

# On Her Majesty's Service

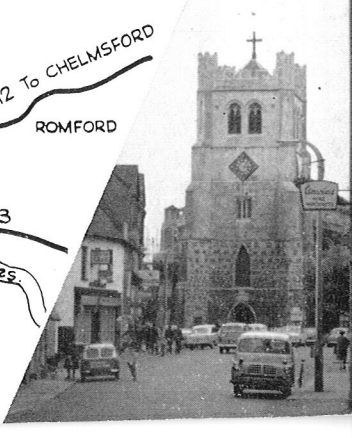
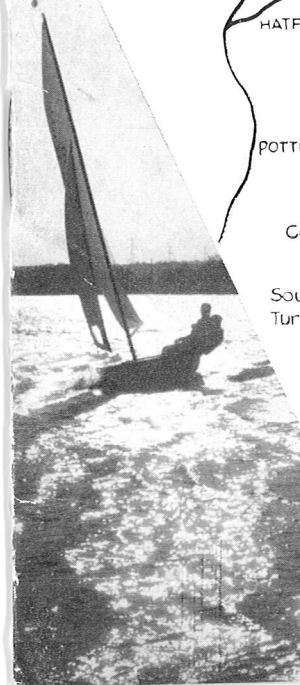
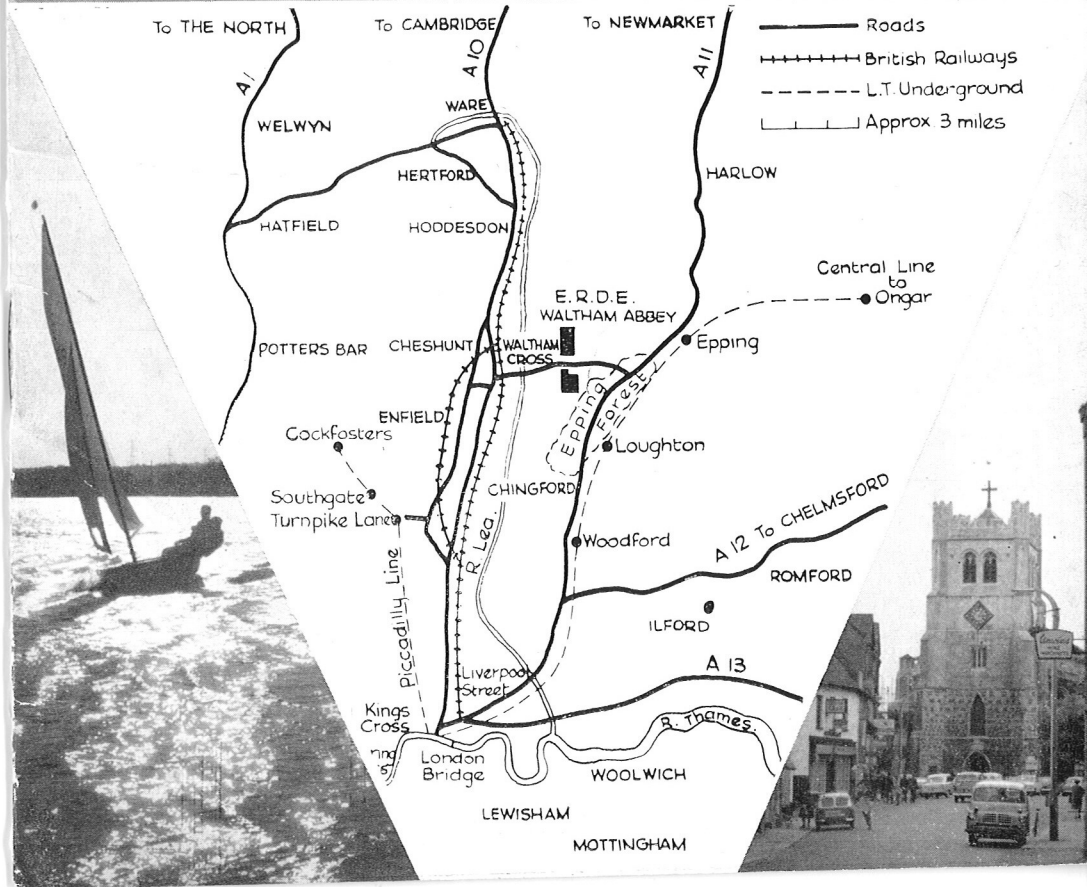
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