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Museum

Research · Development · Products

ERDE diversifies its activities

For the first time in the 400 years since explosives manufacture began on the site the Explosives Research and Development Establishment at Waltham Abbey, Herts, opened its doors in June to show the extent to which its work is now industrially oriented. The Waltham Abbey site has for generations been a centre for the production of black powder, and much of the woodland of the site was until recently devoted to the growing of alders for conversion into charcoal. The explosives and propellants now made experimentally at ERDE are much more sophisticated, and even this work now constitutes only about 50% of the establishment's programme.

Curiously perhaps, development work has not been directed towards the use of explosives for such processes as metal forming, welding, shock hardening and materials transformation, as might have been expected on the basis of the explosives expertise there and the topicality of these metalworking techniques. In fact work is concerned primarily with the development of fibres-reinforced materials, whisker growth, the development of new polymeric materials and evaluation of rubbers and plastics.

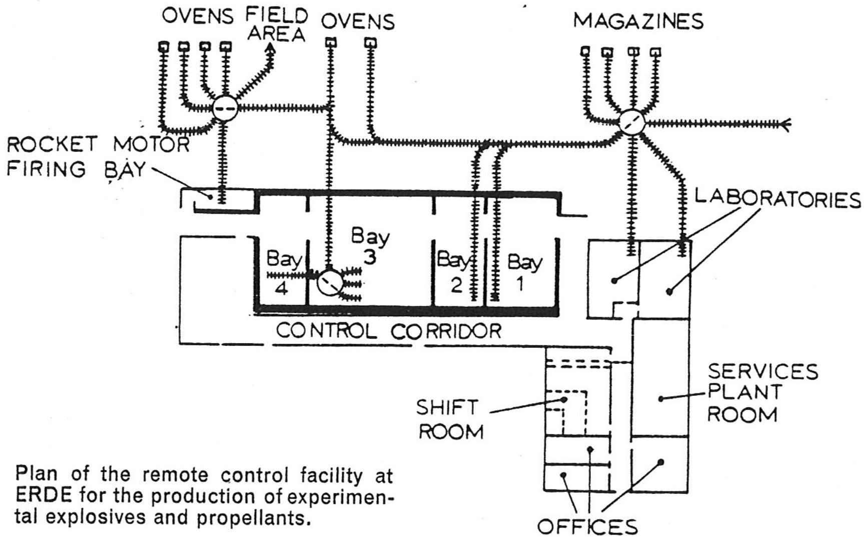
Explosives research

Studies of explosives and propellants at ERDE cover the development of new forms of material from experiment with different types of oxidisers, fuels and binders, improving the long term stability of manufactured material, assessing the characteristics of newly developed materials and devising techniques and procedures for the safe handling of explosives.

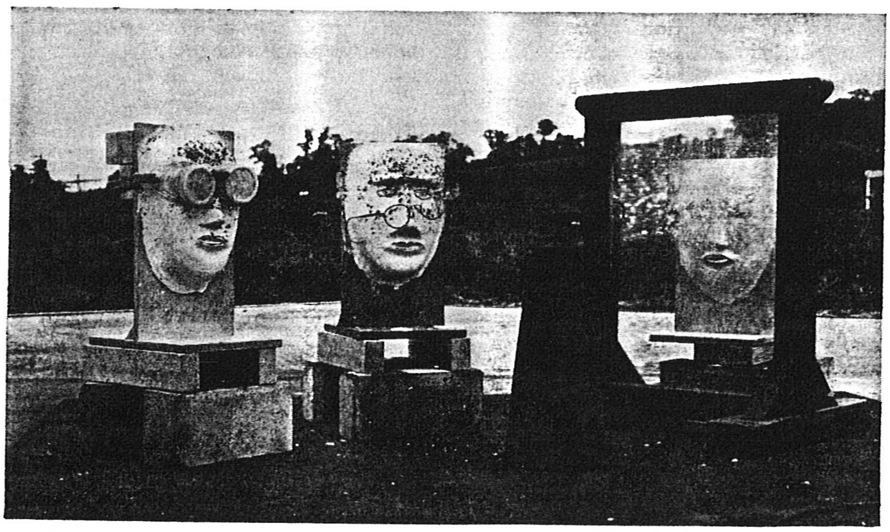
Remote-controlled plant

In view of the extent to which toxic, radioactive, and other dangerous materials are processed in industry today, the plant developed and built at Waltham Abbey for the production of experimental high energy explosives and propellants has many lessons to provide in handling techniques. The plant itself comprises a large sub-divided blockhouse in which dispensing, mixing, vacuum moulding, heat curing, inspection, assembly and test firing of quantities of compounds, equivalent to 15 lb TNT, can be carried out without the operators' having any visual access to the sequence of operations. A 5 in. gauge electric railway transfers all material from magazines to the process bays, ovens and test sites, and samples can be taken from the production line for test firing in armoured work cupboards.

