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MINISTRY OF SUPPLY

DIRECTORATE OF MATERIALS & EXPLOSIVES RESEARCH & DEVELOPMENT

EXPLOSIVES RESEARCH & DEVELOPMENT ESTABLISHMENT WALTHAM ABBEY

Programme of Research and Development 1952 - 53

MINISTRY OF SUPPLY

DIRECTORATE OF MATERIALS AND EXPLOSIVES RESEARCH AND DEVELOPMENT

EXPLOSIVES RESEARCH AND DEVELOPMENT ESTABLISHMENT, WALTHAM ABBEY

PROGRAMME OF RESEARCH AND DEVELOPMENT,

1952 - 53.

The Research Programme has been jointly prepared
by D.M.X.R.D. and C.S., E.R.D.E.

C.S. BRYANT
D.M.X.R.D.

C.H. JOHNSON
C.S. E.R.D.E.

Chief Superintendent	Dr. C.H. Johnson
Deputy	Dr. A. Forster
Superintendent, Propellants Research I. (S.P.R.I.)	Mr. A. Brewin
Superintendent, Propellants Research II. (S.P.R.II.)	Mr. L.A. Wiseman
Superintendent, Chemical Engineering (S.C.E.)	Mr. R.G. Ross
Superintendent, Explosives and Intermediates (S.E.I.)	Dr. A. Lovecy.

INTRODUCTION

Format.

In the autumn of 1951 a formal procedure for progressing (and, in a limited sense, planning) research and development was adopted throughout this Establishment. An essential feature of the procedure is the recording in a ledger of every accepted new task under the appropriate 'Technical Subject' and its breakdown (as convenient) into 'Project', 'Sub-Project', and 'Sub-project sub-title', the latter category comprising self-contained items of research or development on a Section Head's programme.

A corollary is that the Research Programme should follow the same lines and sub-divisions; whence the changed format. However, as in previous editions, each of the four main sections of the 1952/53 programme covers the field of work of one Superintendent under the separate headings of Dated Projects, Undated Projects, Post-Design Services, (i.e. 'trouble shooting'), Basic and Applied Research and Development, and Design and Development of Testing or Laboratory Equipment. From the last two headings is excluded work of the kinds indicated but associated with the first three. The code numbers of the Projects, Sub-projects, etc., e.g. E.13A3, are also derived from the Establishment's progressing scheme. Items relative to a given Project with which more than one Superintendent is concerned carry related code numbers.

Objectives and Priorities.

Primarily, E.R.D.E. is concerned with basic research and development of explosives, and with the working out of processing and manufacturing methods; NOT with 'weapon' research or large scale production. All the items tabulated in the Research Programme refer to work which will be undertaken during the year April 1952 to March 1953. Inactive items are not included.

Fully seventy per cent of the work at E.R.D.E. is of the 'undated' kind, and, strictly speaking, undatable, but wherever possible priority ratings extracted from project lists issued by M.O.S. or the Service Ministries are given in the columns on the extreme right of each page. An asterisk (*) in the priority column headed 'E.R.D.E.' indicates that particular attention is being accorded to that item even though (as is often the case with 'research') it cannot unambiguously, or exclusively, be tied to a requirement of the Services or of the Ministry.

Staffing.

No satisfactory method has been devised whereby the staffing of projects can be indicated on our Research Programme. The position is always fluid, and attempts to represent it can be exceedingly misleading, especially as in most of the individual items inconsiderable portions of a person's time are involved. As far as possible, therefore, readers must infer the staffing situation from the priority markings and from the fact, emphasised above, that only active items - and therefore important ones - are quoted. Some thirty or forty per cent of the total effort of the Establishment is in support of the Guided Weapons programme.

The strength deployed on this Research Programme in April 1952, including the Chief Superintendent and six S.P.S.Os., was approximately 60 Scientific Officers, 90 Experimental Officers, 4 Engineers and 50 Scientific Assistants. It is not anticipated that the numbers will alter significantly during the current year.

Home Office Section.

On March 1st 1952 responsibility for the supervision of this group passed to C.S.A.R.; consequently there are no entries relating thereto.

/Propellants Research I.

nts Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY.	
Name	No.	Name	No,	Name	No.	Name	No.	Service	E.R.D.E.
D ROCKET ANTS: ork for s (cont.)	E.4 (cont.)	Platoon A/T Rocket	E4F	Development of M.7. propellant.	E4F1	Development of stick propellant.	E4F1A	1	
ED ROCKET LANTS: d Work rvices.	E.5	High-Performance Air-to-Surface Rocket for Forward Firing Aircraft.	E5B	Development of propellant	E5B1	Development of charge (when specified)	E5B1A	1	
ED ROCKET LANTS: esign or Services	E.6	Cordites	E6A	Climatic and climatic-ballistic trials.	E6A2	Climatic ballistic trial of motor, rocket, 3-inch, No. 13 Mk.1/1.	E6A2A		
						Compositions based on sulphite pulps.	E6A2B		
CKET, O, SUBMARINE PROPELLANTS: Research and pment.	E.13	General	E13A	Theoretical studies.	E13A1	Thermochemical data on propellant ingredients.	E13A1H		
						Mechanical properties of solid propellants in relation to use	E13A1K		
				Measurement of rates of burning.	E13A3	Vented vessel	E13A3D		
						Crawford "Strand" Burner	E13A3E		
						Micro Rockets.	E13A3F		

