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FIRE RESEARCH AND ITS APPLICATION

by

D. I. LAWSON, MSc, CEng, FIEE, FInstP, FRSA, MIFireE

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FIRE RESEARCH STATION

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SUMMARY

The composition of the research programme for the Fire Research Station is discussed together with steps taken to implement the results of research.

The programme for the period 1967-8 is set out and the responsibilities of the various senior staff indicated.

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* Director, Joint Fire Research Organization, Ministry of Technology and Fire Offices' Committee.

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MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

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D. I. Lawson, MSc, CEng, FIEE, FInstP, FRSA, MIFireE*

The Joint Fire Research Organization came into being at the end of 1946 in order to carry out research to reduce the loss of life and property. Its outlook has always been severely practical and all research projects have been aimed at producing an answer to some given problem within the Station's terms of reference. There has never been any pursuit of knowledge for its own sake, for researches of this kind have always been regarded as falling more within the sphere of universities.

If any Station is to be successful in carrying out research, then certain well-defined activities must be studied closely. These are selection of research, method of attack, and communication and application of results; they will be dealt with in that order.

1. SELECTION OF RESEARCH

About August every year, the Station puts forward proposals for a research programme for the following year which starts at the beginning of April. In drawing up the programme, it tries to take into account the needs of the fire service, other Government departments, industry and insurance; this includes work on standardization, an important sector of the Station's activities. Apart from the information gained from day-to-day contact by the staff while serving on committees, the Station is advised by four specialist committees covering the fields of Building Regulations, extinguishing materials and equipment, the hazards from smoke and toxic gases, and statistics and operational research. These committees are broadly based, having representatives from the fire service, Government, industry, insurance, university departments, etc.

Once the programme has been formally drawn up, it is put before the Steering Committee which already has the reports of the various advisory committees and has the final responsibility of deciding the research programme. The Steering Committee itself has representatives from the Home Office Fire Service Department, industry, insurance, as well as the Ministry of Technology. The research programme is reviewed by the Steering Committee together with the proposals for staff and equipment necessary to carry it out.

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*Director, Joint Fire Research Organization, Ministry of Technology and Fire Offices' Committee.

In drawing up the programme, it is never possible to do everything that one would like and a selection has to be made. The factors which weigh are the range of application of the results, the economic and administrative importance of the work, the probability of success and the degree of commitment. (Obviously, it is not good policy to stop work which is already nearing successful completion.) There is also the practical consideration of the availability of suitable staff and it is clearly not a good plan to put a man on a job for which he has not had the correct training and experience.

Some items of research can be carried out fairly quickly, taking only weeks or a few months; others may take several years. Work that is done quickly is usually tackled in a direct manner and generally, has a limited range of application. The extreme example of this is to carry out a test to a prescribed schedule. Here one obtains a definitive result quickly but the results are often circumscribed by the test conditions. Research which takes several man-years of effort ought to be economically more worthwhile and to have a greater range of application. In properly conducted research, as in other pursuits, one usually obtains benefits commensurate with the effort put into it.

The programme that is proposed is always rather more ambitious than that which is finally carried out. This is because it is based on an assessment of the problems that require attention and on the assumption that the resources in staff and equipment will be available. Some last-minute reappraisal is always necessary in the spring when the Parliamentary vote becomes known.

2. METHOD OF ATTACK

The method of attack for a particular problem has already been planned by the time the research programme has been agreed. This is necessary to obtain an idea of the resources required for the job. The progress of each item is formally reviewed every six months with the Section Head in charge of the work; at these meetings such topics as progress, direction of attack, as well as publication and implementation of the results of projects coming into fruition, are discussed.

It is in the selection of the method of attack that the Station faces its first difficulty in communication. Real fires are usually large phenomena and also complex, so a number of variables such as fire load, ventilation, shape and size of compartment, etc. have to be studied. It is quite impossible to carry out the desired range of experiments at anything like full-scale. The experimental approach must therefore lack verisimilitude in the eyes of the untrained observer. Where the scientific background is fairly well understood, it is possible to forecast results by calculation and if the calculations themselves are complex, computers can be employed. Sometimes as in analogue

equipment, electric currents may be used in circuits to represent heat flow and light to represent radiation. All these seem rather unreal and indirect ways of attacking what should be a straightforward job. The research worker is often faced with a dilemma because of the indirect approach to his problems. His audience says that it wants the results and their application and does not want to be confused with the argument involved in getting them. On the other hand, his audience often says that it cannot believe the results because they are not born of true large-scale fires. This is an impasse which can only be resolved by the user having some training in one of the recognized disciplines so that he can surmount these barriers to understanding.

