AN ECONOMIC APPRAISAL OF ASPECTS OF AUTOMATIC FIRE DEFENCE

A Thesis for the Degree

of

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By

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SUMMARY

The installation of systems of automatic fire defence in commercial and industrial buildings, apart from their protective value, may result in significant financial advantages. Although systems of automatic fire defence are frequently installed in the larger commercial and industrial buildings, in particular industrial buildings with high fire risks, the minimum size and use of buildings where such a system results in a positive financial return has not been established.

This study sets up a framework within which the financial implications of the installation of systems of automatic fire defence can be assessed. Firstly by examining the working of the fire insurance market, in particular the tariff system, and secondly by a survey of systems of automatic fire defence together with their additional initial costs and subsequent running costs.

A discounted cash flow technique has been used to assess the financial return. The technique is based upon a company's cost of capital and a theoretical cost of capital has been established which is both net of inflation and taxation. Taxation allowances and regional development grants have also been examined in detail.

To ascertain the financial return from the installation of an automatic fire defence system, in particular a sprinkler system, four case studies were undertaken; two of these relate to industrial buildings and two to retail premises. The case study buildings are considerably smaller than the size of buildings where sprinkler systems have normally been installed in the past.

The rapid rise in fire losses during the past decade has resulted in considerable increases in insurance premiums. The saving on these premiums, together with taxation allowances for the installation of automatic fire defence systems, resulted in cash flows which produced a positive present value following the installation of a sprinkler system for all four case study buildings. This suggests that there are considerable financial advantages accruing from the installation of such systems.

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Chapter 1

The need for an economic appraisal of systems of automatic fire defence

Losses Resulting from Large Fires - Aim of the Study - Need for the Study - Outline Survey of Literature.

Direct fire losses in Great Britain (excluding Northern Ireland) have increased sharply in money terms during the past 15 years. In 1958, the figure was below £30 million whereas losses for the twelve months ending August, 1973, amounted to £157 million[1.1]. A high proportion of the increase has occurred as a result of fires in commercial and industrial buildings. The value of industrial or commercial establishments of any size is likely to be in excess of £10,000 and any fire occurring in these premises could well result in a "large fire".*

The Fire Research Establishment[1.2] has undertaken an analysis of "large fires" which occurred between 1965 and 1968. The number of fires where direct damage costing more than £10,000 amounted to approximately 1% of the total number of fires in buildings. The direct cost of large fires, however, amounted to £211,305,000 and represented 60.6% of the total direct fire losses from 1965 to 1968. Analysis of large fires which occurred in 1969[1.3], 1970[1.4] and 1971[1.5] has also been undertaken by the Fire Research Establishment. The figures from 1965 to 1971 are shown in Fig. 1 and include fire losses for Northern Ireland, which until 1971 had not reached significant

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*A "large fire" is defined in the "United Kingdom Fire and Loss Statistics" as one where the direct damage exceeds £10,000.

proportions. The estimated cost of all fires occurring in Great Britain and in Northern Ireland is also shown in the table:

COST OF LARGE FIRES, 1965-1971

Year	Estimated Cost of all fires £m		Number of "large fires" in Great Britain and Northern Ireland	Total cost of "large fires" in Great Britain and Northern Ireland £m	Cost of large fires expressed as a % of the cost of all fires in Great Britain and Northern Ireland
	Great Britain	Northern Ireland			
1965	74.0	1.1	777	44.7	59.52
1966	79.9	2.4	890	48.3	58.69
1967	86.8	3.2	928	56.7	63.00
1968	98.7	1.3	1005	61.6	61.60
1969	117.3	3.1	1058	74.6	61.96
1970	106.6	4.3	1040	60.7	54.73
1971	106.1	22.6	1201	77.7	60.37

Fig. 1 Percentage cost of large fires, 1965-1971.

It is possible to reduce fire damage by the use of systems of automatic fire defence, to enable the fire to be tackled at an early stage and prevent it from developing. Insurance companies have long recognised the protective value of systems of automatic fire defence and are prepared to allow considerable insurance discounts, particularly for the installation of sprinkler systems.

The aim of this study is to establish a basis from which the financial return of methods of automatic fire defence for both commercial and industrial buildings can be evaluated.

In testing the economic viability of a decision to install an automatic fire defence system, a method of financial appraisal has

been used in this study which is based upon a discounted cash flow technique. The discounted cash flow technique is based on the concept of cost of capital and takes into account current taxation, regional development aid and reductions in insurance premiums. A theoretical company's marginal cost of capital in real terms[1.6] has been calculated and this has been used to discount the cash flows in the four case studies in Appendix C.

During the early stages of the study it became increasingly clear that previous work on the relationship between value of building to be protected and the financial advantages of protection was limited. Insurance company representatives, fire research specialists, fire prevention officers and sprinkler engineers were not able to say at what size or value of building it became financially worthwhile to protect the building. It is, however, amongst members of the Architectural and Quantity Surveying professions where the knowledge of the relationship between the value of a building and the financial advantages of protection is most needed and least evident.

Stone[1.7] has suggested that design and layout can influence rating valuation and the premiums payable for fire insurance. However, he gives no indication of the likely influence beyond stating that fire insurance premiums are related to risks and can often be reduced by the provision of non-inflammable materials and fire fighting appliances such as sprinklers. In a further study, Stone[1.8] points out that fire insurance rates can vary within a wide range according to the risk of fire starting and spreading in a building and that this depends more on the process and manufacturing materials than on the construction of the building. In a later study Stone[1.9] states that it may not pay to install automatic detectors or sprinkler installations where the annual equivalent cost of the installation and subsequent maintenance

is greater than the reduction that would be allowed in insurance premiums. Stone, however, gives no indication of the range of insurance rates or of the likely reduction in rates resulting from the installation of systems of automatic fire defence.

The Fire Prevention Design Guide[1.10] directs the Architect to consider with the Quantity Surveyor and the client's Accountant, the effect of reductions in insurance premiums over the life of the building compared with the initial capital outlay. All too often, the Quantity Surveyor is unable to make more than a superficial appraisal and is only able to give advice of a general nature. Architects and Quantity Surveyors are frequently unaware of the existance of a tariff structure or of standards of construction[1.11] which are used by the Insurance Companies when assessing the insurance premiums of commercial and industrial risks.