SECRET

ants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E.
CKET, SUBMARINE ROPELLANTS: esearch and ment (Cont.)	E.13 (cont)	Plastic Propellants (cont.)	E13B	Manufacturing techniques (cont.)	E13B3	Load on processing machinery with P.I.B. compositions.	E13B3C		
				Storage temperature effects.	E13B4	Climatic trials and temperature cycling of filled motors.	E13B4A		*
						Effect of temperature on adhesion	E13B4C		
						" " " " cohesion	E13B4D		
						" " " " fatigue	E13B4E		
						Effect of high temperature on salt recrystallisation and on polymer degradation.	E13B4F		
				Ignition and burning	E13B7	Effect of particle size and size distribution on rate of burning.	E13B7A		*
						Ballistic studies of P.I.B. compositions.	E13B7C		
				Ingredients	E13B8	Control of grist of ingredients	E13B8D		*
				Methods of chemical analysis.	E13B9	Methods required by C.C.I. and D.O.F.(X) for process control.	E13B9A		
				Basic research on plastic systems.	E13B10	Dependence of mechanical properties on ingredients (E.M.R. being negotiated).	E13B10A		
		Cordites	E13C	Compositions with improved mechanical properties and wider temperature range	E13C3	Fast-burning compositions of improved characteristics in substitution for F478/148K.	E13C3C		

ants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E.
KET, , SUBMARINE ROPELLANTS: esearch and ment (cont.)	E.13 (cont.)	Cordites (cont.)	E13C	Stability and climatic trials (cont.)	E13C7	Charges inhibited with PQ (including "Swallow").	E13C7E		
						Charges for 2-inch, 3-inch, and 5-inch rockets (current and new compositions.)	E13C7F		
						Engine-starter cartridge: Avon single Mk.I. (Rolls Royce).	E13C7G		
						E.S. cartridge: Ghost (Rotax)	E13C7H		
						Turbo-starter cartridge: Python (B.T.H.)	E13C7J		
				Compatibility with materials	E13C8	Araldite setting cements.	E13C8A		
						Compatibility with rocket cordites of R.D. cements and lutings containing substitute ingredients.	E13C8C		
						Rubbers.	E13C8D		
						Potassium perchlorate with metals.	E13C8E		
						Miscellaneous materials.	E13C8F		
				General research	E13C11	Effect of thermal history on mechanical properties.	E13C11A		
		Cast Double Base Propellants.	E13D	New compositions	E13D2	British equivalents for U.S. formulations.	E13D2A		
						Platonised compositions to cover a wide range of burning rates.	E13D2B		

ants Research, I. (cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E.
CKET. D, SUBMARINE PROPELLANTS: Research and pment (cont.)	E.13 (cont.)	Cast Double Base Propellants (cont)	E13D	Analytical methods.	E13D9	Casting powder. Finished propellant.	E13D9A E13D9B		
				Inspection of charges.	E13D10	X-ray, γ-ray and other methods.	E13D10A		
		Pressed Propellants	E13F	Charges	E13F1	I.C.I., expulsion charges for L.F. rockets (E.M.R.) I.C.I., large pressed charges for rocket motors (E.M.R.)	E13F1A E13F1B		
				Climatic trials.	E13F3	I.C.I. charges (including propellants for engine starters)	E13F3A		
		Composite Propellants.	E13G	Highly elastic composite propellant.	E13G1	Monsanto, (E.M.R.)	E13G1A		

ants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E.
E & S.A. ANTS: Work for es	E.15	Charges for New Equipments.	E15A	New automatic rifle.	E15A2	Propellant loads for 7 mm. ammunition (E.M.R.) I.C.I.	E15A2A	1	
		NATO Charges	E15C	French propellants.	E15C1	Ad hoc problems.	E15C1A		
				Dutch propellants.	E15C2	" " "	E15C2A		
CE & S.A. LANTS: esign work rvices	E.16	Cordites.	E16B	Climatic and climatic-ballistic trials.	E16B1	Compositions based on sulphite pulps.	E16B1A		
NCE AND S.A. LLANTS: Research evelopment	E.17	General.	E17A	Manufacturing methods for ordnance propellants	E17A3	Manufacture of small ballistic sizes	E17A3A		
				Ballistic behaviour.	E17A6	Effect of processing factors.	E17A6A		*
				Flash and smoke.	E17A8	Improved non-blinding propellants for Naval guns.	E17A8B		
				Stability, climatic and climatic-ballistic trials.	E17A9	Imperfectly-sealed S.L. cartridges.	E17A9A		
						Compositions containing substitutes for nitroglycerine.	E17A9B		
						Picrite propellants containing oxamide, DBP or DEGN.	E17A9C		
						Compositions containing mechanically-nitrated cellulose.	E17A9D		
						Compositions containing pulp-boiled NC.	E17A9E		

ants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E.
PLOSIVES: Research velopment.	E.21	General.	E21A	Compatibility of H.E. with materials.	E21A1	Araldite setting cements. Bostick cements. R.D. cements and lutings containing substitute ingredients. Rubbers. Plastics: polystyrene and fromoplast. Miscellaneous.	E21A1A E21A1B E21A1C E21A1D E21A1F E21A1G		
		T.N.T.	E21C	Crystallisation of T.N.T. in poured fillings.	E21C1	Examination of crystal growth	E21C1A		
				"White Compound".	E21C2	Crystal structure.	E21C2A		
		R.D.X.(B)	E21D	Safety of manufacturing process.	E21D2	Crystallographic examination of R.D.X.(B) for presence of H.M.X. polymorphs.	E21D2B		

ants Research, I. (Cont.)