3. COMMUNICATION OF RESULTS

Any research station has the responsibility of seeing that the results of its work are published and that they find their way to the section of society that can make use of them. During the course of a piece of research, reports are prepared. These appear in the Fire Research Note series and are distributed to the fire service, insurance and other research bodies. The reports may be obtained free on request to the Station and a list of their titles appears in the Annual Report 'Fire Research' published by Her Majesty's Stationery Office. Recently digests of some of these reports have been prepared. 'References to Scientific Literature on Fire' is a bibliography of world literature, prepared annually, and has a circulation list of about 500.

PUBLICATIONS

As soon as possible, the results of every piece of research are published, usually in the appropriate trade, technical or scientific journal so that the section of society concerned with the research is able to see its results. About 30 publications are made annually, and these include the Annual Report 'Fire Research', already mentioned.

Some contain data of permanent value to which frequent reference will have to be made and these are published through Her Majesty's Stationery Office. They fall into two series, Fire Research Technical Papers containing background information, and Fire Notes which contain rather practical information, stripped of technical complication.

It will be seen that considerable effort is expended to ensure that the results of the work of the Station are given adequate publicity. We are told by some visitors that the results and their application are the only type of publication that matters and that they are prepared to accept the results of research without being bothered with the validation. Equally the

work of the Station should be exposed to informed criticism. Any industry which avoids these responsibilities is doing the Station a disservice.

LECTURES

The staff of the Station give lectures to architects, the fire service, insurance, and various technical audiences. These are often done in the officers' own time and it is becoming increasingly difficult to comply with all the requests that the Station receives. Last year, for example, the number of lectures given amounted to fifty-three.

SYMPOSIA

From time to time, when a programme of research is coming to an end, about a hundred interested parties are invited to a symposium built around the subject of the research. Papers are given by the research staff and by other experts from outside the Station, often from other countries. The implementation of the work is discussed together with possible future topics in the same field. The symposia have proved very popular and it has been necessary to restrict numbers, both on the score of accommodation and in order to allow ample time for specialist discussion.

VISITORS AND OPEN DAYS

Visitors number about 500 annually. A large proportion of these are from the Fire Service College and spend a whole day at the Station, usually in parties of about twenty to fifty. Every two years the number of visitors is increased by about 1200, when the Fire Research Station holds one week of Open Days in which the work is displayed.

COMMITTEES

Committee work is time-consuming, particularly when it is remembered that the Station is represented on about 100 different committees. On the other hand, it does form a valuable outlet for the work. Once information is incorporated into a code of practice or a British standard or into building regulations, it is likely to be used. At the same time, this work does make great inroads into the Station's resources and it is necessary to review committee activity regularly to make sure that it is paying dividends.

CONSULTATION SERVICES

The latest figures show that the Station is answering about 6,000 technical inquiries per annum (1400 written, 4600 telephone). The written inquiries necessitate a good deal of work and expertise, often entailing the examination of building plans. The indications are that this is a much appreciated and valuable service. Not all inquiries can be answered from existing knowledge, and then sponsored tests have to be carried out for industry on either the fire performance of materials and structures or extinguishing apparatus. These are carried out at a rate of about £20,000 per annum.

4. GETTING RESULTS APPLIED

Fire research can be broadly classified, as can any other research for that matter, under two main headings, that which is going to make money and that which is going to cost money.

Research which is going to make money is usually fairly easy to get applied; this embraces the examination of safety standards and their practical significance, allowing relaxations where possible. It is probably in this area that fire research can be of the greatest economic benefit to the community. The other class of work in which savings are possible is the inventing of new and better techniques such as detecting or extinguishing fires or protecting structures against fire.

Since fire research is concerned with safety its findings must occasionally result in restrictions. Then persuasion is difficult and agreement must be made with the industry on standards or codes of practice, and sometimes legislation is necessary, as in the case of flammable nightdresses, oil heaters, Building Regulations, etc.