During this study difficulty was encountered in obtaining information relating to the tariff structure from Insurance Companies, because the information is regarded by the Companies as confidential. It was largely due to the co-operation of one tariff company and the publication of the report of the Monopolies Commission[1.12] on the supply of fire insurance that information of any relevance was available. In an earlier study, the author[1.13] stated that information on whether the installation of an automatic fire defence system was likely to be economic should be available at the cost planning stage of a building project. It should not be necessary to wait until the scheme has been finalised before the Quantity Surveyor can give such information.

One reason why the Quantity Surveyor can only give advice of a general nature is that many of the publications concerned with the economics of systems of automatic fire defence are outside his normal area of reference. Cost studies[1.14] published by the Central Fire

Liaison Panel‡ indicate the financial return which results from the installation of systems of automatic fire defence, although they give no indication of the size of building involved in the study nor do they take account of the running costs of such installations. The aim of the Fire Liaison Panel literature has, however, been directed towards making industrial and commercial management aware of the advantages of installing such systems. In recent years, the United Kingdom Fire Protection Association* through the publication of the Fire Prevention Design Guide and by sponsoring courses, has made Architects more aware of the need to incorporate fire prevention measures into building at the design stage.

Another reason why the Quantity Surveyor can only make a superficial appraisal is that publications concerned with the economics of automatic fire defence, both in this country and overseas, have been limited in number and the majority have been of a general nature. The following outline survey of literature only includes the principal references directly relating to the economics of the installation of a system of

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‡The function of the Panel is to co-ordinate activities leading to the prevention of fire and the reduction of fire wastage and it undertakes publicity leading to these ends. In addition to the Central Panel, there are twelve regional panels with members from the British Insurance Association, The Chief Fire Officers' Association, The Confederation of British Industry and the Fire Protection Association.

*The object of the Fire Protection Association includes investigating the causes and spread of fire and dissemination of advice on and knowledge of fire protection. Membership is open to all insurers and to subscribers from industry, commerce and the public fire brigades in this country and overseas.

automatic fire defence. Other references of a more specific nature will be dealt with in subsequent chapters.

Papers by Tarrant[1.15], Osborne,[1.16] Doublett[1.17], Farrington[1.18] and Yarnwood[1.19] whilst indicating that savings in premiums will result from the installation of sprinkler systems in buildings used for certain industrial processes, have been expressed in general terms. Work undertaken at the Fire Research Establishment by Ramachandran[1.20,1.21] has been concerned with the national expenditure on sprinkler installations and upon the frequency of sprinklered premises. Ramachandran[1.22] in an unpublished paper has stated that there is a need for a mathematical framework which could be used by the building owner for examining the economic desirability of installing sprinklers in a building. A more recent study[1.23] at the Fire Research Establishment has been concerned with the optimum combination of active* and passive fire defence.

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*The term active fire defence has been stated by Maskell[1.24] to consist of:

> "built-in items such as sprinkler systems, fire alarms, water hydrants and first-aid fire-fighting equipment, and could therefore be regarded as the visible means of fire protection".

The term passive fire defence covers structural protection of the building. In an earlier study[1.13] the author used the term "active fire defence" to cover automatic detection and sprinkler systems. In this study, however, the term automatic fire defence has been used which covers equipment intended to be operated by the effect of fire.

In recent years, increased fire losses have occurred throughout all industrialised nations[1.25,1.26] and with few exceptions the fire loss per head of population, corrected for inflation, has increased. American management has realised the need to check fire losses and they are very much more fire conscious than management in the United Kingdom.[1.27] The National Fire Protection Association of the United States (NFPA) was established in 1896 and published the first edition of the Fire Protection Handbook[1.28] in the same year. The thirteenth edition of the Handbook contains details of a method of economic appraisal undertaken by Clyde M. Wood for the "Automatic" Sprinkler Corporation of America. The method used by Clyde M. Wood is examined in detail in Appendix A. Burtner[1.29] in the United States has developed a method of appraisal based upon an engineering rather than an economic analysis and in a later study[1.30], Burtner examined the concept of risk management.[1.31]

In Australia, Marryatt[1.32] has published the records of fires occurring in sprinklered premises between 1886 and 1968. The records show the advantages of the installation of sprinkler systems and Marryatt has suggested that existing sprinkler systems in Australia and New Zealand, apart from safeguarding life, have, during the past 20 years, saved approximately $100 million[1.33] of property and contents.

Tariff systems[1.34] relating to the fire and consequential loss insurance of property operate throughout the European Economic Community, except Italy. Premiums may be discounted throughout the EEC, including Italy, for commercial risks where certain safety measures, particularly sprinklers, are undertaken. In France, a recently published paper[1.35] indicated the economics of installing sprinkler systems in large industrial and commercial buildings. Work has also been undertaken by the European Fire Alarm Manufacturers Association[1.36] (EURALARM) in developing a method of evaluating the fire risk of a

particular building, which could be used to determine the necessary fire protection measures. Difficulties appear to arise with the EURALARM method in establishing the values used in the calculations.

In this study, a framework has been evolved to evaluate the financial implications which result from the installation of systems of automatic fire defence. It is intended that the methodology devised will enable Quantity Surveyors and others associated with the economic appraisal of buildings to give more accurate cost advice during the design stage of a building.

NOTES

1.1 British Insurance Association "August Fire Damage Brings 12 Months Total to 158 Million" (Press Release - Reference : F 1264(b) September 1973).

1.2 G. Ramachandran and Patricia Kirsop, A Brief Analysis of Large Fires During 1965 to 1968 (Fire Research Station, Fire Research Note No. 792, November, 1969) pp. 1-10 & Tables 1-15.

1.3 G. Ramachandran, Patricia Kirsop and Christine Eveleigh, Large Fires During 1969 (Fire Research Station, Fire Research Note No. 829, July 1970) pp. 1-15.