SUBJECT.		SUBJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E.
LS AND ION SEALING TECTION: ork for s.	E.26	Assessment of Materials and Waterproofing for Ammunition.	E26A	Cartridges.	E26A1	For Battalion A/T gun (120 mm. RCL). Q.F. 20-pr. A.P.D.S. Suitability of protective treatment for cases of 3"/70 cal. ammunition.	E26A1A E26A1B E26A1C		
LS AND ION SEALING TECTION: esign Work rvices	E.28	Ammunition.	E28A	A/P mine No. 6 Mk. I.	E28A1	Treatment of cap shell. Climatic trials of firings.	E28A1A E28A1B		
				Proximity fuzes.	E28A2	N.81: Waterproofing. V.T. and C.V.T: Waterproofing.	E28A2A E28A2B		* *
				Gun ammunition detonators.	E28A3	Waterproofing.	E28A3A		*
				Q.F. cartridges.	E28A4	Waterproofing.	E28A4A		
				Tubes V.E.	E28A5	Waterproofing.	E28A5A		
				Igniter for 3" HEAT rocket motor.	E28A7	Waterproofing.	E28A7A		
				A/C bomb detonators.	E28A8	Waterproofing.	E28A8A		

lants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	D.R.D.E
AL RESEARCH ELOPMENT: Research and opment	E.45	Propellants in General.	E45A	Methods of analysis.	E45A2	Potassium perchlorate propellants.	E45A2A		
				Resistance to Service conditions.	E45A3	Thermal changes. Rough usage.	E45A3A E45A3B		
				Measurement of physical properties at high rates of stress.	E45A4	Elongation at break. Resistance of charges to sudden application of pressure.	E45A4A E45A4B		
		Propellant Ingredients.	E45B	Methods of analysis.	E45B1	Guanidine nitrate. Test for presence of carbamite in propellant doughs, for use in R.O.Fs.	E45B1A E45B1B		
				Oxamide.	E45B6	X-Ray determination of crystal structure.	E45B6A		
				Picrite.	E45B8	Investigation of causes of low heat test.	E45B8A		
		Explosives, Initiators and Propellants.	E45C	General crystallisation problems.	E45C2	Study of polymorphic changes in lead azide. Crystallographic examination of RDX/TNT melts.	E45C2D E45C2E		
		Adhesives	E45G	Fundamental work.	E45G1	Effect of active groups on heats of wetting of adhesives etc. (CMR Dr. Eley, University of Bristol)	E45G1A		

lants Research, II. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.
ROCKET, O. SUBMARINE PROPELLANTS: Research and opment (cont)	E.13 (cont.)	General (Cont.)	E13A	Solid propellants.	E13A2	Ballistic assessment in test motors.	E13A2A		
						Ignition : factors determining ignitability.	E13A2B		
				Rate of burning.	E13A3	NO/fuel and NO_2/fuel combustion processes.	E13A3A		
						Combustion of solid binary systems based on ammonium perchlorate.	E13A3B		
				Heat transfer.	E13A4	Thermal conductivity of liquid oxygen.	E13A4A		
						Viscosity of liquid oxygen.	E13A4B		
						Measurement of radiational heat transfer in motors.	E13A4D		
						Measurement of convectional heat transfer in axial flow.			
						Spectroscopic measurement of emission from combustion gases in motors.			
						Preparation of tabulated data for calculating heat transfer in motors.	E13A4E		
						Theoretical calculation of emissivity of combustion gases.	E13A4F		
						Development of techniques for measuring heat transfer.	E13A4G		

ellants Research, II. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.E
. ROCKET, EDO, SUBMARINE M PROPELLANTS: er Research and elopment (cont)	E.13 (cont.)	Liquid Propellants (Cont.)	E13E	Hydrogen peroxide	E13E6	The physico-chemical problems of concentrated hydrogen peroxide (EMR - Prof. W.F.K. Wynne-Jones, University of Durham.)	E13E6A		
				Stability,	E13E7	Trials at T.T.E., Nigeria, on bulk storage under tropical conditions.	E13E7A		
						Stability of liquid hydrazine.	E13E7D		
						Stability of isopropyl nitrate, alone and in mixtures with ethyl nitrate at 50°C.	E13E7E		
						Tests of a vent for H.T.P. containers at A.D.E.B.	E13E7F		
				Manufacturing processes (hydrazine).	E13E9	Comparison of production by ammonolysis of hydrazine sulphate and by dehydration of hydrazine hydrate (EMR Fisons Ltd.)	(E13E9A (E13E9C		
						Studies of the reactions of hydrazine and NH_2 radicals (EMR Prof. M.G. Evans, University of Manchester	E13E9D		