The whole plant is controlled from a heavily concrete-protected control room and an illuminated track recorder showing the position and movement of the 18 in. long locomotive. The process plant has a light blow-off roof and has been designed to withstand repeated explosions.



1 Plan of the remote control facility at ERDE for the production of experimental explosives and propellants.



2 Testing safety equipment. The photograph shows damage caused by $\frac{1}{3}$ oz of explosive at normal handling distance. One of the models is wearing safety goggles, one a pair of ordinary glasses and the third is protected by a safety screen.

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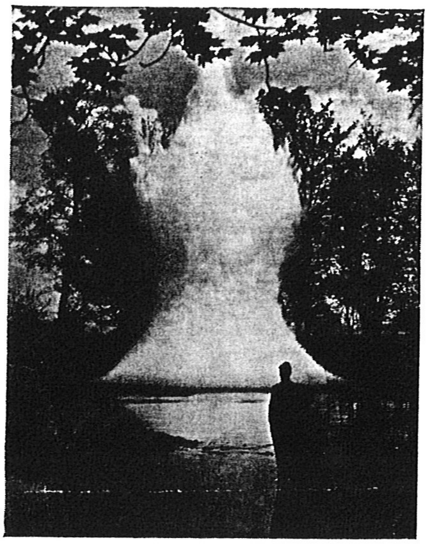


3 Underwater explosives test at ERDE. Effectiveness is measured by the shape of the shock wave produced.

Table I. Mechanical properties of some asbestos filled plastics

Polymer	S.G. gm/cm³	Tensile strength lb/in²	Flexural modulus lb/in² × 10⁶	Price of polymer pence/lb
Polypropylene	0·91	4,400	0·15	39
+ 40% asbestos	1·24	6,800	0·77	
Toughened polystyrene	1·04	3,500	0·27	19
+ 40% asbestos	1·36	9,500	2·02	
ABS	1·04	5,300	0·22	40
+ 30% asbestos	1·27	13,900	1·13	
Polycarbonate	1·22	9,500	0·25	72
+ 30% asbestos	1·42	16,000	1·46	
Nylon 6	1·14	11,000	0·3	72
+ 30% asbestos	1·48	19,000	1·0	
Nylon 66	1·12	11,000	0·3	72
+ 30% asbestos	1·33	19,000	1·3	
glass-filled	1·33	18–24,000	0·8–1·2	78

Areas of development

One field in which there is room for further development is in improving the efficiency of underwater explosives. Very fast pressure gauges and recording techniques have been evolved at ERDE for measuring the shock wave generated on firing. Others include propellants for safety devices such as the Martin Baker ejector seat, and equipment to 'kill' the effects of explosives and propellants, for example in the case of fire.

Structural materials

The work for which ERDE most wishes to be recognised by industry is the development of new structural materials, and a high proportion of the investigations carried out is concerned with the production of fibres- and whisker-reinforced materials, polymeric materials and rubbers.

Fibre-filled thermoplastics

Although the fibre filled plastics field has been dominated in recent years by the glass fibre based materials, this position is likely to be challenged for many purposes by the development of asbestos fibre reinforced plastics. The fibre is plentiful and cheap, and tensile strengths up to 24,000 lb/in² and moduli up to 1·6 × 10⁶ lb/in² have been obtained at ERDE with machine moulded asbestos reinforced material. Table I gives the properties of some of the materials examined. Higher moduli (up to 6 × 10⁶ lb/in²) are possible with styrene based materials, although these composites are more difficult to mould. Results have shown that the length : diameter ratio of the asbestos fibres is important in relation to the degree of reinforcement obtained. Another factor is the ability of the resin to wet the fibres.

Carbon fibres and ceramic whiskers

Whereas at RAE Farnborough continuous carbon filament reinforcement is being investigated, work at ERDE is directed towards the use of chopped fibres. To obtain the maximum properties it is necessary to pack the maximum amount into the matrix, and this is done by alignment. Briefly, the fibres—asbestos, glass or carbon—are dispersed in a carrier of alginate or glycerine and extruded. Alginate aligned fibres are 'frozen' into thread by immersion in HCL and the alginate is then burned off. Glycerine aligned fibres are washed carefully and dried in sheet form, the glycerine being recycled. Material is produced from these bases in bar, tube or specially shaped forms, thin (0·005–0·010 in) sheet for the production of honeycomb structures, and thin narrow strip for winding techniques.