1.4 G. Ramachandran, Patricia Kirsop and Christine Eveleigh, Large Fires During 1970 (Fire Research Station, Fire Research Note No. 891, September 1971) pp. 1-21.

1.5 G. Ramachandran, Christine Eveleigh and Eileen Hudson, Large Fires During 1971 (Fire Research Station, Fire Research Note No. 956, January 1973) pp. 1-22.

1.6 Infra., Chapter 6.

1.7 P. A. Stone, "The Economics of Building Design", (Journal of the Royal Statistical Society. Series A (General) 123.3 1960) p. 247.

1.8 P. A. Stone, The Economics of Factory Buildings (Her Majesty's Stationery Office, Factory Building Studies No. 12 - 1962) p. 33.

1.9 P. A. Stone, Building Design Evaluation : Costs in Use (London, E & FN Spon Ltd., 1967) p. 154.

NOTES

1.10 Fire Prevention Association, Fire Prevention Design Guide, A handbook for architects, (London : Fire Protection Association, 1969) p. DG5.

1.11 Fire Offices' Committee, Standards of Construction I to V with amendments, (London, Fire Offices' Committee, 1959)

1.12 Great Britain, The Monopolies Commission, Fire Insurance - Report on the supply of Fire Insurance (London : Her Majesty's Stationery Office, 1972)

1.13 N. D. Schofield, "The Need for Active Fire Defence", The Quantity Surveyor Vol. 29 No 5 (March/April 1973), p. 120.

1.14 Central Fire Liaison Panel, Fire Defence cost or saving? Fact Sheet, 1973. (London : Central Fire Liaison Panel).

1.15 R. K. Tarrant, "A Guide to the Economics of Fire Protection". Fire Protection Review. Vol 23 1960. pp. 412-413 and 484-485.

1.16 W. Osborne, "The Economics of Fire", Fire Supplement IFE/CFOA Conference Papers 1967. pp. 42-43.

1.17 A. R. Doublett, "Fire Economics and Insurance", Fire Supplement IFE/CFOA Conference Papers 1967. pp. 43-44 and 55.

1.18 J. T. Farrington, "The Economics of Fire Protection "Journal of the Chartered Insurance Institute, Vol 64 1967, pp. 11-16.

NOTES

1.19 A. J. Yarnwood, "The economics of fire prevention", Policy Holder Insurance Journal, (22nd July, 1966) pp. 1089-1093.

1.20 G. Ramachandran, National Expenditure on Sprinkler Installations, (Fire Research Station, Fire Research Note No. 906, December, 1971) pp. 1-5.

1.21 G. Ramachandran, An Enquiry into the Frequency of Sprinklered Premises, (Fire Research Station, Fire Research Note No 828, May 1970) pp. 1-7.

1.22 G. Ramachandan, The Economics of Sprinkler Protection 1 User of the Building - Private Communication.

1.23 R. Baldwin and P. H. Thomas, Passive and Active Fire Protection-The Optimum Combination, (Fire Research Station, Fire Research Note No. 963, March, 1973) pp. 1-8.

1.24 D. V. Maskell, Cost of Fire Protection - Towards a Definition, (Fire Research Station, Fire Research Note No 898, February 1973) p. 5.

1.25 N. C. Strother Smith, "A Global Survey of Fire and its Prevention", Journal of the Chartered Insurance Institute. Vol 65,(1968) pp. 23-34.

1.26 G. Ramachandran, Fire Losses in Different Countries. (Fire Research Station, Fire Research Note No 844, October, 1970) pp. 1-11.

NOTES

1.27 A. R. Doublett, "Fire Insurance Problems and Risk Improvement", Journal of the Chartered Insurance Institute, Vol 67, 1970. pp. 61-74.

1.28 G. H. Tryon, ed; Fire Protection Handbook, 13th ed., 1969. (Boston : National Fire Protection Association) pp. 16/8-9.

1.29 C. E. Burtner, "The Economics of a Fire Protection Program". Fire Technology, (February 1966) pp. 5-14.

1.30 C. E. Burtner, Risk Management : The Economics of Fire Protection Engineering, (Boston : National Fire Protection Association, MP 67-10) pp. 1-8.

1.31 W. Horrigan, Risk, Risk Management and Insurance (Sussex : Withdean Publications Ltd., 1969) pp. 9-18.

1.32 H. W. Marryatt, Fire - Automatic Sprinkler Performance in Australia and New Zealand 1886-1968, (Melbourne : Australian Fire Protection Association, 1971) pp. 1-540.

1.33 Ibid., pp. 511-512.

1.34 Royal Insurance, International Insurance Directory Western Europe (Liverpool : The Royal Insurance Group) pp. 1-23.

1.35 "De L'Utilisation Des Installations D'Extincteurs Automatiques A Eau", Face Au Risque No 91 (15 Mars - 15 Avril, 1973) pp. 26-32.

1.36 G. A. Purt, "The Evaluation of the Fire Risk as a Basis for Planning Automatic Fire Protection Systems", Fire Technology, (November 1972) pp. 291-300.

Chapter 2

Fire Insurance relating to Commercial and Industrial Buildings

Size and Nature of the Insurance Market - Reinsurance and Co-insurance - Fire Offices' Committee - Competition between Tariff and Independent Companies - Fire Tariffs - Adjustment of Insurance Rates, 1963-1973 - Pricing Policy of the Fire Offices' Committee - Consequential Loss.

Fire insurance as defined in Section 59(9) of the Companies Act, 1967* covers the insurance of commercial, industrial and domestic property. In this study it is not the intention to deal with domestic property insurance, the main emphasis is on the insurance of commercial and industrial buildings. In addition to fire insurance, many commercial and industrial organisations also insure against the after effects of fire, which can result in loss of profit, loss of orders, disruption and the payment of wages to workpeople until they can be re-employed. Such cover is known as consequential loss insurance and is additional to the direct fire insurance policy.