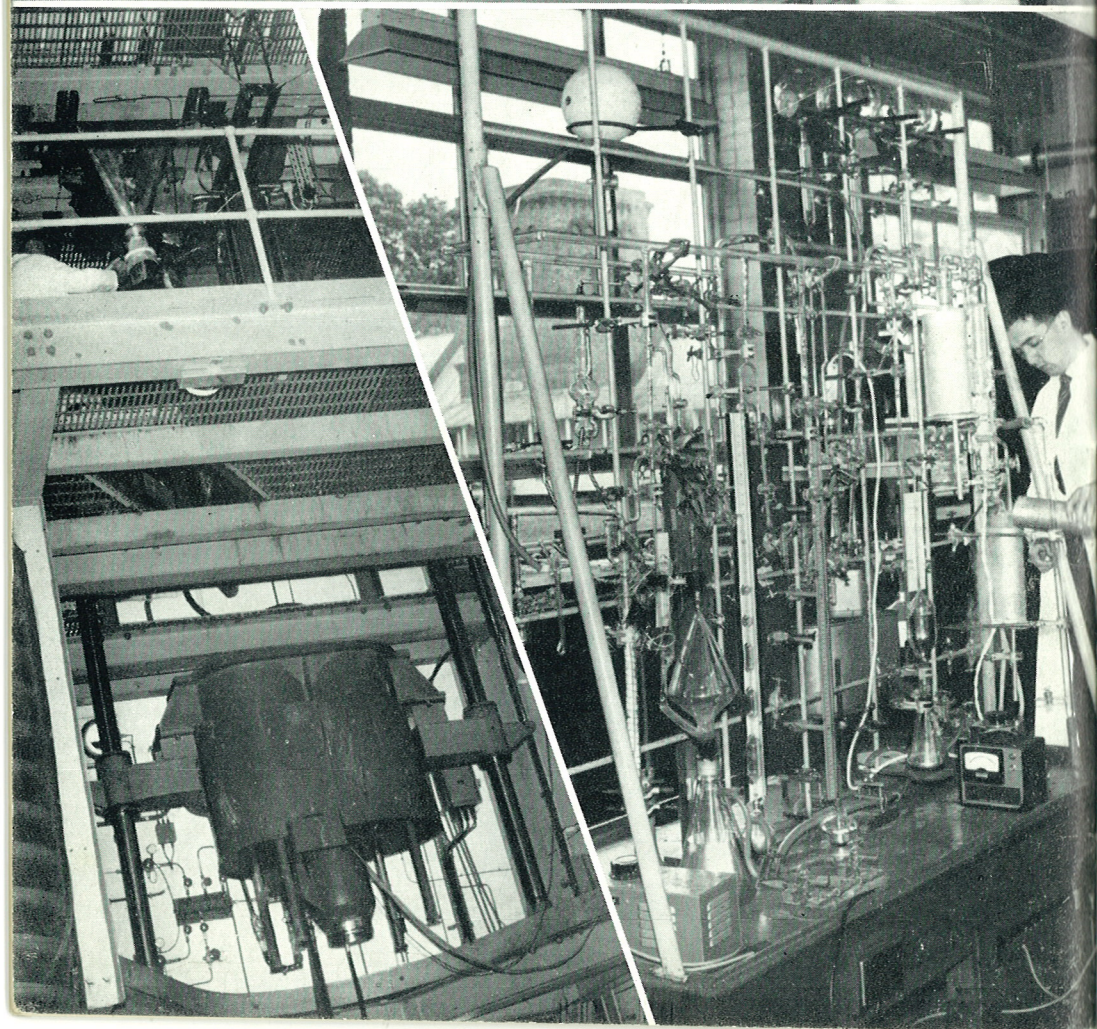
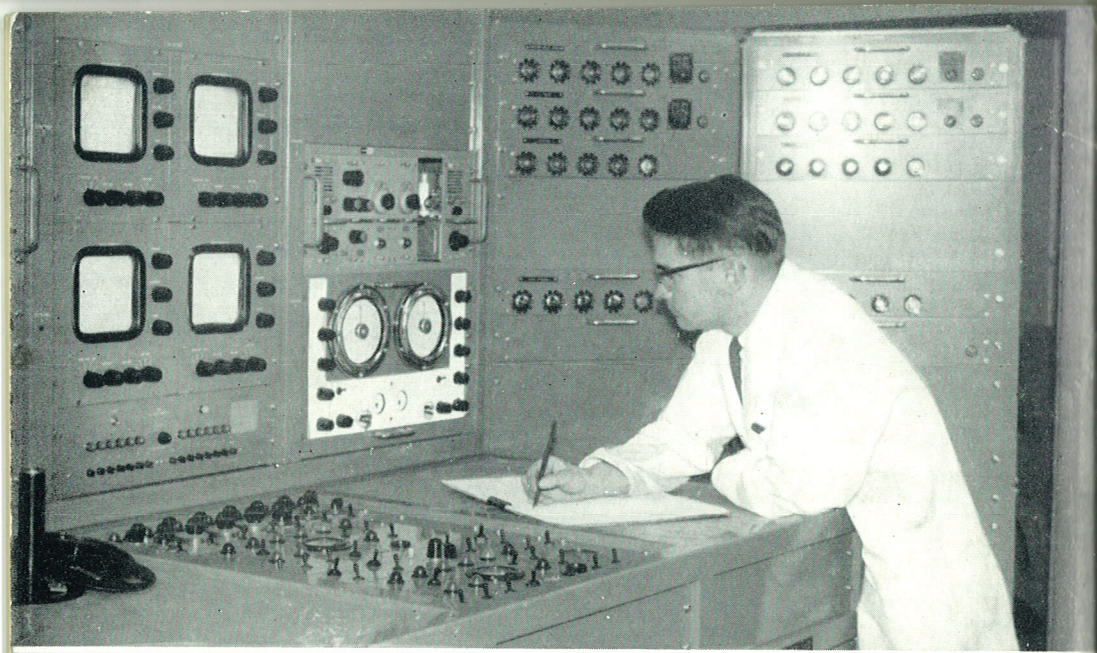
MINISTRY OF AVIATION (ERDE)  
WALTHAM ABBEY BOOKLET  
PREPARED FOR SCIENTIFIC  
RECRUITMENT.