lants Research, II. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.
L RESEARCH LOPMENT: Research and opment	E.45	Propellants in General.	E45A	Combustion.	E45A1	Vapour phase burning and thermal decomposition of liquid explosives including nitric esters (EMR Prof. W.E. Garner, University of Bristol).	E45A1A		
						Viscosity and thermal conductivity of combustion intermediates and propellant gases. (Theor).	E45A1B		
						Study of combustion and thermal ignition of self-combustible compounds in the vapour phase (EMR, Dr. P. Gray, University of Cambridge).	E45A1C		
		Explosives and Propellants in General.	E45C	Long term studies.	E45C1	Molecular structure and energetics Investigations (EMR Prof. H.D. Springall, University College of North Staffordshire.	E45C1A		
				Combustion.	E45C4	Rates of burning of explosives and propellants.	E45C4A		
		Sensitiveness and Detonability.	E45D	Sensitiveness of explosives to friction and impact.	E45D1	Mechanism of initiation and growth of detonation wave (EMR Dr. F.P. Bowden, University of Cambridge.	E45D1A		

						grist size, voids and chemical nature; study of TNT and picric acid in both solid and liquid phases.		E45D6A	

llants Research, II. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.
ERAL RESEARCH VELOPMENT: r Research and elopment (cont)	E.45	Sensitiveness and Detonability (cont)	E45D	Thermal sensitiveness of explosives.	E45D7	Development of test for assessing probability of thermal decomposition passing into detonation.	E45D7A		*

ves and Intermediates (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.R.D.
INITIATORS: rk for (cont.)	E.22	New Equipments. (cont.)	E22A	30 mm. ADEN caps.	E22A2	Applicability of lead styphnate to electric cap. Mainly confirmation for production.	E22A2A		
						Applicability of barium styphnate to replace "A" mixture in E/caps. Improvement of manufacture.	E22A2B		
				Electric detonator for platoon A/T weapon.	E22A3	Applicability of lead azide, RD.1339. Collaboration in production and comfirmatory trials.	E22A3A	(1)	
& INITIATORS: Design Work ervices	E.24	Improvement of Initiators.	E24A	Modified lead azide.	E24A1	Comparative trials on filling and functioning of R.D.1333, 1334, 1335, and Service azide.	E24A1A		
						Replacement for A.S.A. in A/B detonators. Trials in collaboration with I.C.I.	E24A1B E24A1C E24A1D E24A1E		
				Safer cap compositions	E24A2	Applicability of lead styphnate beta form, to percussion caps.	E24A2A		
						Applicability of L.D.N.R. to replace "A" mixture.	E24A2B		
				Low-energy electric initiation.	E24A3	Requirement to be stated by C.S.A.R.	E24A3A		

es and Intermediates (Cont.)

BJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
e	No.	Name	No.	Name	No.	Name	No.	Service	E.R
SEARCH MENT: arch and t (cont)	E.45	Propellant Ingredients (cont)	E45B	Picrite synthesis (cont)	E45B2	Calcium cyanamide synthesis: studies of mechanism and equilibria.	E45B2E		
						Methods of preparing high bulk density picrite (alternatively guanidine nitrate).	E45B2L		
						Urea reactions: studies on chemistry of sulphonation.	E45B2M		
						Hydrocyanic acid route: synthesis of HCN, Bucher process.	E45B2N		
						Hydrocyanic acid route: synthesis of HCN; CO + NH_3 process.			
						Hydrocyanic acid route: synthesis of HCN; formamide process.			
				Nitrocellulose.	E45B3	Continuous disintegration and nitration of wood pulp board.	E45B3A		
						Continuous centrifugal separation of spent acid from NC.	E45B3B		
				Coolants	E45B9	Methylnitroguanidine: exploration of synthesis.	E45B9A		
				Nitric esters.	E45B10	Kinetics of nitration of alcohols (EMR Prof. Gwyn Williams Royal Holloway College).	E45B10A		
		Explosives Initiators and Propellants	E45C	General crystallisation problems.	E45C2	Theory of Nucleation (EMR Prof. W.E. Garner, U. of Bristol).	E45C2A		
						Crystallisation of ammonium perchlorate, potassium chlorate and other explosives ingredients	E45C2F		

/Chemical Engineering.

Engineering (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORI	
Name	No.	Name	No.	Name	No.	Name	No.	Service	
NANCE & S.A. OPELLANTS: ted Work for rvices (Cont)	E.14	Ingredients (cont.)	E14C	Picrite processes (cont)	E14C1	C.Development of crystalliser for guanidine nitrate.	E14C1C		
						D.Liaison with full scale design	E14C1D		
						Calcium cyanamide pilot plant			
						E.Operation of modified plant.	E14C1E		
						F.Production of a suitable CO-feed gas.	E14C1F		
						G.End-gas separator and recovery	E14C1G		
						H.Alternative reactors.	E14C1H		
						J.Co-ordination with direct fusion.	E14C1J		
						Nitration pilot plant	E14C1K		
						Picrite finishing processes: spraying, drying, grinding.	E14C1L		
						Disposal of spent acids (review)	E14C1M		
IGH EXPLOSIVES: ost-Design Work or Services	E.20	R.D.X.	E20B	Manufacture.	E20B1	Investigations jointly with D.O.F.(X):			
						Laboratory study on "icing" of cooling surfaces.	E20B1A		
						Pilot plant study of icing and grist.	E20B1B		
				Purification.	E20B2	Recrystallisation from cyclo-hexanone.	E20B2B		

cal Engineering (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORITY	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.I
NERAL RESEARCH D DEVELOPMENT: her Research and velopment (Cont)	E.45	Chemical Engineering Research.	E45E	Crystallisation.	E45E3	Study of "icing" of cooling surfaces.	E45E3A		
						Crystal size control in continuous crystallisation.	E45E3B		
				Fluid flow.	E45E6	Gas distribution through granular beds.	E45E6A		
				Distillation.	E45E7	Concentration of nitric acid.	E45E7A		