An indication of the size of the United Kingdom fire insurance

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*Section 59(9) - "the business of effecting and carrying out contracts of insurance against risks of loss of, or damage to, material property, not being risks of a kind such that the business of effecting and carrying out contracts of insurance against them constitutes marine, aviation and transport insurance business or motor vehicle insurance business".

market, in which a number of foreign controlled firms operate, can be gauged from figures published by the British Insurance Association[2.1]. The Fire and Accident (non-motor) insurance premium income of member firms of the Association which have head offices in the United Kingdom and who carry the major portion of fire insurance business, amounted in 1971 to £498 million*. Carter[2.2] states that foreign insurance companies are less important in the British market than their number suggests. For non-life business there were only 15 foreign registered companies with United Kingdom premium exceeding £250,000.00 in 1965 and although interest in the United Kingdom has been increasing, many of the foreign companies are only represented in the United Kingdom reinsurance market[2.3]. Carter also points out that in addition to foreign companies there are a number of British registered companies which are wholly or partly owned by foreign insurers; for example 25% of the share capital of the Phoenix Assurance Co., which is the sixth largest British composite company is owned by the Continental of New York.

The Monopolies Commission in their report on the supply of fire insurance[2.4] stated that over 90% of all the United Kingdom

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*The figure of £498 million for Fire and Accident (non-motor) income is based on the returns of the Department of Trade and Industry and includes premiums for pecuniary loss, personal accident, property and liability insurance. The last time the figure for property fire insurance was shown separately was in 1968 when it amounted to 51.5% of the total. Assuming a similar percentage applied in 1971, then the property fire premium would be £256 million.

commercial and industrial fire insurance is handled by the insurance companies, the remaining percentage by the Lloyds underwriters. The insurance companies are however grouped into two distinct bodies known as the tariff and the so called independent companies. The tariff companies are those who are members of the Fire Offices' Committee and are therefore bound to charge premiums which are not less than the rates calculated in accordance with agreed tariffs. In 1968 there were 29 tariff and 76 independent companies[2.5]. A number of companies have grown so large that their premium income amounts to many millions as shown in the following table which relates to the volume of fire insurance premiums for property in the United Kingdom and has no reference to the absolute size of companies.

SIZE OF TARIFF AND INDEPENDENT COMPANIES

Premium Income 1968	TARIFF COMPANIES		INDEPENDENT COMPANIES	
	Number of Companies	% of premium income	Number of Companies	% of premium income
Less than £10000	15	1	44	3
£100000 to £1m	3	1	22	17
£1m to £2m	2	3	4	13
£2m to £5m	2	6	4	27
£5m to £10m	3	17	1	15
over £10 m	4	72	1	25

Fig. 2 Distribution of premium income - Tariff and Independent Companies

Source - Fire Insurance[2.6]

In 1968, approximately 63% of the fire insurance premium income was controlled by the tariff companies, 30% by the independent companies and the remaining 7% by the Lloyds underwriters. Within the tariff group, 95% of the business was controlled by 9 firms and in the independent group 6 firms controlled 67% of the total business. Thus approximately 80% of the total figure for the fire insurance of property in the United Kingdom was, in 1968, controlled by 15 firms, nine of which are under agreement to charge the same minimum rate.

Fire insurance is similar to other forms of non-life insurance in that there is an agreement by the insurer to accept the liability for indemnifying against loss, in return for the payment of a premium. In commercial and industrial fire insurance, however, the value of the property and contents together with the consequences of a disastrous fire can create such an enormous liability that even the largest of the insurance companies would be unwilling to accept the risk on its own. A look through the fire loss records will reveal a number of fires where the direct loss alone has totalled many millions. The extent to which an insurer can accept a risk is limited by Section 63 of the Companies Act, 1967 which governs both the insurance companies and the members of Lloyds. Before a firm can undertake the business of property insurance, authority must be received from the Board of Trade. The Board of Trade will not grant the authorisation until they are satisfied with the firms margin of solvency and also their arrangements for reinsurance[2.7]. Some risks are so hazardous that insurance companies would be unwilling to accept them anyway; for example, the insurance of a factory producing plastic components, which is not protected by any form of automatic fire defence, would in all probability be an unacceptable risk because of the number of fires that have occurred in similar buildings. Other risks may be hazardous but the company

is prepared to accept part of the risk, although not the whole risk and will do so provided that reinsurance or co-insurance facilities can be obtained.

Reinsurance is a system of risk transfer and is undertaken either by specialist firms or else by the larger insurance companies and enables a company to accept a risk which is larger than it would normally expect to carry on its own. The smaller are the premium income, capital and free reserves of an insurance company, the greater is its need for reinsurance protection[2.8]. The reinsurance market tends to be international with a substantial amount of business being placed overseas with foreign companies[2.9]. Most reinsurance business is carried out under reinsurance treaties, these are standing arrangements usually renewable each year and as a result a percentage of the direct insurers business is automatically reinsured[2.10].

An alternative or sometimes additional method of spreading the risk is by co-insurance. Co-insurance differs from reinsurance in that two or more companies will agree to accept a certain percentage of a given risk. One of the companies will be known as the "leading office" and it is usual for that company to carry out the survey and then quote the rate. The "following companies" would normally, if they had confidence in the "leading office", accept the rate quoted. Where the lead is taken by a tariff company it is usual to find the "following tariff" and also many independent insurers agreeing to the rate. However, it is comparatively rare to find tariff companies following the lead of an independent company and where it does occur it is likely that the tariff company will carry out its own survey and insist that the provisions of the 65/35 Rule are adhered to[2.11]. The 65/35 Rule is a clause in the Co-insurance Agreement which relates to the sharing of insurance between tariff companies and between tariff

and independent companies. The rule which was criticised in the report of the Monopolies Commission states that tariff companies will not enter into co-insurance agreements unless at least 65% of the business is placed with the tariff company. The Commission, although unable to obtain precise figures, estimated that in terms of premium income more than half the total of commercial and industrial fire insurance was co-insured[2.12].

Despite a tariff system which sets out minimum rates for various risks and is largely followed by the independent companies, it is surprising that commercial and industrial fire insurance from the early sixties up to 1969 showed either a marginal profit or else a loss. A study of premiums, expenses, profits and losses of selected tariff companies from 1963-1970 shown below indicates the way in which both premiums and claims have been increasing.