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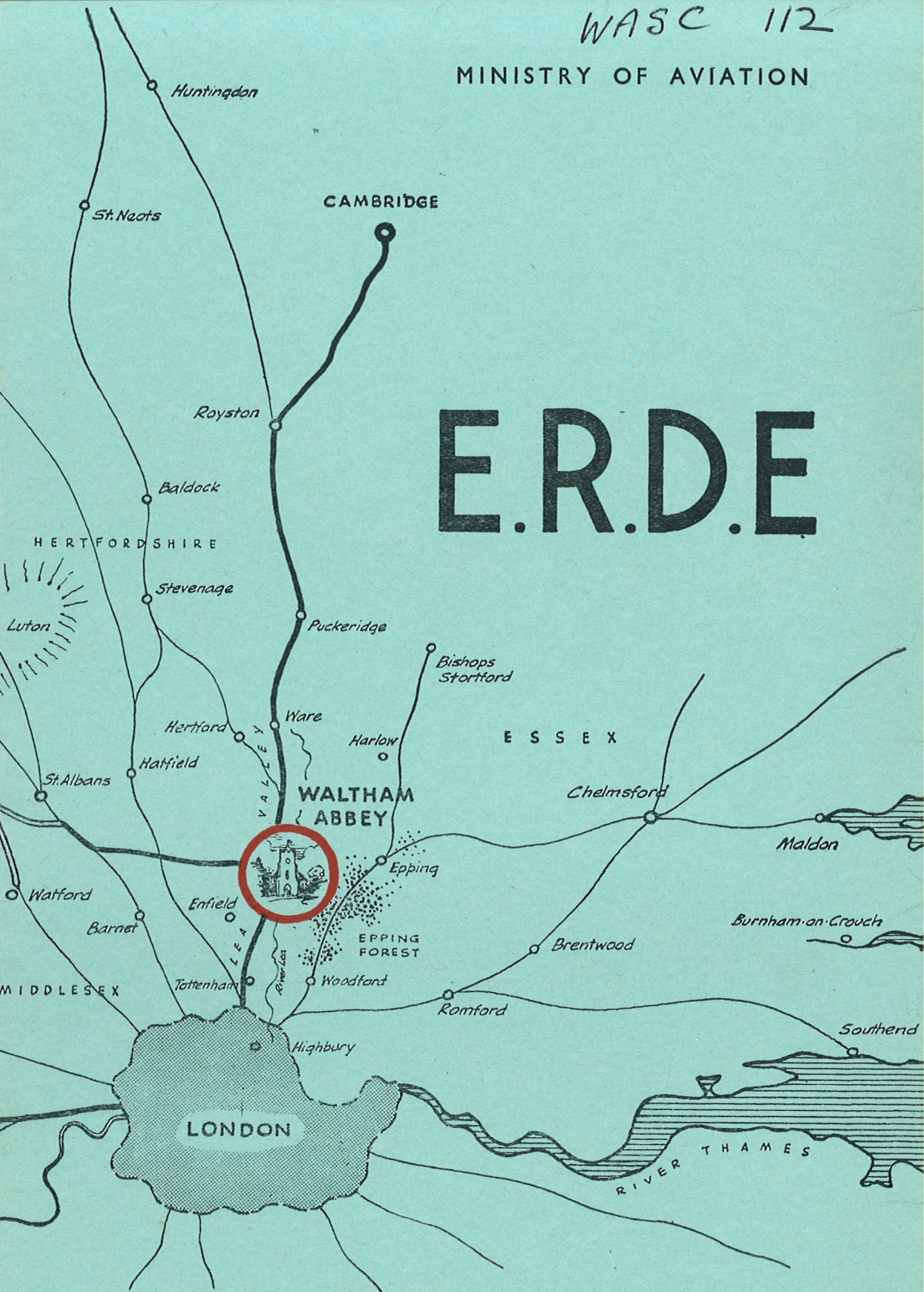






