WASC 2004

ERDE - History, Role, Personnel/ Organisation

WASC 2004

THE HISTORY, ROLE AND ORGANISATION OF ERDE

1 HISTORY

1 1 Early history

ERDE is the central chemical research establishment of the Procurement Executive. Its position stems from its history as a gunpowder mill which existed on this site from the middle of the seventeenth century. It passed into public ownership in 1787 under the direction of General Sir William Congreve whose son is remembered as the moving spirit behind the British Land Service and Naval Rocket Brigades of the Napoleonic era and after. As the Royal Gun Powder Factory, the Establishment saw what must be one of the earliest applications of Quality Assurance in the Ordnance field: under Sir William Congreve it soon acquired a high reputation for the high quality of its powder. What is more, this was achieved at considerably lower unit cost than before, so that the Mills, as they have continued to be called locally, anticipated the Rayner reforms by some 200 years!

1 2 Middle nineteenth and early twentieth centuries

Nitrocellulose and nitroglycerine were first produced for the British Service at Waltham Abbey - indeed until 1915 it remained the only source of cordite in the country. The manufacture of gunpowder continued side-by-side with that of more modern propellants and explosives until the Second World War when German bombing brought production to a halt.

1 3 Post-war history

At the end of the last war the site was largely derelict and might have remained so but for a decision to transfer much of the work of the Research Department of the Royal Arsenal at Woolwich progressively to Waltham Abbey where the name Explosives Research and Development Establishment was adopted. Old buildings were renovated or converted and since these early years new buildings and facilities have been added. In spite of these changes, the Powder Mill origin of the Establishment is not far to seek. On the North Site you may see a powder barge of the type used to transport gunpowder within the Establishment and, via the Lea Navigation Canal, to the Thames and Woolwich. A narrow gauge powder truck can also be seen there, recalling the days when oil-fired steam locomotives were used for internal transport. Walton House on the North Site, originally the residence of the family which owned the Mills before nationalisation, now houses a small historical collection associating the names of Congreve, Henry Cavendish, Benjamin Count Rumford, Sir Joseph Banks and Micheal Farraday (he spells his name thus) with the Mills.

1 4 Expansion

Since it was founded in its modern form, the Establishment's function as an explosives R & D organisation has been extended to cover solid propellants for rockets and by the incorporation of materials laboratories dealing with rubbers and plastics. Additionally a group was incorporated which studied the production and development of ultra-stiff materials which are attractive to the designer of such Ordnance stores as guided and free-flight weapons. Rubbers and plastics are studied because of their widespread use in proximity to explosives and propellants.

2 RELATIONSHIPS WITH OUTSIDE ORGANISATIONS

2 1 Relationships with Procurement Executive as a whole and with industry

ERDE is a joint Directorate with the Rocket Propulsion Establishment at Westcott, near Aylesbury in Buckinghamshire. Formal relationships with the remainder of the Procurement Executive and especially with Quality Assurance and Naval Ordnance Services are shown in Figure 1. The pecked lines show the routes by which contact is maintained at the working level. In the Ordnance field, ERDE has close

relationships with Nobel's Explosives Company Ltd, with Summerfield Research Station (operated by Imperial Metals Industries Ltd and looser relationships with the Martin Baker Company Ltd and with IMI Kynoch Ltd. As integration with RPE is implemented, relationships with Bristol Aerojet Ltd are becoming closer.

2 2 Relationships with overseas organisations

In addition to close and continuing relationships with the Defence Departments of many overseas countries, commercial agreements exist for the manufacture under licence of initiatory explosives compositions in the RD1300 series in Canada, the Indian sub-continent, Sweden and the USA. In the field of strong fibres (used in the production of the ultra-stiff materials previously mentioned) ERDE processes are operated in Finland and Switzerland. In a recent package deal, ERDE and RPE have been involved with Bristol Aerojet Ltd in supplying plant and "know-how" to INTA in Spain for the manufacture and filling of plastic (solid) rocket propellant for sounding rockets.

3 ORGANISATION AND ACTIVITIES

3 1 General

Figure 2 shows the organisation of ERDE. The Director, Dr L J Bellamy CBE, is responsible for this Establishment and for RPE. He is a world authority on infra-red spectroscopy, a technique which has been at least partly responsible for many advances in our knowledge of the structure of non-metals and thus for the emergence since the mid-1930s of a plethora of new fibres, paints, plastics and rubbers. Dr Bellamy's Deputy at ERDE is Mr G K Adams who has specialised in the study of the complicated reactions involved in explosions and propellant burning. Dr Young, the Deputy at Westcott, is a specialist in the formulation and life-testing of solid propellants.

Administrative and engineering support are the responsibilities of the Administrative and Engineering Facilities Branches under Messrs S F M Whiteside, Chief Admin Officer and R Fisher, Chief Engineer, respectively. The role of the Establishment is fulfilled directly through six functional Branches described below.