M.No. 544/52
S.No. 285 CA

EXTERNAL DISTRIBUTION

Ministry of Supply

Chief Scientist
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Chairman, S.A.C.
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C.S.A.R. (8)
C.S.M.E.X.E.
C.S./R.A.E./R.P.D. (Westcott) (3)
D.Amm.P.
D.Arm.R.D.(Air)
D.G. of A.
D.G.O.F.
D.O.F.(X) (2, including Mr. R. Edgeworth Johnstone)
D.O.F.(F)
P.D.G.W. (3)
D.R.A.E. (3, including Chemistry and Guided Weapons Depts.)
D.W.R.(D)
P.D.S.R.(A)
P.D.S.R.(D)
Sec. O.B. (2)
Dr. L. Phillips, B.J.S.M., through TPA3/TIB.

Admiralty

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Air Ministry

S.A./A.M.

Ministry of Defence

Sec. D.R.P.C.

/Internal

SECRET

Chief Superin

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Superintenden

Superintendent

Superintendent

Superintendent

PROPELLANTS RESEARCH, I.

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE.		PRIORIT	
Name	No.	Name	No.	Name	No.	Name	No.	Ser-vice	E.
GW PROPELLANTS: Dated Work for Services.	E.1	Seaslug	E1A	Boost, cordite.	E1A7	Development of special composition.	E1A7A	(1)	
				Cordite charge for liquid expulsion.	E1A12	ditto	E1A12A	(1)	
		Test Vehicles when Particular Missile is not Specified.	E1C	Boost, plastic.	F1C6	Supply of filled motors and collaboration with R.O.Ps.	E1C6A		
GW PROPELLANTS: Undated Work for Services.	E.2	Red Dean	E2A	Motor, cordite.	E2A7	Development of special composition.	E2A7A		
		Red Shoes	E2B	Sustainer motor, plastic propellant.	E2B1	Development of slow burning compositions.	E2B1A	1	
UNGUIDED ROCKET PROPELLANTS: Dated. Work for Services.	E.4	Air-to-Air Unguided Rocket Battery.	E4A	Life of propellant.	E4A3	C.T. of 2-inch rocket propellant. Post-design studies to improve storage life.	E4A3A E4A3B		
		3.5-inch HE/AT Rocket.	E4E	Development of M.7. propellant.	E4E1	Development of composition. Effect of processing cariables.	E4E1A E4E1B		
				Supply of propellant, (pre-production)	E4E2	Propellant for performance trials.	E4E2A		

Propellants Research, I. (Cont.)

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Propellants Research I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIORIT	
Name	No.	Name	No.	Name	No.	Name	No.	Service	E.
GW, ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development (cont.)	E13 (cont)	General (cont.)	E13A	Study of stress concentrations.	E13A4	For the adhesive bond between plastic propellant and metal.	E13A4A		
						For all solid propellants at points of curvature.	E13A4B		
				Inhibition	E13A7	Mechanical properties.	E13A7A		
						Adhesion and diffusion of	E13A7B		
						Thermal expansion relative to propellant.	E13A7C		
						Polymers alternative to cellulose acetate and ethyl cellulose.	E13A7D		
		Plastic Propellant	E13B	New compositions	E13B2	Containing alternatives to "polymeths"	E13B2A		
						Containing alternatives to lecithin.	E13B2B		
						Containing other moderants	E13B2D		
						Containing ammonium nitrate.	E13B2E		
						Containing degraded rubber.	E13B2F		
						Containing degraded butyl rubber.	E13B2G		
				Manufacturing techniques.	E13B3	Elimination of rolling (control of salt grist)	E13B3A		
						Processing temperatures of P.I.B. compositions.	E13B3B		

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Propellants Research I. (Cont.)

Propellants Research, I. (cont).

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRI
Name	No.	Name	No.	Name	No.	Name	No.	Service
GW, ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development (cont.)	E.13 (cont.)	Cordites (cont,)	E13C	Compositions with improved mechanical properties and wider temperature range. (cont.)	E13C3	Tough non-cracking compositions (containing 2-NDPA, DEGN, DBP, DNT, etc.), with particular reference to large web sizes.	E13C3D	
				Manufacturing techniques	E13C4	Large extrusion presses; collaboration with factories.	E13C4A	
						Back-pressure and long-parallel die techniques of extrusion.	E13C4B	
						Segmanted charges.	E13C4C	
						Mechanics of rolling and rheological studies.	E13C4E	
						Processing problems in connection with new compositions	E13C4F	
				Rate of burning.	E13C6	Compositions containing platonisers.	E13C6B	
						Factors governing platonisation	E13C6C	
						Laboratory studies of catalysed burning.	E13C6D	
				Stability and climatic trials.	E13C7	DEGN as substitute for nitro-glycerine.	E13C7A	
						Compositions containing potassium perchlorate.	E13C7B	
						Compositions containing mechanically nitrated cellulose.	E13C7C	
						Compositions containing pulp-boiled NC.	E13C7D	

Propellants Research, I. (Cont.)