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MINISTRY OF AVIATION



# E.R.D.E

EXPLOSIVES RESEARCH & DEVELOPMENT  
ESTABLISHMENT, WALTHAM ABBEY, ESSEX



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EXPLOSIVES RESEARCH AND  
DEVELOPMENT ESTABLISHMENT  
WALTHAM ABBEY

*"Choose money and Gunpowder."*

—from "Major Barbara," by Bernard Shaw.

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1963



EXPLORATIVE RESEARCH AND  
DEVELOPMENT ESTABLISHMENT  
WALTHAM ABBEY

CONFIDENTIAL AND PROPRIETARY

Major Robert J. ...  
Major Robert J. ...

CONFIDENTIAL AND PROPRIETARY



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**The Explosives Research and Development Establishment**

**Ministry of Aviation**

**Waltham Abbey, Essex.**

'Phone: Waltham Cross 23688

**SENIOR STAFF**

Director	Dr. C. H. Johnson, C.B.E. (C.S.O.)
Deputy Director	Dr. G. H. S. Young (D.C.S.O.)
Heads of Branches (S.P.S.O.)	Mr. P. R. Freeman
	Mr. J. E. Gordon
	Dr. A. L. Lovecy
	Mr. R. G. Ross
	Mr. H. Warburton Hall
	Mr. E. G. Whitbread
	Dr. R. L. Williams
	Dr. W. G. Williams

**Individual Merit Appointments**

(D.C.S.O.)	Mr. G. K. Adams
	Dr. L. J. Bellamy
(S.P.S.O.)	Dr. A. W. H. Pryde
	Mr. G. W. C. Taylor
	Dr. N. Uri
	Mr. H. Ziebland



## HISTORY AND PRESENT FUNCTIONS

Essentially E.R.D.E. is a centre of chemical and physical research. It was set up immediately after the last war on the site of the old Royal Gunpowder Factory which had an unbroken history stretching back at least to Stuart times and possibly earlier. Waltham Abbey is the only Government Department carrying out research on all aspects of military explosives and propellants, although, as will be seen later, much work is done on non-metallic materials. Because of our special position in the explosives field a very wide variety of questions are put to us from all three Services—on topics ranging from guided missile and stratosphere rockets to pilot ejector seat cartridges and even smaller components. Our primary function is to provide the answers to such questions, but this does not mean that we are restricted to *ad hoc* technological problems. We can only properly fulfil our function as expert consultants if we are actively engaged on research in the subjects with which we are concerned. For this reason our interests cover a quite surprisingly wide field of science.

## MINISTRY OF AVIATION

E.R.D.E. is part of the Ministry of Aviation but serves all the Defence departments, Navy, Army, and Air, as it did in the days of the Ministry of Supply. Close working arrangements exist with other Government establishments, notably with the Rocket Propulsion Establishment (Westcott) and the Royal Armament Research and Development Establishment (Fort Halstead) on explosives; and with the Royal Aircraft Establishment (Farnborough) and Royal Radar Establishment (Malvern) on materials research.