3 2 Explosives branch

This branch is headed by Dr C A Beck who came to us a few years ago from RARDE. The branch is divided into six functional sections as follows. Explosive Composition section headed by Mr F H Doe, formulates new compositions and products for specific applications. Explosives Performance, under Mr S J Hawkins evaluates compositions as explosives, while Initiating Explosives under Dr R McGuchan develops new initiatory compositions to replace existing formulations which, in spite of intensive development since the Second World War, still possess some undesirable features. Sensitiveness and Hazards 1 Section under Dr R M H Wyatt studies and advises on general hazards associated with explosives while the second section under Dr K N Bascombe is responsible for some aspects of hazards associated with propellants. Both of these sections classify candidate materials according to the hazards associated with their use. Finally, the Woolwich Section headed by Mr K J Holloway operates pilot scale and intermediate scale plant for the production of initiatory explosives developed at Waltham Abbey.

3 3 General chemistry branch

Under Dr A R Osborn, this branch provides a wide range of specialist supporting services from ultrasensitive analytical techniques to glassworking. The Compatibility and Stability section under Mr N J Blay, studies the sensitising effect of a wide range of materials of construction on the thermal stability of explosives and propellants. Crystallography, under Mr J R C Duke, studies the crystalline forms in which explosives and propellants ingredients can exist; these forms can have an important bearing on the functioning of ingredients in compositions.

General Analysis section under Mr E J Gallcher provides a wide range of sensitive analytical techniques, mainly in connection with the determination of stabilisers and their degradation products in propellants. The Glassworking section, led by Mr R Watkins, undertakes laboratory glassblowing and glass engineering for small scale production of chemicals etc. Mr D A G Eldridge heads the group combining glassworking and electronic and mechanical instrumentation. Library and Information Services (Mr M McLaren) is self-exlanatory, as is Maths and Computing Section with Mr M Bergh in charge. The muster of section in this branch is completed by Physical Chemistry section under Dr L Phillips; this is concerned with the mechanisms by which explosives and propellants degrade under storage conditions.

3 4 Non-metallic materials branch

Under the leadership of Dr B L Hollingsworth, this branch has recently been augmented by the transfer of Composites Design and Applications section headed by Mr N J Parratt. The functions of this section are self-explanatory except that the composites concerned are largely those using very stiff fibres such as discontinuous carbon fibres and carefully graded and aligned asbestos fibres. Polymer Assessment (Dr A Davis) deals with the characterisation of the mechanical properties and durability of polymeric materials (rubbers, plastics etc) while in Polymer Chemistry section, led by Dr D H Richards, speciality adhesives of high performance are synthesised. Such adhesives may find widespread use in Defence equipment in future. Polymer Development and Applications section with Dr D Sims in charge undertakes the design and in many cases, serial production of, plastics and rubber components for Service equipment. Finally, Polymer characterisation under Dr A V Cunliffe operates sophisticated instruments for the determination of polymer structure which can determine quite critically the fitness of a polymer for a given application.

3 5 Process research branch

Mr L E Dingle has recently assumed charge of this branch which is currently divided into four functional sections. Chemical Engineering 1, led by Dr A W H Pryde, develops to pilot plant scale processes for the production of explosives and propellants ingredients and optimises existing processes. Chemical Engineering 2 (Dr C C Evans) has similar responsibilities for polymers, fibres and ceramics. The two Preparative Chemistry Sections headed respectively by Drs N F Scilly and G F Hayes are concerned with the laboratory scale study of processes for the production of explosives and propellants ingredients and of polymeric materials respectively. The Thermophysical Properties Section under Mr H Ziebland is a lodger group reporting to the Department of Industry (National Physical Laboratory) and operates the British Calibration Service for thermal measurements.

3 6 Propellants 1 branch

This branch, headed by Dr S W Bell, deals with propellants based on nitrocellulose. It is divided into five functional sections, of which three relate to the principal methods of manufacture. The Cast Double Base (CDB) section under Mr R P Ayerst works on propellants formed by introducing a liquid (usually containing nitroglycerine) into moulds filled with granular nitrocellulose which are then consolidated by the action of gentle heat. In Rocket Cordites (Mr E A Baker), the ingredients after mixing are consolidated by rolling and formed by extrusion into lengths which can be cut as required for charges. Mr Wallace heads the section generally dealing with Gun Propellants and compositions which require the use of solvents for the nitrocellulose; in this group work on combustible charge containers is also carried out. All three propellant types find wide Service application and ERDE is intimately involved in (and indeed is ultimately responsible for in many cases) everything from composition selection and early manufacture through to post-design problems even although full development and production may be elsewhere. In the section under Dr T J Lewis is a small team working on the development of a propellant and charge design for LAW and he also leads our other research on nitrocell-

ulose propellants, notably that on the structure and behaviour of nitrocellulose itself. Ballistic Assessment under Mr Stocks provides services to the remainder of the branch and to other parts of ERDE in measuring the ballistic properties of propellants and small rocket motors.

