was appointed Senior Assistant Engineer (Technical Operations) to Northern District of Central Division of the North West Water Authority, moving to the Head Office of the Authority as Senior Engineer (Mains and Services) in March 1980.

E C Reed is President of the Institution of Water Engineers and Scientists.

N Rice served an apprenticeship with Humber Motor Co in Production Engineering. Upon completion of his apprenticeship he joined the RAF and served for 12 years as a pilot in Transport Command. He subsequently formed Haxey Engineering which in recent years has specialised in fusion welding of plastics.

Dr J Ridgeway graduated with an honours degree in biology from the University of Bradford in 1967 and undertook research in animal nutrition at the same University for which he received his PhD in 1971. He joined the distribution Division of the Water Research Association (now Water Research Centre) in 1971 as an applied biologist with special interest in microbiology. In 1978 he transferred to the Water Quality and Health Division at the Medmenham Laboratory of WRC, a group which he currently manages.

M J Rouse is with the Water Research Centre.

H D M Speed graduated from Edinburgh University in 1957 with an Honours Degree in engineering and joined the staff of Crouch and Hogg, Consulting Engineers. There followed a spell of 3½ years in the Airfield Construction Branch of the Royal Air Force, spent mostly in the Middle East, after which he rejoined Crouch and Hogg, becoming an Associate in 1968. In 1969 he gained the degree of MEng from Glasgow University in Soil Mechanics and Foundation Engineering. The latter years with Crouch and Hogg were spent mainly on the Loch Lomond Water Supply Scheme.

Dr R F Stokes graduated with an honours degree in Physical Metallurgy from Birmingham University in 1966, and received his doctorate at the same university in 1970. In 1969 he joined Lucas Group Research Centre, transferring to Girling Ltd in 1973 and leaving that company in 1978 as Laboratory manager. He was appointed Chief Development Engineer at Glynwed Centre Resources Unit and subsequently moved to WRC Engineering Centre in 1980 as Manager responsible for the Materials Group, in Swindon

J M Stuart is an Associate of the Plastics and Rubber Institute. He has been employed for 25 years in polymer processing with Export Packing Services, De Havilland Aircraft Company and the Cranfield Institute of Technology. He has recently returned to Cranfield after spending two years in Algeria working for the Algerian Institute of Petrol, helping to establish a graduate course in polymer engineering. He is currently engaged in the study of defect propagation in polymer pipes under fatigue loading.

D B Sweetland is a member of the Institute of Civil Engineers and was for 4 years involved in applications of geotextiles and 4 years in the application of specialised cements, before joining Netlon Ltd and working on civil engineering applications of Netlon and Tensar grids. He has been with Netlon Ltd for 2 years.

J E Templeman is a Chemical Engineer specialising in polymer processing engineering and has worked in the polymer processing engineering industry for 25 years, mainly in product development and business development activities. He is currently Overseas Director of Netlon Ltd and a Director in charge of civil engineering applications.

D Walton PhD CEng MIMechE (Company Technical Manager, Wavin Plastics Ltd). After obtaining a BSc in Mechanical Engineering at the University of Bath, Dr Walton joined Rolls Royce as a technical engineer, designing turbine blade cooling systems for

aero engines. This was followed by two research contracts at the University of Bristol studying creep, fatigue and non-destructive testing of steel and fibre reinforced plastics. He then joined the Engineering Research Station of British Gas where he was involved in the development and use of polyethylene pipe and fittings for the distribution of natural gas. Currently Dr Walton is employed at the Durham plant of Wavin Plastics where he leads a team of technologists and technicians working on a wide range of plastic products and processes.

R M Webber gained the Graduateship of the Plastics and Rubber Institute through study at the Polytechnic of the South Bank, and is currently studying for a Masters Degree in Polymer Engineering at Brunel University. He joined Imperial Chemical Industries PLC, Plastics Division (now Petrochemicals and Plastics Division), in 1970 where he worked in Polypropylene Research before transferring to Technical Service Department. He is responsible for technical service and development on polypropylene pipe, profiles and general extrusion.

Mrs E A Wells is with Evode Holdings Ltd.

Professor J G Williams is Professor of Polymer Engineering in the Department of Mechanical Engineering at Imperial College, London. He is responsible for a research group working in all areas of polymer engineering, including mechanical properties and processing. He has been active in consulting activities in the polymer industry for some years and is also engaged in the teaching of polymer engineering at both undergraduate and postgraduate levels. He is the author of many papers published by authoritative journals in the field of polymer engineering.

Dr A F E Wise graduated with honours in mechanical engineering from Manchester University in 1946. In a varied career he spent some nine years in the nuclear and mechanical engineering industries and 20 years at the Building Research Establishment plus a period of six years at DOE HQ. He has specialised in environmental studies and research into building services. In 1974 he was awarded the degree of Doctor of Technology for research in environmental engineering. He was appointed Assistant Director at the BRE in April 1980 and moved into private practice in the autumn of 1981.

Dr B C Lindley Before joining Dunlop Ltd in 1979 as Director of Research he was Chief Executive and Managing Director of ERA Technology Ltd (formerly the Electrical Research Association) which he joined in 1968. He graduated from University College London with first-class honours in Mechanical Engineering. Later he obtained his PhD in Mechanical Engineering from University College London and in 1979 was made a Fellow of the College. Dr Lindley has established an international reputation in the field of advanced energy conversion and in 1963 initiated a major breakthrough in the application of superconductors to large-scale electrical machines. He has published widely in many areas of electrical and mechanical engineering, plasma physics and the broader aspects of innovation, exploitation and management of technology. After periods with National Gas Turbine Establishment and with the Hawker Siddeley Group, he joined C A Parsons & Co Ltd,

becoming the first Manager of their R&D Division in 1965. He has been a member of the former Science and General Divisional Board and in recent years has served the Science, Education and Management Division of the IEE, becoming Chairman for 1974-75. He has seen service on the IEE Council and committees, on the Boards of the Power and Electronics Divisions and as a member of the Professional Group Committees S1 and S6 of which he has been Chairman, and has been a member of the Engineering Policy Board. In addition to his involvement with the IEE, the IMechE, IoP and other responsibilities, Dr Lindley is a Fellow of the Institute of Directors and a member of many other committees.