### **SCOPE AND SIZE**

The organisation of E.R.D.E. is such that no young man of ability and originality will be denied a satisfying research outlet. Generally, new entrants join one or other of the research teams. Interesting and important problems also arise on the applied side, and in order to ensure that the development staff continue to keep in touch with science many of them devote a proportion of their time to longer term investigations. The present strength is between seventy and eighty Scientific Officer grades (chemists forming the majority, with a sprinkling of physicists and research engineers) and some hundred and sixty Experimental Officers and Scientific Assistants. Most of the research is carried on by small teams numbering two to six, headed by a Senior or Principal Scientific Officer.

### **EQUIPMENT AND FACILITIES**

The establishment is housed in numerous well-furnished laboratories, with plenty of working space. Specialised equipment is designed in the drawing office and fabricated in one or other of the main machine shops, but most groups have minor facilities of this sort of their own. A team of glass blowers under expert supervision produces apparatus for research purposes, and makes experiments with designs of their own devising. There is usually no difficulty about the provision of any type of instrumentation which may be required. For example, several infra-red and other spectrometers are available, and the establishment is equipped for work in X-ray and electron microscopy, very high speed photography, mass spectrometry, preparative gas chromatography, precision calorimetry, and radio-chemistry, to mention some well-known techniques of measurement. A nuclear magnetic resonance outfit has been ordered since there is now the prospect of application to our specialised problems.



## **LOCATION AND HOUSING**

Waltham Abbey is about thirteen miles north-east of Charing Cross on the edge of Epping Forest, and is bordered on two sides by open country. There are pleasant residential districts within a few miles. About half a mile from the Main Gate, we have an estate of a hundred houses, and a few more are situated along the fringe of the establishment itself. These are allocated as they become vacant by a committee composed of staff. The waiting period varies, but recently the average time for a new entrant, a married Scientific Officer, say, has been about six months.

## **RESEARCH AND DEVELOPMENT ACTIVITIES**

The broad basis of our research interests is illustrated in Appendices 1 and 2 at the end of this brochure, in which references to some of our latest publications are given with descriptions of the kinds of investigation for which we should like to recruit staff. The establishment is organised in eight main branches, each covering particular types of work and co-operating as necessary with others in joint approaches to projects and problems. For obvious reasons little can be said of the development side of our affairs, although it can be assumed that any Defence or Civil project publicly mentioned involving the use of propellants or explosives will have had our attention in the initial stages at least. Two of the branches, and the Chemical Engineering Branch, are mainly concerned with development work, but they also carry out parallel investigations of a basic sort such as mass-transfer phenomena, the control of crystal size and habit, fractionation of polymers, and the design of furnaces for the conduct of high-temperature reactions. Two research branches give support to the development teams and, on their own account, engage in a variety of studies: organic synthesis and reactions; radical reaction kinetics; equations of state at detonation pressures; critical



phenomena in liquids; rheology; theoretical investigations of bond energies, and of a wide selection of problems. In the missile and aerodynamic fields especially, the practicability or efficiency of advanced engineering objectives are entirely dependent on the existence of suitable materials, and in consequence the amount of effort devoted to materials at Waltham Abbey is being systematically increased. New materials may take the form of particular types of polymer (for plastics, rubbers, or adhesives) or ceramic fibres or films, or some of these in association. Basic research is in progress on nucleation and growth in single crystals of oxides, nitrides and carbides and on factors affecting their mechanical properties at high temperature. Chemical study and control of the preparation of materials for solid-state devices such as semi-conductors and lasers are urgently required, and a broadly based chemical establishment such as exists at Waltham Abbey is well suited to undertake these tasks. Two very active branches are engaged on materials research. The research sections of the Analytical Branch are tackling difficult applications of the radio-chemical technique, and the measurement of fluorescence spectra of chelating compounds and chelates. In short, a substantial proportion of E.R.D.E.'s professional staff is devoted to matters having long-range implications for Defence, with the object of building up scientific and technological capital against possible future requirements.

#### **PUBLICATIONS**

Little of the basic work carried out is of a secret nature and the research staff are encouraged to contribute to the scientific journals. Examples are given in Appendix 1. When security requirements restrict or prevent open publication, or when the patentable character of the work makes it unsuitable for immediate communication outside, the establishment's reports are circulated within the Defence departments and to University consultants, thus permitting criticism and discussion.