3 7 Propellants 2 branch

Mr P R Freeman leads this branch which has three sections. The first of these, Adhesion and Rheology headed by Mr W A Dukes, is concerned inter alia with structural adhesives which are finding increasing use in Ordnance, with sealants which are already widely used in that field and with the longterm flow properties of propellants, their shortterm strength as conventionally measured and with their response to the fast-acting forces generated in solid rocket motors on pressurisation and projection. Another field of investigation has been the adhesion of explosive fillings to the walls of shell cases. Failures can occur as a result of the migration of additives to the filling/wall interface and of the thermal contraction arising as the charge cools. The plastic propellant section under Dr J A Hicks formulates, develops and tests this class of propellant which consists of an oxidiser (fine ammonium perchlorate powder) incorporated into a very viscous matrix of poly-iso-butylene and filled into rocket motor cases (sometimes at somewhat elevated temperatures). This propellant, which has already been mentioned as having been sold to Spain as a package deal, is the cheapest available: it has a very wide temperature range and is capable of very high burning rates, a desirable feature in a propellant for an unguided rocket. The Rubbery Propellants section under Mr G J Spickernell, develops composite propellants in which the ammonium perchlorate oxidiser is bound by a matrix made from a liquid rubber prepolymer which, on mixing with a crosslinking agent at room temperature, is a quite mobile liquid easily cast into moulds with complex profiles. Curing is effected by heating. The method is clearly attractive, but the chemistry of crosslinking and staorage stability is still far from clear. Much work is therefore being done on such systems here and overseas.

4 CONCLUSION

This brief account of the Explosives Research and Development Establishment has necessarily glossed over a number of aspects of our work. Those who seek further information should approach the officers named, or the Technical Training Officer, Mr D Gordon, extension 233 who is responsible for co-ordinating visits to the Establishment.