Propellants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PR
Name	No.	Name	No.	Name	No.	Name	No.	Servic
GW, ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development (cont.)	E.13 (cont.)	Cast Double Base Propellants (cont.)	E13D	Manufacturing techniques	E13D3	Improvement of methods. Casting base. Casting liquids. Restrictive containers. 15-inch charges.	E13D3A E13D3D E13D3E E13D3F E13D3G	
				Ignition	E13D4	Minimum ignition for low temperatures and pressures.	E13D4A	
				Ballistic and mechanical properties.	E13D5	Measurement of ballistic properties. Effect of characteristics of ingredients on ballistic properties. Formulation for specific ballistic properties. Measurement of physical properties. Effect of characteristics of ingredients on physical properties. Formulation for specific physical properties.	E13D5A E13D5B E13D5C E13D5D E13D5E E13D5F	
				Stability and climatic trials	E13D6	Accelerated (80°C.) cracking trials. 60°C. cracking trials.	E13D6A E13D6B	
				Safety	E13D7	Solvent vapours over casting powder.	E13D7A	

Propellants Research, I. (cont.)

Propellants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		
Name	No.	Name	No.	Name	No.	Name	No.	Serv
ORDNANCE & S.A. PROPELLANTS: Dated Work for Services.	E.14	Charges for New Equipments.	E14A	3-inch 70-cal. gun.	E14A1	Development of propellant and charge (with C.S.A.R.)	E14A1A	1
				5-inch Mk. N.1. gun.	E14A2		E14A2A	2
				Light A.A. L.70.	E14A5		E14A5A	1
				" " - ADE 42 mm.	E14A6		E14A6A	1
				4-inch full calibre.	E14A8		E14A8A	1
				"Red Maid" (5" FSDS).	E14A10		E14A10A	1
				120 mm. gun for FV.214 "Red Adder".	E14A11		E14A11A	1
				3-inch gun for armoured car.	E14A12		E14A12A	
				30 mm. ADEN gun.	E14A15	Granular powder for aircraft guns. (E.M.R.) I.C.I.	E14A15A	
				180 mm. gun for FV. ("Red Viper").	E14A16	Development of propellant and charge (with C.S.A.R.)	E14A16A	
		Charges for Improved Ammunition	E14B	Q.F. 17-pr., and 77 mm. A.P.	E14B3	Development of propellant and charge (with C.S.A.R.). A suitable propellant form is required for smoke shell.	E14B3A	

Propellants Research, I. (Cont.)

Propellants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT		SUB-PROJECT SUB-TITLE		PRIOR
Name	No.	Name	No.	Name	No.	Name	No.	Service
ORDNANCE & S.A. PROPELLANTS: Other Research and Development (cont.)	E.17 (cont.)	General (cont.)	E17A	Compatibility with materials.	E17A10	Araldite setting cements. R.D. cements and lutings containing substitute ingredients. Rubbers. Miscellaneous.	E17A10A E17A10C E17A10D E17A10E	
				Safety.	E17A11	Fires in A.F.Vs. Habitability: DEGN cordites.	E17A11A E17A11B	
				Foreign propellants.	E17A12	Analysis, stability and climatic trials.	E17A12A	

Propellants Research, I. (Cont.)

Propellants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIOR
Name	No.	Name	No.	Name	No.	Name	No.	Service
FUZES & INITIATORS: Other Research and Development.	E.25	Chemical Stability of Initiators.	E25C	Mechanism and assessment of deterioration.	E25C1	Silver azide. Mercury fulminate. Substitutes for Compositions A and B. Styphnates R.D.1650, 39, St.3. Barium styphnate.	E25C1A E25C1B E25C1C E25C1D E25C1E	
				Effect of moisture.	E25C2	Lead azide. Fuze 254, unplated and tin-plated.	E25C2A E25C2B	
				Climatic trials.	E25C3	A/C bomb detonators. Correlation of chemical deterioration with effective life.	E25C3A E25C3B	
		Compatibility of Initiators and Delay Systems.	E25D	With metals, plastics, sealing materials, varnishes, etc.	E25D1	Lead azide and substitutes. Silver azide. Substitutes for Composition A. Burster compositions. Miscellaneous materials.	E25D1A E25D1B E25D1C E25D1E E25D1F	
				With other initiators .	E25D2	Lead azide with substitutes for Composition A. Lead azide with R.D.1650.	E25D2A E25D2B	

Propellants Research, I. (Cont.)

Propellants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PR
Name	No.	Name	No.	Name	No.	Name	No.	Servic
MATERIALS AND AMMUNITION SEALING AND PROTECTION: Other Research and Development.	E.29	Ammunition Sealing	E29A	New sealing compositions	E29A1	Luting, serviceable over whole Service temperature range.	E29A1A	
						Improved non-solvent self-setting cements.	E29A1B	
						Improved fenestrating varnishes	E29A1C	
				Cocooning and sheathing	E29A2	Plastic sheaths for fuzes.	E29A2A	
						Wax dipping of fuzes.	E29A2B	
		Materials	E29B	Protectives for surfaces of explosive stores.	E29B1	Varnishes and paints for special purposes e.g. R.D.1177 type.	E29B1A	
						Internal lacquering of cartridge cases.	E29B1B	
						Heat insulating enamel for cartridge cases.	E29B1C	
						Hot-melt compositions for H.E. stores.	E29B1D	
				Cartridge-bag materials	E29B2	Alternatives to silk, viz. viscose, box cloth.	E29B2A	
				Lubricants.	E29B5	Fuze 208.	E29B5A	
				Assessment of new materials.	E29B6	Phoryl resins.	E29B6A	