A good way of getting results applied is to work directly with industry on a research project. In the past, this has usually been on a fifty/fifty basis, and the project has had to be one of general interest with results made freely available. Ways are now being explored for the Fire Research Station to work on research projects on a confidential basis with particular firms, as it has always done in carrying out fire tests. Recently, where research will culminate in the manufacture of some equipment, the government has favoured placing contracts with industry, the idea being that the Government will underwrite the risk capital and then hope to regain its outlay once the project becomes viable.

At this stage the question arises as to why the Government should participate in fire research at all; why not leave it to industry, or alternatively place contracts with universities. Some central research body is clearly necessary for research connected with safety standards as this is not likely to be undertaken by industry, which quite rightly owes its first loyalty to its shareholders. The fixing of correct levels of safety is of economic importance to the nation but not to any one industrial concern. University research is largely geared to the requirements for higher degrees; moreover the unit of two-man years or less consequently imposed is not adequate for many projects.

A central government establishment can have equipment which it would not pay industry to install and it can call on the various disciplines necessary for the solution of problems. The staff of the Fire Research Station for example includes physicists, chemists, mathematicians, statisticians, engineers (civil, mechanical, electrical and chemical) as well as architects, all of whom have become specialists in the application of their discipline to fire research.

It would be wrong to end without emphasizing the important part that both industry and the fire service can play in fire research. Both ought to be more closely integrated with research and with the Fire Research Station. Some firms have sent people to work at the Fire Research Station for periods of up to six months and a few brigades have attached officers for varying periods. In all cases the people concerned have been enthusiastic about the benefits that have been reaped and this method of working together could be extended. The benefit is twofold; the visitor gets to know the staff well and can approach them more easily in the future and, equally important, he gets an appreciation of the work that is put into the validation of any statements that are made. This is vital in a complex science which has been so riddled in the past by the results of single tests.

Of course transactions of this kind should be in two directions. The Fire Research Station should be prepared to release staff to spend time both in industry and in the fire service. The single day visits made at present do not really give an insight into the working of firms or the fire service. It is necessary to spend a longer period actually partaking in the work of an establishment to know its problems.

APPENDIX

The staff of the Fire Research Station are grouped into sections under Division Heads as shown in Fig. 1. Six Sections are concerned with the research programme directly and these, together with the support groups which deal with administration, library and publications, and Station services, comprise the staff.

The Section Heads are obviously important for it is they who have the day-to-day supervision of the research programmes.

OPERATIONAL RESEARCH AND STATISTICS (MR. J. F. FRY)

Nearly ~~2 000~~ 300,000 reports are received each year from brigades on the fires they have attended. These are tabulated and classified to prepare data on the pattern of fire and its cause and effect throughout the country. It is also possible to use the statistical information to solve administrative problems relating to the siting of fire stations, attendance times and value of fire detection and sprinkler systems. This Section is also carrying out work on the value of fire protection publicity.

IGNITION AND GROWTH (DR. P. H. THOMAS)

The study of the ignition of materials is essential for deriving acceptable building separation if individual fires are not to become conflagrations; it is also important for civil defence purposes. The rapidity of the growth of fire in compartments governs the hazard to life, the loss of property and the size of the fire a brigade has to fight on arrival. The duration of a fire governs the type of structure which will have to be used to resist it.

STRUCTURAL FIRE PROTECTION (MR. E. G. BUTCHER)

Once a fire has become firmly established in a building, the structure is called upon to withstand the fire while still supporting its load and acting as a fire barrier in the case of walls or floors. This Section is concerned with the study of the forces to which modern constructions are subject in fire and also with the safety of the occupants of buildings escaping from fire. In addition studies are being made of the economics of fire protection in buildings. By the choice of the correct level of protection, is is possible to effect great economies in the building industry.

SPECIAL INVESTIGATIONS (MR. H. L. MALHOTRA)

A large amount of sponsored testing is carried out for the building industry. Some of these tests are formulated in British Standards and for others tests have to be devised to simulate practical conditions. The non-standard test of today often becomes the standard test of tomorrow and it is fitting, therefore, that this Section should be concerned with

the drafting of new standards in the home and international field. The tests carried out range over the fire performance of materials, structures and fire extinguishers.

EXTINGUISHING MATERIALS AND EQUIPMENT (MR. P. NASH)

This Section deals with research into materials and equipment used in fire extinction. Its work includes evaluation of the performance of sprinkler and detection systems, and the production of both standards of performance and codes of practice.