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November 1975

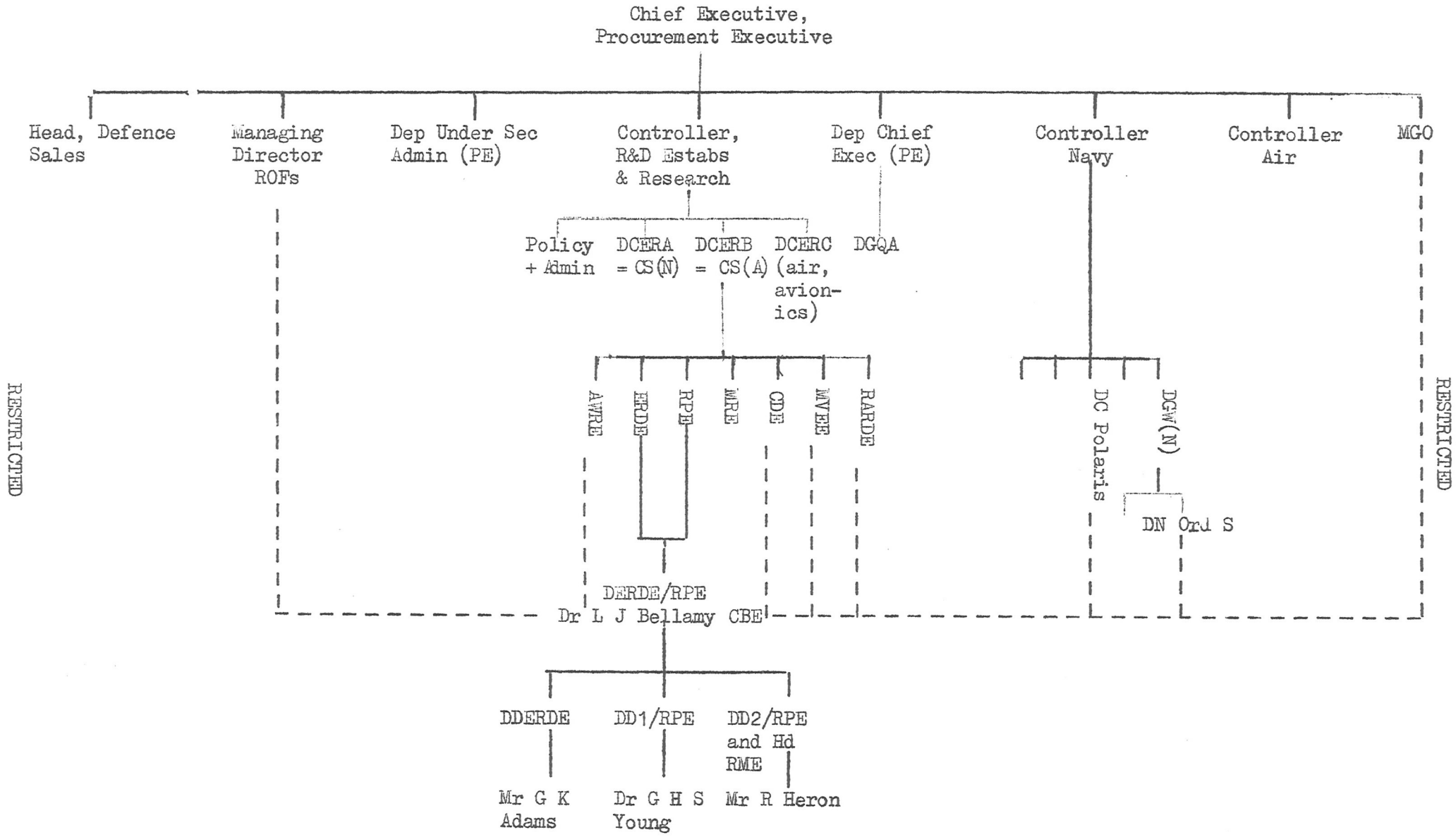

FIGURE 1 - RELATIONSHIPS BETWEEN ERDE/RPE AND THE REMAINDER OF PROCUREMENT EXECUTIVE, MINISTRY OF DEFENCE

Director Dr L J Bellamy CBE Under Sec 203 (Estab Safety Off J V Griffiths PSO 229, Tech Asst D Gordon SSO 233)

Deputy Director G K Adams DCSO 413 (Tech Asst R S Smith PSO 518)

	Sec	Section name	Section leader, grade and tel no(s)
Explosives Dr C A Beck SPSO 306	EC	Explosive compositions	F H Doe SSO 562 433
	EP	Explosives performance	S J Hawkins PSO 436 439
	IE	Initiating explosives	Dr R McGuchan PSO 240 210 523
	IS	Interservices research	Dr R Campbell PSO 321
	SH1	Sensitiveness & hazards 1	Dr R M H Wyatt (general hazards) PSO 322 307
	SH2	Sensitiveness & hazards 2	Dr K N Bascombe (FARM) PSO 307 322
	WS	Woolwich section	K J Holloway PSO 84237 84239
General Chemistry Dr A R Osborn SPSO 346	CR	Crystallography	J R C Duke SSO 305
	CS	Compatibility & stability	N J Blay PSO 237
	EI	Electronic instrumentation	D H L Mansell SSO 348
	GA	General analysis	E J Gallacher SSO 494 311 236
	GW	Glassworking	(R Watkins HSO)†* 349
	LI	Library and information	M McLaren SSO 256 235
	MC	Mathematics & computing	(M Bergh SO)† 396
	MI	Mechanical instrumentation	R I Cracknell HSO* 348
	PC	Physical chemistry	Dr L Phillips PSO 276 409 547
NM Materials Dr B L Hollingsworth SPSO 390	CD	Composite design and applications	N J Parratt PSO 597 411
	PA	Polymer assessment	Dr A Davis PSO 382
	PC	Polymer chemistry	Dr D H Richards SPSO(SM) 480
	PD	Polymer development and applications	Dr D Sims PSO 590
	PX	Polymer characterisation	Dr A V Cunliffe SSO 462 458
Process Res L E Dingle SPSO 374	CE1	Chemical engineering 1	Dr A W H Pryde SPSO(SM) (expl, prop) 351
	CE2	Chemical engineering 2	Dr C C Evans PSO (polymers fibres and ceramics) 415 411
	PC1	Preparative chemistry 1	Dr N F Scilly PSO (expl, propellants) 515
	PC2	Preparative chemistry 2	Dr G F Hayes PSO (polymers) 423
	TP	Thermophysical properties	H Ziebland PSO (reports to Dept of Industry, NPL) 553
Propellants 1 Dr S W Bell SPSO 319	BA	Ballistic assessment	G W Stocks PSO 291
	CD	Cast double base propellts	R P Ayerst PSO 545
	GD	General DB propellants	Dr T J Lewis PSO 202
	GP	Gun propellants	R A Wallace PSO 381
	RC	Rocket cordites	E A Baker SSO 469
	TA	Technical adviser	R J Walley SSO 372
	TR	Trials	Dr J Gooding SSO 532
Propellants 2 P R Freeman SPSO 414	AR	Adhesion and rheology	W A Dukes PSO 463
	PP	Plastic propellants	Dr J A Hicks PSO 487
	RP	Rubbery propellants	G J Spickernell PSO 301
Engng Facs R Fisher PPTO 249	DCE	Deputy chief engineer	J M Davies PTO1 330
	DOM	~~Des offices &~~ m/c shop	R P Clarke PTO1 596 283
	DO	Des offices	H C Turner PTO1 435
	BWD	Building works dept	J E Brown PTO2 279
	ES	Electrical services	M D Hicks PTO2 524 263
	MS	Mechanical services	F H Mills PTO2 582 564
Administration S F M White-side CEO 300	SAO	Senior admin officer	S G Lock SEO 338
		AO/G = " " gen.	A J Eley HEO 378
		AO/P = " " pers[1]	G E Chapman HEO 334
		AO/P = " " stores	J C Turner HEO 336

*report to D A G Eldridge PSO ext 522 † in charge in absence of designated Sec Ldr

FIGURE 2 - LINE MANAGEMENT CHART FOR THE EXPLOSIVES RESEARCH AND DEVELOPMENT ESTABLISHMENT

Mr Stocks. WSmith

RESTRICTED

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THE HISTORY, ROLE AND ORGANISATION OF THE EXPLOSIVES RESEARCH AND DEVELOPMENT ESTABLISHMENT, WALTHAM ABBEY, ESSEX