COMMERCIAL AND INDUSTRIAL FIRE INSURANCE

BUSINESS-SELECTED COMPANIES - 1963 - 1970

£ millions

Year	Premiums earned	Expenses				Profit (Loss)
		Claims incurred	Commission	Other outgoings	Total	
1963	39.2	30.4	5.9	11.4	47.6	(-8.4)
1964	42.4	28.8	6.4	12.1	47.3	(-4.9)
1965	47.0	29.9	6.9	12.9	49.7	(-2.7)
1966	51.5	30.2	7.4	13.9	51.5	(negl)
1967	54.2	30.0	8.3	13.9	52.2	2.0
1968	61.7	42.6	9.3	14.5	66.4	(-4.7)
1969	72.8	46.0	11.0	15.5	72.5	0.3
1970	86.6	36.3	13.2	16.0	65.5	21.1

Fig. 3 Premiums and expenses of selected tariff companies, 1963-1970

Source - Fire Insurance[2.13]

Commercial and industrial fire insurance has again become profitable because of the large increases in insurance premiums during the past ten years, some classes of risk being increased by as much as 750% over the 1963 level.

Membership of the Fire Offices' Committee (FOC) which operates the tariff is restricted to those insurance companies who will accept the principle of common minimum premium rates for fire insurance. One other condition of membership is that member companies must undertake to regard all meetings and papers issued by the Committee as private and confidential[2.14]. However, many of the independent insurance companies make use of the tariff documents as a guide to fixing premium rates because they do not have access to central statistical information. The representative of one tariff company remarked that the larger independent companies probably had information relating to changes in a tariff within 24 hours of a tariff company receiving it.

The high losses that have occurred in buildings insured in both tariff and independent sectors, together with the large volume of co-insurance makes competition for rates, between the tariff and independent insurer, marginal in those classes of business where the risk is high or the sums insured are large. One broker, however, was of the opinion that there was still competition between tariff and independent companies so far as the basic rate was concerned and quoted the following example:-

Company A (independent)	-	25p for every £100 insured
Company B (tariff)	-	35p for every £100 insured

both companies, however, were applying the same loading of 300% to the basic rate. The difference of 10p between the basic rates is due

to the different attitudes taken by the companies over the particular risk being based upon their past experience. Evidence of similar competition was also found in two of the case studies in Appendix C.

There is also competition in the amount of discount and commission allowed to a broker. The independent companies allow both discount and commission whereas the tariff companies only allow commission. The combined amount of discount and commission allowed by the independent companies has been reduced on a number of occasions since 1959 and at present it would appear that they pass on between 23.5% and 23.7% of their premium income in discount and commission where the risk is co-insured; whereas the tariff companies pass on 15% as commission to the insurance brokers[2.15]. The independent companies have always paid higher commission rates, because companies when entering the fire insurance market and not joining the FOC found that it was usual to begin by securing a small share in a co-insured risk and then to use the high commission and discount rate to induce brokers to offer them the business. They were able to afford this because the expense of co-insurance fell on the "leading"office. The independent companies have found that with rising fire losses it has been necessary to reduce the amount of discount and commission, which was as high as 40% in 1959, down to a figure which at present is between 15 and 20%[2.16].

In addition to operating the tariff, the FOC is responsible for formulating rules relating to standards of construction, automatic sprinkler installations, automatic fire alarm installations, wired glass, external drencher systems and fireproof doors. It is, however, industrial risks which have occupied most of the Committees time since its formation in 1868[2.17]. At the present time there are 95 tariffs in operation all of which relate to commercial or industrial risks, the tariff dealing with domestic fire insurance was abolished in 1971.

The tariff documents are private and confidential and the following information relating to the tariffs has been obtained from interviews with insurance company representatives, insurance brokers and the report of the Monopolies Commission.[2.18]

A number of the tariffs relate to buildings, wharves and quays used for the storage of merchandise within a specific area of a town, as for example the Hull Warehouses, Leeds Carriers and the Liverpool Mercantile and Carriers. There are 20 of these tariffs which apply mostly to the ports, some to a paticular trade and others to a wide range of trade and industry. Of the remaining 75 tariffs, four relate to the Republic of Ireland and 66 to a particular trade or industry in England, Wales, Scotland or Northern Ireland and include for example the following:-

Aircraft Engine Manufacturers (Great Britain and Northern Ireland)
Aircraft Factories
Bleach, Dye and Print Works
Bleach and Dye Works (Scotland)
Bleach and Dye Works (Ireland)
Bonded Stores (Scotland)
Bonded Stores (Ireland)
Boot and Shoe (Great Britain and Ireland) etc.

The tariffs are under constant revue to take account of changes in technology and the latest tariff to come into force is concerned with the plastics industry. This tariff came into operation on the 1st January, 1974. The remaining 5 tariffs deal with the following:-

(i) Special perils - not concerned with fire risk.

(ii) Sprinkler leakage - this tariff is concerned with damage caused by unintentional escape of water from a sprinkler installation which may be due to leakage or bursting. In

Chapter 4, this tariff is considered in more detail.

(iii) Combined Insurances Tariff - a set of regulations concerned with the combining of different classes of insurance covering fire, consequential loss and employers liability into a single policy. Although known as a tariff it does not lay down rates, but states that the other tariffs and rules of the Fire Offices' Committee must be adhered to.

(iv) Special Floating Policies Tariff - concerned with the rating of goods which may be kept at two or more premises, the proportion at each of the premises being liable to fluctuation.

(v) Minimum Rates Tariff - provides for a minimum net rate of $7\frac{1}{2}$p per annum for every £100.00 insured, except where an alternative minimum rate is provided in any other tariff or regulation.

In addition to the tariffs, there are regulations which have the effect of tariffs because they are concerned with rating and include the following:-

(i) Rules for the insurance of public property.

(ii) Regulations for the insurance of buildings whilst in course of erection and completion.

(iii) Rules applicable to fire insurance - London and Country Printers and Allied Trades.

(iv) Rules applicable to fire insurance - London and Country Theatres, Music Halls and Cinemas.

(v) Rules applicable to fire insurance - Film Production Studios.