Silicon carbide and silicon nitride

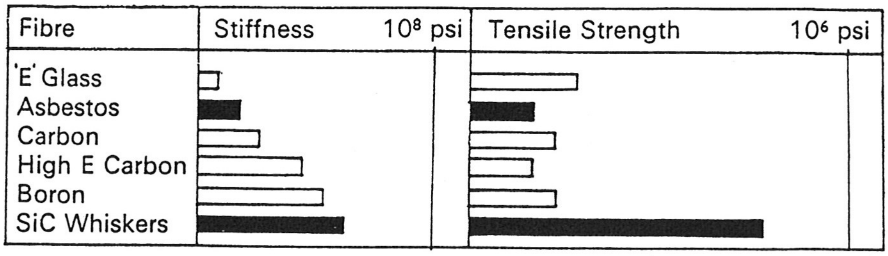
Whiskers of silicon carbide and nitride are produced at ERDE by a chemical route in experimental high temperature reactors. These are essentially expensive materials and it usually requires a period of 60 hr at 1,400° C to yield 1 kg of raw whisker wool. Whiskers may be incorporated by way of the alginate or glycerine processes but are also added to light alloys by pressure casting and subsequent working into bar, rod or other shapes.

For carbide in aluminium—claimed to produce a material of the strength of titanium but with a substantial weight saving—pressure casting produces void free composites with the fibres intact and completely stable. The comparison of stiffness and tensile strength capabilities for various fibres is given in Table II and the relationship between SIC and the US favoured boron is particularly interesting.

Synthesis of new polymers

One of the major interests of the polymer chemistry section at ERDE is in developing methods of synthesising new and potentially important polymers. Recently a method has been developed that enables regular co-polymers to be prepared easily and in quantity. Co-polymers generally have chains consisting of two different monomer units linked in random order but in unalterable proportions. In the 'regular' linking varying proportions of the monomers can be incorporated and this leads to an ability to 'tailor make' polymers to specific requirements.

Table II. Comparative stiffness/tensile strength levels for various fibres

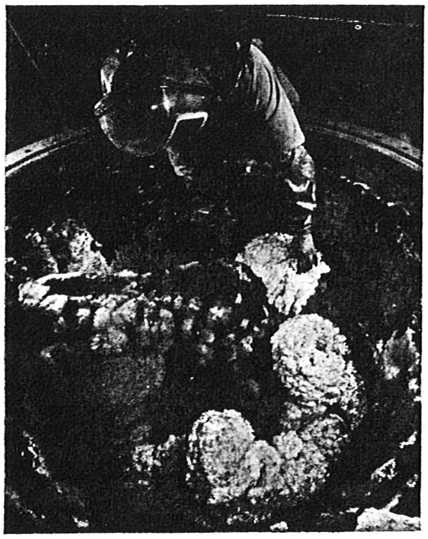


Problems and industrial/ research relationship

ERDE faces two major problems. First, before it came under the aegis of the Ministry of Technology, the primary object of its public relations was 'no public relations'. Now, highly industry oriented, it is an organisation with products, ideas and expertise of substantial potential benefit to industry, but for which it is virtually unknown. It is a non-commercial body and none of its staff would wish to see production lines set up comparable with those that produced 25,000 barrels of gunpowder a year at the time of the Napoleonic wars. It is therefore hard up against the inbuilt reluctance of industry to adopt new ideas, and at the same time it lacks the commercial prestige needed to make industry pay heed.

The second problem is the close parallelism between work being done outside the field of explosives and propellants with that done, for example, by the British Rubber and Plastics Research Association and by other government sponsored and industrial bodies. In spite of the advanced thinking going on there in these non-traditional fields and the obvious experimental successes that have attended this work, it might be difficult in any move to 'rationalise' research effort in this country to justify more than a domestic interest by the establishment in the studies to which it is now so committed.

Possibly one way out of the dilemma would be for the Government to abolish specific titles for establishments, naming them Waltham Abbey, Warren Spring, and the like. Then perhaps industry, encouraged by some powerful and badly needed publicity from Mintech itself would not have to think it odd to consult explosives experts for advice and money-making ideas on the use of fibres reinforced metals and materials.



4 Removing silicon nitride whiskers from an experimental reactor. A protective suit is needed to obviate breathing in of the fine whisker dust.