1 HISTORY

1 1 Early history

ERDE is the central chemical research establishment of the Procurement Executive Ministry of Defence. This position stems from its history as a gunpowder mill, established on the River Lea at Waltham Abbey in the middle of the seventeenth century. The mill passed into public ownership as the Royal Gun Powder Factory in 1787, under the direction of General Sir William Congreve, whose son of the same name is remembered as the moving spirit behind the British Land Service and Naval Rocket Brigades of the Napoleonic era and afterwards. As the Royal Gunpowder Factory, the Establishment saw what must be one of the earliest applications of Quality Assurance in the Ordnance field: under Sir William, it soon acquired an unrivalled reputation for the quality of its powder. This was achieved at considerably lower unit cost than before nationalisation, so that the Mills, as they have continued to be called locally, may be said to have anticipated the Rayner reforms by some 200 years!

1 2 Middle nineteenth and early twentieth centuries

Single and double-base propellants and their ingredients nitrocellulose and nitroglycerine were first produced for the British Service at Waltham Abbey - indeed until 1915 it remained the only source of cordite in the country. The manufacture of gunpowder continued side-by-side with that of more modern explosives and propellants until the Second World War, when German bombing brought production to a halt.

1 3 Post-war history

At the end of the Second World War the site was largely derelict and might have remained so but for a decision to transfer much of the work of the Research Department of the Royal Arsenal at Woolwich progressively to Waltham Abbey where the name Explosives Research and Development Establishment was adopted. Old buildings were renovated as laboratories, and process areas up-dated. Since these early days, new buildings and facilities have been added. Three major items from Royal Gun Powder Factory days have been preserved: a millstone from an edge runner incorporating mill (displayed at the Main Gate entrance to the North Site), a gunpowder barge used for transport of powder within the Factory (beached opposite the North Site boilerhouse) and a narrow gauge powder wagon, propelled by hand or as part of a train drawn by an oil-fired locomotive (mounted opposite the entrance to the Library and Lecture Theatre building in North Site). Walton House, also on North Site, was the residence of the family which owned the mills before nationalisation: it houses a small historical collection associating the names of Congreve, Henry Cavendish, Benjamin Count Rumford, Sir Joseph Banks PRS and Michael Farraday (he spells his name thus) with the Factory.

1 4 Expansion

Since it was founded in its present form, the Establishment's function as an explosives R & D Organisation has been extended to cover solid propellants for rockets and non-metallic materials for use in Ordnance where the proximity of explosives and propellants constitutes a particularly exacting environment. Non-metallic materials work embraces the study of ultra-stiff materials which are attractive to the designer of such Ordnance stores as guided and free-flight weapons.

2 RELATIONSHIPS WITH OUTSIDE ORGANISATIONS

2 1 Relationships with Procurement Executive as a whole and with industry

ERDE is a joint Directorate with the Rocket Propulsion Establishment at Westcott, near Aylesbury in Buckinghamshire. Formal relationships with the remainder of Procurement Executive and especially with Quality Assurance and Ordnance Branches are shown at figure 1. The pecked lines show the routes by which technical contact is maintained at the working level. In the Ordnance field, ERDE has close relationships with Nobel's Explosives Company Ltd, with Summerfield Research Station (operated by Imperial Metal Industries Ltd) and looser relationships with the Martin Baker Company Ltd and IMI Kynoch Ltd. As integration with RPE is implemented, relationships with Bristol Aerojet Ltd are becoming closer.

2 2 Relationships with overseas organisations

In addition to maintaining close and continuing relationships with the Defence Departments of many overseas countries, commercial agreements exist for the manufacture under licence of initiating explosive compositions in the RD1300 series in Canada, the Indian sub-continent, Sweden and the USA. In the field of strong fibres (used in the production of the ultra-stiff materials previously mentioned), ERDE processes are operated in Finland and Switzerland (the latter suspended for the time being). In a recent package deal, ERDE and RPE have been involved with Bristol Aerojet Ltd in supplying plant and "know-how" to INTA in Spain for the manufacture and filling of plastic (solid) rocket propellant for sounding rockets.

3 ORGANISATION AND ACTIVITIES

3 1 General

Figure 2 shows the organisation of ERDE. The Director, Dr L J Bellamy CBE, who is responsible for this Establishment and for RPE, is a world authority on infra-red spectroscopy, a technique which has been at least partly responsible for many advances in our knowledge of the structure of non-metals and thus for the emergence since the mid-1930s of a plethora of new fibres, paints, plastics and rubbers. Dr Bellamy's Deputy at ERDE is Mr G K Adams who has specialised in the study of the complicated reactions involved in explosions and in propellant burning. Dr Young, Deputy Director 1 at Westcott, a specialist in the formulation and life-testing of solid propellants, is in charge of Research there, while Mr R Heron, Deputy Director 2, covers Development and is also Head of the Rocket Motor Executive. Administrative and engineering support at ERDE are the respective responsibilities of the Administrative Branch under Mr S F M Whiteside and the Engineering Facilities Branch under Mr R Fisher. The role of the Establishment is fulfilled directly through six functional Branches, described below.