Propellants Research, I. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		
Name	No.	Name	No.	Name	No.	Name	No.	Ser
G.W. PROPELLANTS: Dated Work for Services.	E.1.	Seaslug.	E.1A	Liquid sustainer motors	E.1A5	Less reactive substitute for kerosine.	E.1A5A	(
						Phase diagram $HNO_3/NO_2O_4/H_2O$	E1A5B	(
						Safety aspects of R.F.N.A. with hydrocarbon fuels.	E1A5C	(
G.W., ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development.	E.13	General.	E13A	Theoretical studies.	E13A1	The preparation and isolation of labile molecules (EMR Prof. C.E.H. Bawn, University of Liverpool).	E13A1B	
						The preparation and properties of the polyhydrides of non-metals (EMR Prof. C.E.H. Bawn, University of Liverpool).	E13A1D	
						Numerical integration of combustion equations for reactions involving consecutive reactions.	E13A1E	
						Thermodynamic functions of simple molecules and radicals (Theor.).	E13A1L	
						Thermochemistry and stability of molecules (EMR Prof.M.G.Evans University of Liverpool).	E13A1M	
						The preparation of alkyls and hydrides of light metals (EMR Prof.W.E.Garner, University of Bristol.)	E13A1N	

Propellants Research, II. (Cont.)

SUBJECT.	PROJECT.	SUB-PROJECT.	SUB-PROJECT SUB-TITLE

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		
Name	No.	Name	No.	Name	No.	Name	No.	Sor
G.W., ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development (cont)	E.13 (cont.)	General (Cont.)	E13A	Attenuation.	E13A5	Survey of attenuating properties of jets from solid propellants.	E13A5A	
						Emission spectra of propellant flames (especially infra-red).	E13A5F	
				Combustion.	E13A8	Platonisation : Mechanism of action of lead compounds and others.	E13A8A	
						Platonisation : spectroscopic study of reaction zone in combustion of ethyl nitrate. Effect of lead compounds.	E13A8B	
		Plastic Propellant	E13B	Combustion.	E13B8	Thermal decomposition of inorganic perchlorates (EMR Dr. Bircumshaw, University of Birmingham.)	E13B8B	
		Liquid Propellants	E13E	Proofstand assessment of propellants.	E13E2	Nitric acid with selected fuels	E13E2A	
						Monopropellants based on ethyl nitrate..	E13E2C	
				Ignition.	E13E4	Spark ignition in gases and liquids (EMR Prof. J.M. Meek, University of Liverpool).	E13E4B	
						Monopropellants : methods of ignition.	E13E4	
						Bipropellants : comparison of pyrotechnic, spark and heated target methods of ignition.	E13E4	

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE
Name	No.	Name	No.	N		

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		P
Name	No.	Name	No.	Name	No.	Name	No.	Servi
FUZES & INITIATORS: Other Research and Development.	E.25	Mechanism of Sensitization.	E25B	Test of 'hot spot' theory.	E25B1		E25B1A	
		Sensitiveness of Initiators.	E25E	Electrostatic hazards.	E25E1	Spark initiation. Analysis of factors determining ignitability. Attainment of electrostatic charge on pouring.	E25E1B E25E1C	
				Development of routine tests.	E25E2	Friction: impact: electrostatic	E25E2A	
				Friction sensitiveness	E25E3	Effect of particle size, grit and hardness of crystals.	E25E3A	
		Physical Properties of Initiators.	E25G	Electrical conductivity	E25G1		E25G1A	
				Absorption spectra.	E25G2		E25G2A	

Propellants Research, II. (Cont.)

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Propellants Research, II. (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIOR
Name	No.	Name	No.	Name	No.	Name	No.	Service
GENERAL RESEARCH & DEVELOPMENT: Other Research and Development (cont)	E.45	Sensitiveness and Detonability.(cont)	E45D	Relationship between sensitiveness and thermal decomposition.	E45D2	Thermal decomposition of crystalline non-ionic compounds (oxamide) (EMR Dr. L.L.Bircumshaw University of Birmingham).	E45D2A	
				Impact sensitiveness.	E45D3	Sensitiveness to high velocity fragments: correlation with rifle bullet tests and 'gap' tests.	E45D3E	
						Development of a propagation test: analysis of initiation and propagation by means of 'gap' test.	E45D3F	
						Impact tests: analysis of results which can be obtained from Rotter Machine.	E45D3G	
						'Gap' test: extension to high energy liquids; extension to plastic and colloidal explosives and propellants; sensitiveness as function of temperature.	E45D3C	
				Sensitiveness of solid Explosives.	E45D6	Sensitiveness as a function of grist size, voids and chemical nature; study of TNT and picric acid in both solid and liquid phases.	E45D6A	

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Propellants Research, II. (Cont.)

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EXPLOSIVES AND INTERMEDIATES.