## **SCIENTIFIC CONFERENCES AND MEETINGS**

We try to maintain personal contacts at all levels with members of Universities and Research Associations. Our staff make visits, give lectures and present papers at conferences. Related research in pure science at several Universities is financed by the Ministry at our instigation, and this makes for close ties with the people concerned. We are in the fortunate position of being able to ask the help of distinguished scientists who serve on Government consultative committees connected with our work. Representation at scientific meetings is supported whenever these bear generally on our interests. Many staff go abroad to attend conferences and to effect co-operation with other countries. During 1962, for example, numerous journeys have been made to the U.S.A. and some to European countries and Canada. We are continuously represented on the Defence Research Staff in Washington, our men serving for terms of up to four years.

## **CURRENT VACANCIES**

Details of posts which we wish to fill with Scientific Officer grades are given in Appendix 2. A list of vacancies is, of course, liable to sudden changes and therefore no-one should be put off from applying simply because he does not feel well suited to any of those mentioned. Applicants having specialised interests in parts of our work will be particularly welcome. The best way of finding out whether we have vacancies of a sort likely to interest you, is to write and ask, or visit us and talk things over. We shall be glad to arrange this.

## **SALARIES AND PROMOTION PROSPECTS**

A summary of current salary scales is given in Appendix 3 at the end. Below the age of 26, you would join us as a Scientific



Officer and your salary would be determined by your age and length of post-graduate experience. For example, at age 24 and with two years' research experience the commencing salary would be in the region of £970 p.a. Promotion to S.S.O. (£1,446 to £1,780) is decided solely on merit, and the outstanding man can achieve it at 26, or may join in this grade at that age. The average graduate will attain the S.S.O. level at about 28 or 29. The long S.O. salary scale so often quoted in official statements is largely fictional, as very few enter at the bottom and practically all jump the last four or five steps on promotion. Subsequent promotion to P.S.O. (£1,845 to £2,575) is similarly a question of merit. Outstanding people attain this in their early thirties and the average man at about 40.

Those who are successful as P.S.O.s and who have managerial qualities as well as research ability will in due course be promoted to higher grades of the Class. Those of outstanding research ability may be promoted to non-managerial posts under the Individual Merit Promotion Scheme, and are then free to concentrate on research. Our total of between seventy and eighty Scientific Officer grades include seventeen who are Senior Principal Scientific Officers or of higher rank. Of these, six hold "Individual Merit" posts.

#### **HOLIDAYS AND PENSIONS**

Holidays for Scientific Officers are initially 22 days per annum (equivalent to four weeks plus two days), exclusive of public holidays and one or two special days, rising progressively to 30 days (six weeks).

The Government's pension scheme for established officers is non-contributory and offers a pension based on 1/80th of the retiring salary, averaged over the concluding three years of service, for each year of reckonable service. In addition a lump sum is payable amounting to three times the first year's pension. There

is also a contributory scheme for widows' and children's pensions. A person insured in the Federated Superannuation Scheme for Universities brought under the Government's pension scheme may maintain privately all, or part, of his F.S.S.U. policies. If he does not wish to maintain them, they are kept by the Trustees of the Scheme as fully-paid-up policies until retirement. Much fuller details are given with offers of appointment, but we shall be pleased to answer any questions you may care to raise.

### **SPORTS AND SOCIAL ACTIVITIES**

The E.R.D.E. Sports and Social Club organises a wide range of activities from chess and film societies to cricket and table tennis. There is a flourishing sailing club which has access to 200 acres of attractive water, barely a mile away, through the local branch of the Civil Service Sailing Association.

### **HOW TO APPLY**

There are two distinct methods of entry into Government service. The first is to write to us, when we will arrange an interview here, at a time convenient to yourself. You must have a first or second class honours degree, and preferably some research experience. If all goes well we can offer you a post as S.O. or, if you are an experienced man, S.S.O. in what is called an "unestablished" capacity. The term "unestablished" is used to distinguish between appointments made by a Ministry and those by the Civil Service Commission, who are the only body empowered by law to engage "established", i.e., pensionable, civil servants. Alternatively you can, if you wish, apply for employment to the Commissioners who advertise regularly in the



Press, and ask to be put in touch with E.R.D.E. Waltham Abbey. However, it is often convenient to make this application after you have acquired a year or two's experience here. Provided we are able to say then that you are doing a satisfactory job, it naturally carries weight with the Commissioners. You lose nothing by going about it in this fashion since when you eventually become "established" by the C.S.C. your pension rights are back-dated to cover the whole period of service.