3 2 Explosives branch

This Branch is headed by Dr C A Beck and is divided into six sections as follows. Explosive Compositions under Mr F H Doe formulates new compositions and products for specific applications. Explosives Performance under Mr S J Hawkins evaluates new compositions as explosives and advises on explosive effects, while Initiating Explosives under Dr R McGuchan develops new compositions to replace existing formulations which, in spite of intensive development since the Second World War, still possess some undesirable features. Sensitiveness and Hazards 1 Section under Dr R M H Wyatt studies and advises on general hazards associated with explosives while Section 2 under Dr K N Bascombe is responsible for the study of some aspects of hazards associated with rocket and gun propellants: both of these sections classify candidate materials according to the hazards associated with their manufacture and use. Finally, the Woolwich Section under Mr K J Holloway operates pilot scale and intermediate scale plant for the production of initiating explosives developed at ERDE.

3 3 General chemistry branch

Under Dr A R Osborn, this branch provides a wide range of specialist services grouped as below. Compatibility and Stability section headed by Mr N J Blay studies the sensitising effect of a wide range of materials of construction on the thermal stability of explosives and propellants. Crystallography, with Mr J R C Duke in charge, studies the crystalline forms in which explosives and propellants ingredients can exist; the form can have an important bearing on the functioning of ingredients in compositions. General Analysis under Mr E J Gallacher apply a wide range of sensitive analytical techniques, mainly in connection with the determination of stabilisers and their degradation products in propellants. The Glassworking section lead by Mr R Watkins, undertakes laboratory glassblowing and glass engineering for the small-scale production of chemicals etc. Mr D A G Eldridge heads the group combining glassworking, electronic and mechanical engineering, the two last being under the supervision of Messrs D H L Mansell and R I Cracknell respectively. Library and Information Services (Mr M McLaren) and Mathematics and Computing Sections provide the services named and the muster of sections in this branch is completed by Physical Chemistry under Dr L Phillips studying the mechanisms by which explosives and propellants degrade under storage conditions.

3 4 Non-metallic materials branch

Under the supervision of Dr B L Hollingsworth, this branch comproses the following sections. Composites Design and Applications lead by Mr N J Parratt is concerned with composite materials using very stiff reinforcement such as discontinuous carbon fibres and carefull graded and aligned asbestos fibres. Polymer Assessment (Dr A Davis) deals with the characterisation of the mechanical properties and durability of polymeric materials (plastics, rubbers etc) while in Polymer Chemistry section, led by Dr D H Richards, speciality polymers of potentially high performance are synthesised. Such materials may find widespread use in Defence equipment in future. Polymer Development and Applications section under Dr D Sims, undertakes the design and in many cases, serial production of, plastics and rubber components for Service equipment. Finally, Polymer Characterisation lead by Dr A V Cunliffe operates sophisticated instruments for the determination of polymer structure: such structure can critically determine the fitness of a polymer for a given application.

3 5 Process research branch

Mr L E Dingle has charge of this branch which is divided into three functional sections. Chemical Engineering 1, led by Dr A W H Pryde, develops to pilot plant scale, processes for the production of explosives and propellant ingredients, and optimises existing processes. Chemical Engineering 2 (Dr C C Evans) has similar responsibilities for polymers, fibres and ceramics while Preparative Chemistry Section under Dr G F Hayes is concerned with the laboratory scale study of processes for the production of explosives and propellant ingredients and of certain polymeric materials. The Thermophysical Properties Group under Mr H Ziebland is a lodger group reporting to the National Physical Laboratory (Department of Industry) and operates the British Calibration Service for thermal measurements.

3 6 Propellants 1 branch

This branch, headed by Dr S W Bell, deals with propellants based on nitrocellulose. It is divided into five functional sections, three of which relate to the principal methods of manufacture. "C" (Cast Double Base) section under Mr R P Ayerst works on propellants formed by introducing a liquid (usually containing nitroclycerine) into moulds filled with nitrocellulose granules which swell and consolidate under the action of gentle heating to fill the mould and reproduce its shape. "E" (Extruded Cordite) section under Mr E A Baker, develops charges formed by extrusion from blanks cut from sheet prepared by mixing and rolling the ingredients. "G" (Gun Propellants) section (Mr R A Wallace) develops propellant made from nitrocellulose fabricated when gelatinised by solvents and combustible charge containers for large calibre ordnance.

All three propellant types find wide application in the Service and ERDE is intimately involved in (and indeed, in many cases, is ultimately responsible for) everything from composition selection and early manufacture through to post-design services even although full development and production may be elsewhere. In "L" section under Dr T J Lewis, a small team works on the development of a propellant and charge design for the Light Antitank Weapon (LAW): Dr Lewis also leads our research on nitrocellulose propellants, notably that on the structure and behaviour of nitrocellulose itself. "B" (Ballistic Assessment) section under Mr G W Stocks provides services to the remainder of the branch and to other parts of ERDE in measuring the ballistic properties of propellants and small rocket motors.