The tariff documents are basically similar and apart from defining the buildings covered by the tariff they lay down the normal rates to

be charged, expressed in pence per £100 of the insured value. Adjustments to the basic rate are detailed so that bad features are penalised and allowances are made for favourable features. The following would in all probability obtain a percentage reduction from the basic rate:-

(a) Fire resistant construction in accordance with Standards of Construction I to V of the Fire Offices' Rules[2.19] - Standards of Construction I and II can almost be ignored, because apart from bonded warehouses, it is unlikely that modern forms of construction will come up to these standards due to the required thickness of walls. Standards of Construction III and IV also require heavy forms of construction, which for multi-storey buildings can be achieved with little extra cost. The discount for Standard III construction is usually between 20%-25% and slightly lower for Standard IV. The discounts for Standards of Construction relating to the tariff for retail premises are dealt with in more detail in Chapter 8.

In September 1972, the FOC issued rules for the Construction of Buildings Classes I, II and III[2.20]. The FOC state that these have been drafted to incorporate new standards in line with modern construction methods. At the present time the rules only apply to manufacturing and warehouse buildings within the plastics tariff. The FOC have indicated, however, that eventually they will apply to other tariff and non-tariff risks.

(b) The provision of automatic fire extinguishing systems and automatic fire alarms - Discounts for automatic fire extinguishing systems are usually restricted in the tariffs to sprinkler installations. In order to obtain the sprinler discounts it is necessary to

provide manually operated appliances* as well. The allowance off the basic insurance rate for a sprinkler installation may vary from 60% down to 12½% according to the type of sprinkler, the nature of the water supply and whether the installation complies with the 29th edition of the Fire Offices' Committee Rules for Automatic Sprinkler Installation[2.21]. A further allowance of 5% may also be given where the installation is connected to an approved automatic alarm system which is linked to a manned fire brigade control panel. Allowance is also made for approved automatic detector systems varying from 7½% to 12½% according to the distance of the premises from the Fire Station. In a few tariffs, allowances for other methods more suited to the particular risk of the tariff will be permitted such as foam systems for petroleum risks and carbon dioxide in textile risks.

Additional rates are charged for those features which are considered to increase the hazard. The additional rate is generally between 2½p and 5p for every £100.00 insured but can be as high as 25p and occasionally higher[2.23]. The following are the more usual:-

(i) Where the building's standard of construction does not conform with the lowest standard of the Fire Offices' Committee - a very high proportion of modern industrial and commercial buildings do not comply with even the lowest standards of construction.

(ii) Buildings of more than a specified number of storeys.

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*Discounts off the basic insurance premium, up to a maxiumum of 12½%[2.22], are allowed for the provision of manually operated appliances in buildings where a system of automatic fire defence is not installed.

(iii) Buildings using particular forms of heating and lighting or where certain types of machinery is in use, or a particular process is being carried out.

(iv) Multiple tenancy of the premises or where the premises are being used for more purposes than are covered in the normal rates.

(v) Buildings where more than a specific number of workpeople are in employment.

The clothing tariff, for example, which is concerned with the rating of factories where the cutting out of clothes, mantles or waterproof garments is undertaken has a basic rate of 10p for every £100.00 insured, which is expressed as 0.10p%. There are, however, additional charges which are based upon the use of irons, the type of ceiling lining, type of material used and the number of employees. The increase of rate because of the number of employees is particularly large; as soon as more than 100 people are employed the minimum basic rate rises from 10p% to 25p%, to which must be added the extra costs of all other poor features. It is, however, the surcharges that have been applied to premiums since 1963 which have had the greatest impact. At the present time the clothing tariff has a standard adjustment of 300% and this percentage would be applied to the basic rate of a factory employing less than 100 people as well as to one employing a very much larger number. If, for example, two clothing factories were of similar standards of construction which neither incurred an increase nor obtained a percentage reduction and had no poor features, then the premium per £100.00 of building and contents insured would be:-

Factory with less than 100 employees - 10p% + 300% = 40p%

Factory with more than 100 employees - 25p% + 300% = £1%

By 1963, the Fire Offices' Committee was disturbed by the increasing

fire losses and although it had been their policy to review tariffs, it was now decided to look at the whole rating structure. A sub-committee was set up and subsequently reported that because of the continuing rise in the cost of claims it would be necessary to apply a surcharge with few exceptions, to all non-tariff and tariff risks. The surcharge was intended to be an interim measure pending a more detailed investigation and the exceptions included domestic property, churches, chapels, church halls and Sunday schools, sprinklered risks and consequential loss insurance. The recommendations were accepted and a surcharge of 15% was applied from the 1st December, 1963[2.24]. The purpose of the surcharge was two fold, firstly to cover the rising costs and secondly to encourage the use of sprinkler systems. The document published by the Fire Offices' Committee recommending the surcharge was accompanied by explanatory notes which included a passage stating that:-

> "sprinklered risks had been excluded because of the better claims experience; the increase in the difference between the premiums for sprinklered and non-sprinklered premiums should be seen as a further encouragement of fire protection".

In the following year the FOC considered a further report by the sub-committee which recommended that the 15% surcharge should be replaced by a more flexible system of percentage adjustments for different classes of risk, with reduced percentage adjustments for sprinklers and for buildings of a high standard of fire resistant construction. The report also recommended that the percentage adjustments should be calculated so as to give a greater return than the 15%, and in addition they should be selective in so far that they related to each particular class of risk. As a result of the report, the Committee issued a schedule of percentage adjustments in 1964 which applied to 350 classes of risk, both tariff and non-tariff. Generally, non-

sprinklered risks which did not conform to Standards of Construction I, II and III were increased from 15% to 200%[2.25], whereas non-sprinklered risks which did conform, generally remained the same. The basic rate for sprinklered risks, in cases where the installation was considered to be of a high standard, was generally reduced by 20%.