If you are interested you should write to any of the persons named on page iv of this brochure at the address given on that page, and ask for an interview.

#### **RESEARCH FELLOWSHIPS**

In addition to the posts described in Appendix 2 there are openings in E.R.D.E. for Research Fellows. These are intended to be held by outstanding young men who want to do a further two or three years' research before deciding upon a career. For this reason the research topics chosen tend to be of an academic type and are always suitable for open publication. Fellowships are therefore as valuable to those who wish ultimately to follow an academic career as they are to those who elect to stay in government service. It is always our hope that a large proportion of Fellows, having seen something of the facilities and conditions of government research will want to transfer to the permanent staff. A regular post of equivalent status is open to the holder at any time.

The research topics are largely decided by the interests and experience of the candidate although, of course, they usually bear on some aspects of our current work. We are therefore prepared to consider applications for fellowships in any of our various fields of interest. We would particularly welcome applicants experienced in autoxidation, spectroscopy, crystal growth phenomena or in chemical engineering.

A Junior Fellowship carries a salary within the range of £985 to £1,320 p.a. and a Senior Fellowship from £1,430 to £1,765. Further details can be obtained by application to the Director or to any of the senior staff listed on page iv known to the candidate.



## APPENDIX 1

### SOME RECENT PUBLICATIONS BY E.R.D.E.

During the past four years nearly 100 publications from E.R.D.E. have appeared in well-known scientific journals. These include the *Journal of the Chemical Society* (21), *Transactions of the Faraday Society* (7), *Proceedings of the Royal Society* (3), *Combustion and Flame* (3), and many others. A selection of titles is given below.

Arden, E. A., and Phillips, L., 'Reduction and Oxidation of Nitric Oxide in the System Diethyl Peroxide—Nitric Oxide: Reactions of HNO,' *Proc. Chem. Soc.*, 1962, 354.

Bellamy, L. J., and Williams, R. L., "Solvent Effects on Infrared Group Frequencies," *Proc. Roy. Soc.*, 1960, **A255**, 22.

Bellamy, L. J., Lake, R. F., and Pace, R. J., "Hydrogen Bonding in Carboxylic Acids—II. Monocarboxylic Acids," *Spectrochim. Acta*. 1963, **19**, 443.

Blay, N. J., Pace, R. J., and Williams, R. L., "Boron Hydride Derivatives. Part VIII. Some Reactions of Sodium Decaborate in Relation to Decaboranylmagnesium Iodide," *J. Chem. Soc.*, 1962, 3416.

Bromberger, (Mrs.) B., and Phillips, L., "The Abstraction of Nitric Oxide from Alkyl Nitrites in the Vapour Phase by Methyl Radicals," *J. Chem. Soc.*, 1961, 5302.

Dedman, A. J., and Owen, A. J., "Calcium Cyanamide Synthesis. Part 4—The Reaction  $\text{CaO} + \text{CO}_2 = \text{CaCO}_3$ ," *Trans. Faraday Soc.*, 1962, **58**, 2027.

Dukes, W. A., "The Endurance of Polythene under Constant Tension whilst Immersed in Igepal," *Brit. Plastics*, 1961, **34**, 123.

Dunstan, I., and Griffiths, J. V., "Determination of Carbon by Wet Combustion. Application to Explosives and Initiators," *Analyt. Chem.*, 1962, **34**, 1348.

- Golden, J. H., "The Degradation of Polytetrafluorethylene by Ionising Radiation," *J. Polymer Sci.*, 1960, **45**, 534.
- Gooding, R. W., and Parratt, N. J., "Solid Titanium Nitride and other Refractory Compounds made by Direct Gas-Metal Reaction," *Powder Metallurgy* (in the press).
- Harding, G. W., "An Improved Suspended Level Viscometer," *J. Polymer Sci.*, 1961, **55**, S.27.
- Maxwell, W. R., and Young, G. H. S., "Solid Rocket Motors," *J. Roy. Aero. Soc.*, 1961, **65**, 252.
- Owen, A. J., "The Electronic Structure of Some Heteroatom Conjugated Compounds," *Tetrahedron*, 1961, **14**, 237.
- Powling, J., Smith, W. A. W., and Thynne, J., "The Flame Decomposition of Some Substituted Ethyl Nitrates," *Combustion and Flame* 1960, **4**, 201.
- Powling, J., and Smith, W. A. W., "Measurement of the Burning Surface Temperature of Propellant Compositions by Infrared Emission," *Combustion and Flame*, 1962, **6**, 173.
- Roberts, J., "Estimation of Dynamic Modulus and Dynamic Yield Stress for 'Perspex'". *Nature*, 1961, **190**, 799.
- Ziebland, H., "The Thermal Conductivity of Toluene. New Determinations and an Appraisal of Recent Experimental Work," *Int. J. Heat Mass Transfer*, 1961, **2**, 273.
- Ziebland, H., and Patient, J. E., "Thermal Conductivity of n-Octadecane. New Measurements and a Critical Appraisal of the Article by Sutherland, Davis and Seyer," *J. Chem. Eng. Data*, 1962, **7**, 530.