3 7 Propellants 2 branch

Mr P R Freeman leads this branch, which is divided into three sections. The first of these, Adhesion and Rheology headed by Mr W A Dukes, is concerned inter alia with structural adhesives which are finding increased use in ordnance together with sealants which are already widely used in that field and with the study of the long-term flow properties of solid propellants and their response to the fast-acting forces arising on pressurisation and projection. A further field of investigation covered by this section has been the adhesion of shell fillings to case walls. Failures can occur as a result of the migration of additives to the filling/wall interface and of the thermal contraction arising as the charge cools after filling. The plastic propellant section under Dr J A Hicks formulates, develops and tests this class of propellant which consists of an oxidiser (fine ammonium perchlorate powder) incorporated into a very viscous matrix of poly-iso-butylene or polyisoprene and filled into rocket motor cases (sometimes at somewhat elevated temperatures). This propellant, which has already been mentioned as having been sold to Spain as a package deal, is the cheapest available: it has a very wide temperature range of satisfactory operation and is capable of giving very high burning rates, a desirable feature in a propellant for an unguided rocket. The Rubbery Propellants section under Mr G J Spickernell develops composite propellants in which the ammonium perchlorate oxidiser is bound by a matrix made from a liquid rubber prepolymer which, on mixing with a crosslinking agent at room temperature, is a mobile liquid easily cast into moulds with complex profiles and cured to a rubbery mass by gentle heating. The method is clearly attractive, but the chemistry of crosslinking (curing) and of storage stability is still far from clear and much work is therefore being done here and overseas to elucidate it. Rubbery propellant is also a candidate for LAW and propellant and charge design are being developed in parallel with the double base propellant mentioned above.

4 CONCLUSION

This brief account has necessarily glossed over a number of aspects of our work, in particular the advisory role of the Establishment towards Defence branches, establishments and contracts in its field of expertise. Those seeking further information should approach the officers named (their telephone extensions are given on Figure 2) or the Technical Training Officer, Mr D Gordon, extension 233, who is responsible for coordinating visits to the establishment.