The schedule of percentage adjustments has been reviewed annually since 1967 and a very substantial number of adjustments have been made. By 1969 over half the original adjustments had been increased and in the majority of cases, the increases applied to non-sprinklered risks. In some classes of risk there had been very large increases and in four classes the percentage adjustment had reached 500%[2.26]. In 1971 there were further increases to a very large number of rates and the highest classes of risk were now carrying increases of 600% and 750% over the 1963 rate[2.26]. Since 1964, there have been comparatively few increases in sprinklered risks which has meant that the difference between a sprinklered and a non-sprinklered risk, which was in many instances substantial in 1964, has widened steadily; certainly in the higher risk categories.

"Under insurance" of property has also assumed a greater significance as a result of the rise in fire losses during the early sixties. In 1967, the FOC took the decision that with the exception of private dwellings, churches, halls and Sunday schools associated with churches; all fire insurance was to be made subject to "average". If a policy of fire insurance is subject to "average", then in cases where the building and contents are not insured for their full value, the insurer is only liable to pay that proportion of the amount of any loss or damage which the sum insured bears to the full value. If a building is valued at £100,000 but is insured for £75,000 because its value has increased in money terms due to inflation, and a fire occurs which destroys the

roof; then the insurance company would be liable for only 75% of the cost. For the purposes of "average", a building should generally be insured for its reinstatement cost less an allowance for depreciation if necessary. There are, however, exceptions where a building is of historic or architectural interest and may be worth more on the market than its notional value. In this case it is the market value that should be insured and not the cost of reinstatement[2.27].

During the past decade there has been a steady increase in many insurance premiums, which because of the continuing increase in fire losses may well continue. In 1962, the Director of the Fire Prevention Association[2.28] was predicting that the cost of fire was likely to rise rapidly because of the increase in volume and value of goods at risk, the increase in the use of fuels and the increased mechanisation of industry together with a more careless attitude on the part of many employees. Since 1962, fire losses have been increasing at about 10% per annum[2.29]. One anomaly that is seen from a study of rates is that sometimes they move downwards, possibly resulting from over compensation after very high losses for a particular class of risk, when the rate had been increased too sharply. This is illustrated by changes in the percentage adjustments which took place on the 1st January, 1973 to two classes of risk resulting in lower premiums. The metalwork tariff was reduced from 10p% + 75% to 10p% + 50% and in the boot and shoe tariff the 600% loading on factories was reduced to 400% whilst for boot and shoe warehouses, the 300% loading was reduced to 200%. To explain why it is possible for tariff figures to be reduced at a time when fire losses are increasing it is necessary to examine the methods used by the FOC when assessing tariff and non-tariff rates.

The pricing policy adopted by the FOC[2.30] reflects the increasing fire losses during the last decade and the reasons for the losses. In

the early sixties fire losses had been increasing at a faster rate than premium income. There had been a tendency for insurers to underestimate the effects of new industrial techniques and processes together with the use of new materials, the increase in arson and the construction of buildings with large undivided areas. These factors combined to make fire insurance unprofitable by 1963 and for a number of years this trend was to continue so that fire insurance, particularly relating to commercial and industrial property was to show either a loss or only a marginal profit - see fig. 3.

In 1964, following the inquiry by the sub-committee of the FOC a method was developed for adjusting premium rates[2.31]. The method required an estimate to be made of the expected total premium income for the following year, taking into account possible reductions due to improved methods of fire prevention, the increase in premium income because of the fall in the value of money and the expected increase from new business. On the other hand a forecast was made of likely claims for the coming year taking into account inflation, the likely increase in fire wastage and the possible reduction in claims due to an increased use of fire prevention techniques. When the forecast of the claims had been ascertained, the amount of required income was assessed by applying a selected target loss ratio to the forecast of claims. The target loss ratio is the desired ratio of claims to premium income expressed as a percentage. Initially the ratio was fixed at 55%[2.32] and this meant that 55% of all premium income was set aside to cover the anticipated losses and the remaining 45% was to cove profit and expenses. In 1968, the Fire Offices' Committee raised the ratio from 55% to 57½%[2.32] because of the continuing trend in losses and in 1970 a further investigation was undertaken by the Committee into its method of assessment. Up to 1970, the assessment had been based on a target loss ratio using premiums earned and claims

incurred and this method was now compared with a target loss ratio based on premiums written and claims paid. The method of calculation was investigated because when fire losses are increasing and are also subject to inflation, in any one period the claims incurred are going to be greater than the claims paid and in addition premiums earned are liable to be less than premiums written because claims are paid in arrears whereas premiums are paid in advance. The yearly difference for the eight years between 1963 - 1970 is shown below:-

COMPARISON OF TARGET LOSS RATIO FIGURES

Year	Earned/Incurred	Written/Paid
1963	77.5	66.2
1964	67.8	61.6
1965	63.6	55.3
1966	58.6	60.0
1967	55.4	52.7
1968	68.9	56.1
1969	63.2	51.2
1970	41.9	45.7

Fig. 4 Comparison of target loss ratio figures

Source - Fire Insurance[2.33]

The FOC in the past have based their statistics on premiums written and claims paid and for this added reason it was decided in 1971 to adopt this method and as a result the ratio was changed from 57½% to 50%[2.34]. Having arrived at an overall total of premium income to be retained for profit and expenses by applying the selected target loss ratio, it is then necessary to consider class by class the changes which will have to be made in premium rates in order to achieve the required total. Because of considerable irregularity of losses for

individual classes, the Committee has not attempted to use the method of forecasting losses and then applying a target loss ratio to adjust the rate of a particular class, but has had regard to earlier (pre 1963) statistics of loss ratios and has then adjusted the cost by applying a percentage adjustment to classes of risk which have shown high loss ratios. The FOC is not satisfied that the present method achieves a desired level of accuracy and at present they are trying to overcome the effect of large irregular losses by splitting losses into three different categories[2.35]:-

(i) small losses - forecast class by class,

(ii) medium losses - forecast by a major group of classes,

(iii) large losses - forecast by combining all classes.

It is hoped that this method which will also be based upon losses divided by sums insured, known as the "burning cost ratio"[2.36], will lead to greater accuracy.