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRIOR
Name	No.	Name	No.	Name	No.	Name	No.	Service
G.W., ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development	E.13	Plastic Propellants	E13B	Ingredients	E13B8	Constitution of lecithin (EMR Prof. W.E. Garner, Bristol)	E13B8A	
		Cast Double Base Propellants.	E13D	Ingredients	E13D8	Suitability of N.C. and methods of conversion to casting powder	E13D8A	
						Preparation of platonising agents.	E13D8B	
HIGH EXPLOSIVES: Post-Design Work for Services	E.20	R.D.X. Manufacture	E20B	Grist control	E20B1	Pourability studies of R.D.X. suspensions.	E20B1B	
				Purification	E20B2	Investigation of compounds found in R.D.X./T.N.T. fillings.	E20B2A	
IGH EXPLOSIVES: ther Research and evelopment	E.21	R.D.X.(B)	E21D	Safety	E21D2	H.M.X. polymorphs, and mixtures of H.M.X. with R.D.X.	E21D2A	
ZES & INITIATORS: ted work for rvices	E.22	New Equipments	E22A	30 mm. delay fuzes.	E22A1	Applicability of L.D.N.R. Modification to suit changes in fuze development by C.E.A.D.	E22A1A	(1)
						Applicability of barium styphnate to suit alternative fuze development by B.S.A.	E22A1B	(1)

/30mm. ADE

SUBJECT. PROJECT.

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE.		PRI
Name	No.	Name	No.	Name	No.	Name	No.	Servic
GENERAL RESEARCH AND DEVELOPMENT: Post-Design Work for Services	E.44	Propellant Ingredients.	E44A	Nitrocellulose	E44A1	Manufacturing trials on available wood pulps.	E44A1A	
GENERAL RESEARCH AND DEVELOPMENT: Other Research and Development	E.45	Propellant Ingredients.	E45B	Picrite Synthesis.	E45B2	Utilisation of H_2S: conversion via CaS. Utilisation of H_2S: production of H_2SO_4. Production of ammonium thiocyanate: use of CS_2. Production of ammonium thiocyanate: preparation of CS_2. Thiocyanate route: treatment of guanidine thiocyanate for nitration. Thiocyanate route: formation of guanidine thiocyanate from ammonium thiocyanate.	E45B2A	
						Utilisation of H_2S: direct conversion of CS_2 (EMR) Dr.Sykes, University College of Swansea.	E45B2B	
						Utilisation of H_2S: indirect conversion to CS_2 (EMR) Professor D.M. Newitt Imperial College.	E45B2C	
						Iso-urea route: studies on reactions, to raise yields. Iso-urea route: preparation of diethyl sulphate. Iso-urea route: exploration of pilot-plant prospects.	E45B2D	

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CHEMICAL ENGINEERING

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PR
Name	No.	Name	No.	Name	No.	Name	No.	Servic
G.W., ROCKET, TORPEDO, SUBMARINE & LPM PROPELLANTS: Other Research and Development	E.13	Cast Propellants	E13D	Manufacturing techniques	E13D3	Design and provision of C.D.B. pilot plant.	E13D3B	
		Liquid Propellants	E13E	Stability and corrosion (a) W.F.N.A. (b) R.F.N.A.	E13E8	Aluminium alloys, phosphoric acid inhibition - mechanism	E13E8A	
						Ditto. - improved methods of phosphating.		
						Sealed tube tests.	E13E8B	
						Closed vessel storage tests.	E13E8C	
						Corrosion of welds in Al.alloys	E13E8D	
				Manufacturing processes	E13E9	Provision of hydrazine (ammonolysis) plant.	E13E9B	
						Mobile oxygen plant for rockets: separator unit (EMR) B.O.Co.)	E13E9E	
						Mobile oxygen plant for rockets: engine-compressor unit (EMR Howden)	E13E9F	
						Manufacture of R.F.N.A. in experimental quantities.	E13E9G	
						Manufacture of nitric esters (on request).	E13E9H	
ORDNANCE & S.A. PROPELLANTS: Dated Work for Services.	E.14	Ingredients.	E14C	Picrite processes.	E14C1	Direct fusion pilot plant.		
						A. Operation with improved reactor and sludge-wash.	E14C1A	
						B. Investigations on scaling factors for full scale design.	E14C1B	

Chemical Engineering (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-TITLE		PRI
Name	No.	Name	No.	Name	No.	Name	No.	Servic
COMPRESSED GAS PLANTS: Dated Work for Services	E.30	New Equipments.	E30A	Standard mobile oxygen plant.	E30A1	Development of prototype (EMR B.O.Co. Ltd.)	E30A1A	3
				Mobile dissolved acetylene plant.	E30A2	Development of prototype (EMR) B.O.Co. Ltd.)	E30A2A	
COMPRESSED GAS PLANTS: Undated Work for Services.	E.31	New Equipments.	E31A	On-site glider transportable oxygen plant.	E31A1	Development of prototype (EMR) Ricardo and Co. (1927) Ltd.)	E31A1A	
				Air transportable oxygen plant.	E31A2	Development of prototype (EMR) B.O.Co. Ltd.)	E31A2A	3
COMPRESSED GAS PLANTS: Other Research and Development	E.33	Research on Production Plants.	E33A	Mobile liquid oxygen plants.	E33A1	Development of rotating still (EMR, Ricardo & Co. (1927) Ltd.)	E33A1A	
						Efficiencies of column packings (EMR B.O.Co. Ltd.)	E33A1B	
				Mobile acetylene plants	E33A2	Alternative processes of manufacture.	E33A2A	
GENERAL RESEARCH AND DEVELOPMENT: Other Research and Development	E.45	Chemical Engineering Research	E45E	Use of dimensional similarity in analysis of processes.	E45E1	General consideration.	E45E1A	/Cryst

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Chemical Engineering (Cont.)

SUBJECT.		PROJECT.		SUB-PROJECT.		SUB-PROJECT SUB-T	
				Name	No.	Name	