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March 1976

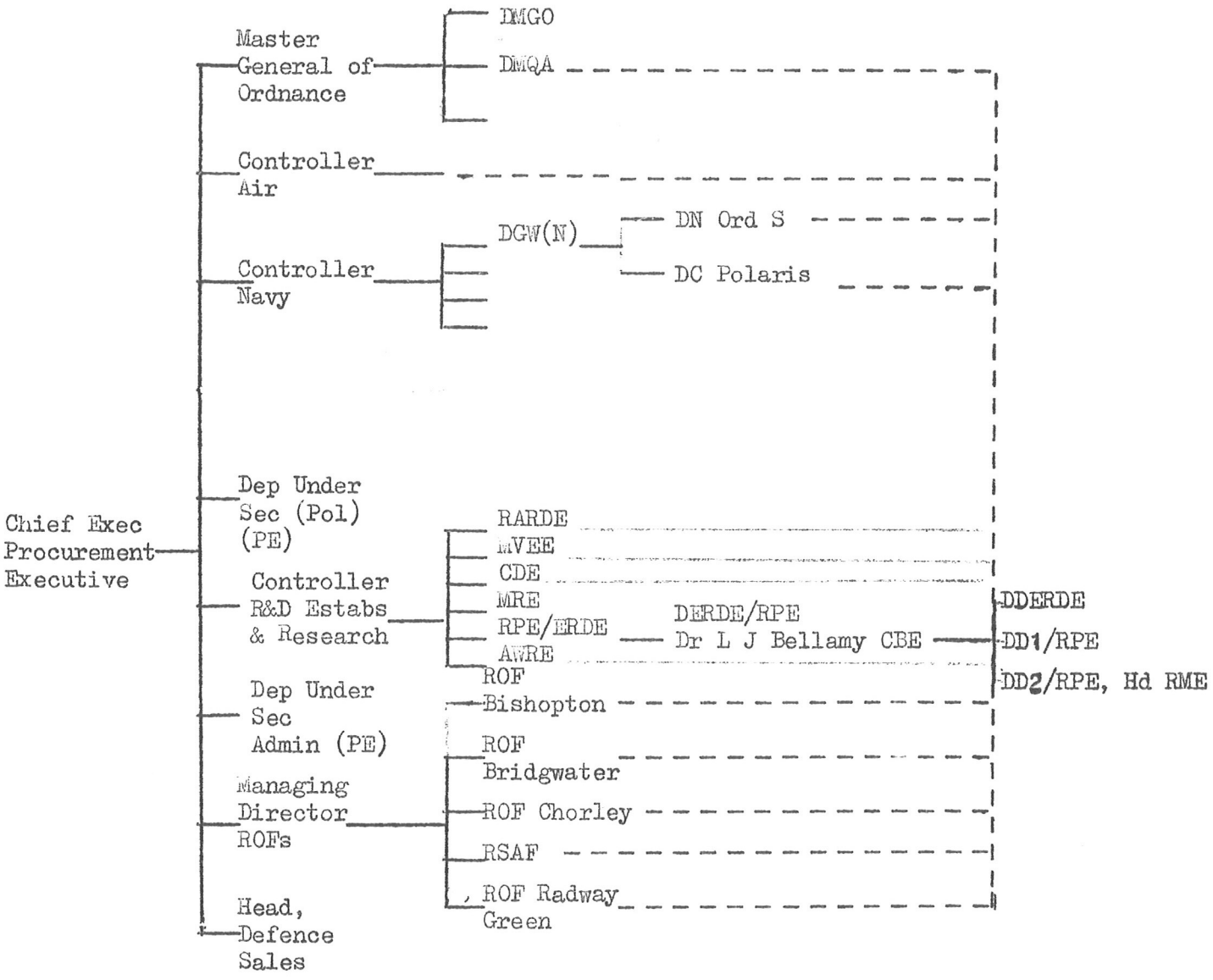

FIGURE 1 - RELATIONSHIPS BETWEEN ERDE/RPE AND THE REMAINDER OF PROCUREMENT EXECUTIVE

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(Safety Officer J V Griffiths PSO 229; DIRECTOR Dr L J Bellamy US 203 (Tech Asst D Gordon SSO 233)
(Sy Officer Capt E A Burt RN(Rtd) 580) DEP DIRECTOR G K Adams DCSO 413 (Tech Asst A S Smith PSO 518)

		Sec	Section name	Section leader, grade and tel no(s)
Explosives Dr C A Beck 306 SPSO		EC	Explosive compositions	F H Doe SSO 562 433
		EP	Explosives performance	S J Hawkins PSO 525 436 439
		IE	Initiating explosives	Dr R McGuchan PSO 210 523
		SH1	Sensitiveness & hazards 1	Dr R M H Wyatt PSO 322 307
		SH2	Sensitiveness & hazards 2	Dr K N Bascombe PSO 307 322
		WS	Woolwich section	K J Holloway PSO 84237 84239
General Chemistry Dr A R Osborn 346 SPSO		CR	Crystallography	J R C Duke SSO 305
		CS	Compatibility & stability	N J Blay PSO 237
		EI	Electronic instrumentation	D H L Mansell SSO* 348
		GA	General analysis	E J Gallacher SSO 494 311 236
		GW	Glassworking	R Watkins*† 349
		LI	Library and information	M McLaren SSO 256 235
		MC	Mathematics and computing	M Bergh†SO 396
		MI	Mechanical instrumentation	R I Cracknell HSO* 348
		PC	Physical chemistry	Dr L Phillips PSO 276 409 547
Non-metallic Materials Dr BL Hollingsworth†		CD	Composite development and and applications	N J Parratt PSO 597 411 390
		PA	Polymer assessment	Dr A Davis PSO 382
		PC	Polymer chemistry	Dr D H Richards SPSO(SM) 480
		PD	Polymer development and applications	Dr D Sims PSO 590
		PM	Polymer morphology	Dr B J MacNulty SSO 430
		PX	Polymer characterisation	Dr A V Cunliffe SSO 462 458 †SPSO
Process Research LE Dingle†		CE1	Chemical engineering 1 (expl & propts ingredients)	Dr A W H Pryde SPSO(SM) 351 268 316 593
		CE2	Chemical engineering 2 (polymers fibres ceramics)	Dr C C Evans PSO 415 411 347
		PC	Preparative chemistry	Dr G F Hayes PSO 423 †SPSO
Propellants 1 Dr S W Bell 319 SPSO		B	Ballistic assessment	G W Stocks PSO 291
		C	Cast double base (CDB) propellants	R P Ayerst PSO 545
		E	Extruded propellants	E A Baker SSO 469
		G	Gun propellants	R A Wallace PSO 381
		L	Laboratory services	Dr T J Lewis PSO 202
Propellants 2 P R Freeman 414 SPSO		AR	Adhesion and rheology	W A Dukes PSO 463
		PP	Plastic propellants	Dr J A Hicks PSO 487
		RP	Rubbery propellants	G J Spickernell PSO 301
Engineering2 Facilities 4 R Fisher CE9		MS	Machine shops	R P Clarke PT01 596 283
		DO	Design offices	H C Turner PT01 435
Dep CE J M Davies PT01 330		BWD:	building works dep	J E Brown PT02 279
		ES:	elec services dep	M D Hicks PT02 524 263
		MS:	mech services dep	F H Mills PT02 582 564
Administration S F M White-side Prin 300	Sen Admin Off S G Lock SEO 338	AO/G	General) admin officer	A J Eley HEO 378
		AO/P	Personnel)	G E Chapman HEO 334
		AO/S	Stores)	J C Turner HEO 336

*reports to D A G Eldridge PSO 522 †in charge in absence of designated Sec Ldr

FIGURE 2 - LINE MANAGEMENT CHART FOR THE EXPLOSIVES RESEARCH & DEVELOPMENT ESTABLISHMENT