CHEMISTRY AND CHEMICAL ENGINEERING (MR. K. N. PALMER)

Many industrial processes, materials and equipment involve hazards of a chemical nature. These include unstable compounds, flammable dusts and flammable atmospheres; both safe equipment and safety standards have to be evolved if disastrous explosions are to be avoided. Plastics are now commonly used as building materials and the smoke and toxic hazards of these have to be assessed in the light of the hazards of materials to which we are accustomed.

RESEARCH PROGRAMME

In setting out the research programme, there is always conflict between giving an organisational or a functional pattern to the arrangement of items, as often more than one Section will be concerned with one field. The following programme current in 1967/8 is set out functionally but the Sections having a responsibility for the project are shown in the first column.

SYNOPSIS OF PURPOSE OF FIRE RESEARCH PROGRAMMES, 1967-1968

Section concerned	
	Statistics
OR & S	Collection and collation of fire statistics for the purpose of research and administration
OR & S	Study of large fires with a view to ascertaining the value of investment for their prevention
OR & S	Records of fires in tall buildings. Information required for planning purposes
OR & S	Study of industrial fires as a system so that account can be taken of the interplay of fire prevention, structural fire precautions, fire-fighting, and reinstatement of production
OR & S	Collection of information on casualties in fires with a view to the identification of hazard
	Fires in Buildings
I & G	Study of factors governing the duration of fires with a view to providing information on the fire-resistance necessary for buildings - international programme
I & G	Study of thermal economy in fires - required to provide background information on fire-resistance in buildings
SFP	Application of research results to Building Regulations
SFP	Restraints on structures in fires - required for the understanding of the fire performance of modern buildings
SFP	Fire protection of services in buildings
I & G	Study of the role of ceiling linings in the spread of fire in buildings - required for Building Regulations
I & G	The use of water curtains and roof vents to prevent the spread of fire in large factory and storage spaces
I & G	The use of models to study how fires develop in compartments - international programme
I & G	Spread of fire between items of furniture for civil defence and onset of firestorms - linked with last item
SFP	Properties of concrete at high temperatures - required for computer design of buildings
SFP	Behaviour of structural steel in fire

Section concerned	Fires in Buildings (Cont'd).
SI	Continuity and fire-resistance of beams and floors - required for the understanding of the behaviour of multi-storey buildings
SI	Behaviour of slender reinforced columns - information required for building codes
SI	Fire-resistance of laminated timber beams required for codes of practice
SFP	Cost of fire protection in buildings. Part of cost/benefit analysis of Building Regulations and fire services
I & G	Spread of fire in forest and heathland
I & G	Growth of fire in built-up areas leading to study of firestorms in civil defence
I & G	Instrumentation for United States conflagrations
I & G	Burning rate of unenclosed fuel beds
	Extinction
EM & E	Experimental work in connection with production of British standard for smoke detectors
EM & E	Measurement of ambient smoke levels in buildings - linked with last item. This fixes ultimate sensitivity of detectors
EM & E	Reliability of fire alarm indicating equipment - necessary for the prevention of the present large number of false alarms
EM & E	Test for line fire detectors
EM & E	Effect of cotton fly on operation of sprinklers
EM & E	Assessment of powders for use in fire extinction - commercial exploitation
EM & E	Storage and flow of powders - aimed at improving fire extinguishers
EM & E	Compatibility of powder and foam in fire extinction
EM & E	Use of high expansion foam to extinguish fires in compartments having a large area
EM & E	Analysis of foam compound with a view to finding the active agents

Section concerned	
	Extinction (Cont'd.)
EM & E	Performance of sprinkler systems - study with manufacturers
EM & E	Water distribution from sprinklers - required for development of test for sprinklers
OR & S	Cost/benefit analysis of sprinklers and fire detectors
EM & E	Evaluation of perfluorinated compounds for the extinction of liquid fuel fires
SI	Durability of fire-retardant treatments
	Safety
SFP	Movement of smoke and toxic gases on escape routes required for Building Regulations
C & CE	Toxic products of combustion of plastics - required for Building Regulations
C & CE	Production of standard for the evolution of smoke from building fires - required for Building Regulations
C & CE	Hazards due to dusts - fundamental study of dust explosions
C & CE	Dust explosions in cyclones
C & CE	Protection of equipment to be used in flammable atmospheres
C & CE	Examination of unstable compounds used in industry
C & CE	Spontaneous heating of materials in industry
OR & S	Measurement of effectiveness of fire protection publicity
	Fire Tests
SFP & SI	Design of new furnaces
SI	Modernization of existing furnace instrumentation
SI	Correlation of furnace performance in different countries
SI	Work in connection with international standards for fire tests
SI	Work required in connection with revision of British Standard tests
C & CE	Tests for susceptibility to fires in pipe lagging for chemical and petroleum industries
EM & E	Tests on extinguishers for international standard