## APPENDIX 2

### POSTS WE WISH TO FILL AT E.R.D.E.

Vacancies for graduate students, preferably with two or more years' research experience, exist in certain areas of work at E.R.D.E., particularly in those which are just starting up or are taking a new direction.

We have recently set up a new branch in E.R.D.E., which will be primarily concerned with the properties of inorganic materials. Their chief research interests lie in the preparation and study of whisker crystals of refractory materials such as silicon nitride. These whiskers exhibit remarkable physical properties in that, if properly grown and of the right size, their strength is many times greater than that of the normal bulk compound. They may therefore have application as reinforcing agents in metals and possibly in ceramics. The chemical features of this work—apart from those met with in the preparation of the whiskers themselves—arises from problems of incorporation within a matrix. Data are required, for example, on the chemical stability of silicon nitride in nickel alloys at high temperatures. For this work we need:

1. An inorganic chemist, preferably with some experience of crystal studies or of refractories.

Many problems of general physics are thrown up by this work, including electron microscopy, and the measurement of elastic properties. We therefore have a vacancy for:

2. A physicist or physical chemist with specialist experience in one or other of these subjects.

This group is also active in other directions including semi-conductor chemistry and materials for optical lasers. Although we are not primarily looking for recruits in these latter fields we would be very willing to consider applicants possessing specialised knowledge or experience.

We are also anxious to expand our research in chemical engineering. Routine production work is not envisaged, but experimental work on many

products, processes, and problems is carried on up to the semi-technical scale. We have a number of vacancies in this area, as follows:—

3. To take part in research and development work in connection with controlled crystallisation; typical materials being studied are ammonium perchlorate and cyclotrimethylene trinitramine. Also to take part in research into technical methods of drying fine powdered materials to exceptionally low water content.
4. To lead a small team in the study of methods of conveying and metering flows of materials, particularly solids; the mixing of pastes and powders; the design of furnaces for special purposes.
5. To study methods suitable for remote control, and their application in the experimental processing of normally hazardous materials. This work will be done in collaboration with the Instrumentation Section, and one of the Development Branches.



### APPENDIX 3

#### SALARY SCALES IN THE SCIENTIFIC OFFICER CLASS

The following salary scales, current at March, 1963, apply equally to men and to women working in the London area where Waltham Abbey is situated.

Scientific Officer	Senior Scientific Officer	Principal Scientific Officer	Senior Principal Scientific Officer
£	£	£	£
808	1,446	1,845	2,860
841	1,500	1,926	2,960
873	1,564	2,007	3,085
922	1,645	2,088	3,210
970	1,726	2,169	
1,019	1,780	2,250	
1,056		2,331	
1,089		2,412	
1,121		2,494	
1,154		2,575	
1,186			
1,218			
1,251			
1,284			
1,321			

#### FELLOWSHIPS

Junior Fellowship, within the range £985 to £1,320 p.a.

Senior Fellowship, " " " £1,430 to £1,765 p.a.





1.00	1.00	1.00
1.05	1.05	1.05
1.10	1.10	1.10
1.15	1.15	1.15
1.20	1.20	1.20
1.25	1.25	1.25
1.30	1.30	1.30
1.35	1.35	1.35
1.40	1.40	1.40
1.45	1.45	1.45
1.50	1.50	1.50
1.55	1.55	1.55
1.60	1.60	1.60
1.65	1.65	1.65
1.70	1.70	1.70
1.75	1.75	1.75
1.80	1.80	1.80
1.85	1.85	1.85
1.90	1.90	1.90
1.95	1.95	1.95
2.00	2.00	2.00

APPENDIX

LIST OF THE NAMES OF THE MEMBERS OF THE BOARD OF DIRECTORS OF THE COMPANY FOR THE YEAR 1900