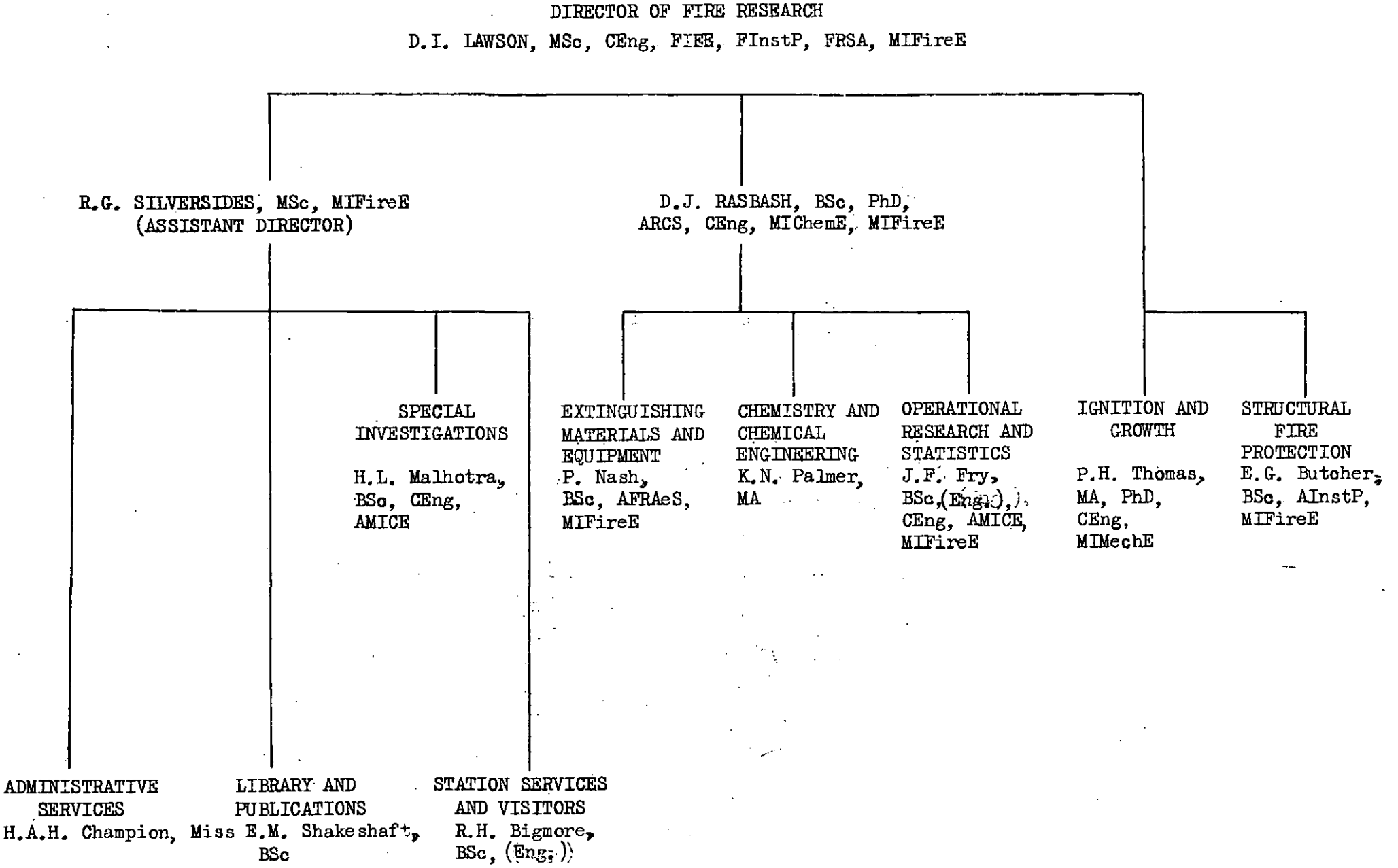

FIG. 1. Senior Staff