Although it is the direct losses resulting from fire which receive most publicity, it is likely that the consequences of a fire will result in a firm suffering a loss which is very often greater than the direct loss. During the course of correspondence, it was pointed out by the British Insurance Association that accurate information on the cost of consequential loss was not available because up to the present the statistics have not been collated. A number of attempts had been made to produce an indication of the probable cost of consequential loss which has been used by various authorities and has varied from 100% to over 333% of the direct loss. Silcock[2.37] when investigating the background to the costs of protecting buildings against fire used a consequential loss figure which was 133% of the direct loss.

Losses resulting from the consequences of a fire can be insured

under a consequential loss policy. An insurance specialist in the employment of a national banking organisation was of the opinion that a well drawn up consequential loss policy should enable a firm to withstand the consequences of fire because it was possible to insure for payments to key staff, standing charges and loss of profits normally for between one and two years. The fact remains, however, that a high proportion of firms suffering a severe fire fail to survive the strain and go out of business, possibly due to under insurance or because of the time taken to recover from the fire which may be many years as illustrated below:-

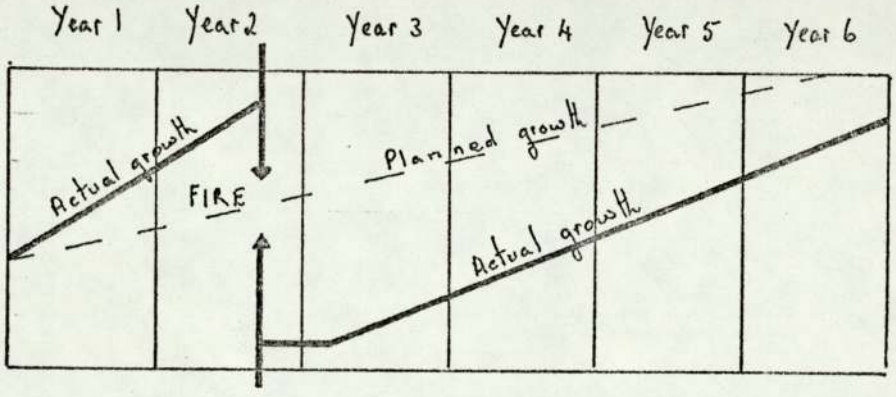

Fig. 5 Effect on company growth as a result of a fire.
Source - Fire Prevention Design Guide[2.38]

As industry becomes more highly mechanised not only do the cost of contents per square metre of floor area increase in value but also the consequences of fire can have a far greater effect. The loss of one production area can affect other production areas as illustrated in fig. 6.

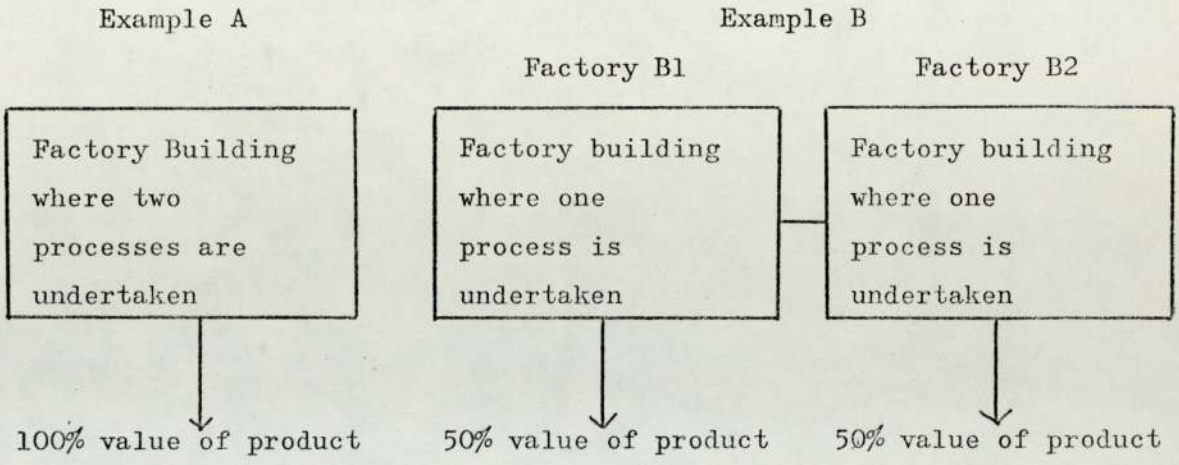

Fig. 6 Alternate production processes

A fire which completely destroys the factory building in Example A would, if covered for adequate consequential loss, ensure that the loss would be apparent and be borne by the insurance company. A fire in factory B1, where only one process is carried out, would effectively stop production at factory B2. Whether the consequential loss policy would be adequate is in doubt. It would certainly not cover the loss of production in factory B2 unless extended to do so. Many of the products of industry are dependant on components manufactured by different organisations and a fire in a factory producing a specialist component can have widespread reprocussions on the industry. Alternatively, a comparatively small fire in a highly mechanised plant can have consequences which are far greater than the direct loss because of the resulting loss in production. The business interruption risk is one which presents enormous difficulties for the insured and also one which is in need of constant revision, where it is necessary for the insurer to estimate the maximum probable loss as opposed to the maximum possible loss[2.39].

Consequential loss policies cover a stated period of indemnity which is usually 12 months but occasionally 18 or 24 months. The policy is based upon the gross profits of the company and there are

two methods of arriving at a figure[2.40]. Firstly based upon turnover, which may be sales less the net purchase price of goods sold or alternatively based upon the net profit plus all standing charges on the business such as rent, rates, taxes etc. Of the two methods, the first which is known as the difference basis is by far the more satisfactory as it automatically includes all charges, whereas under the second method it is up to the insured to include all the individual charges.

It is of the utmost importance that the indemnity is adequate as most consequential loss policies are subject to "average" and the insurance cover is based on the previous years profits. The problem which can arise is that if a firm increases its profits by 20% per annum and a fire occurs at the beginning of the year then the sum insured would be only 83% of the value. Should the fire occur at the end of the year then the losses would occur during the second year after the assessment of gross profit had been made and the insured sum would have reduced to 71% of the value. The effect of an increase in gross profit is illustrated below where it is assumed that the gross profit for 1971 amounted to £100,000.00.

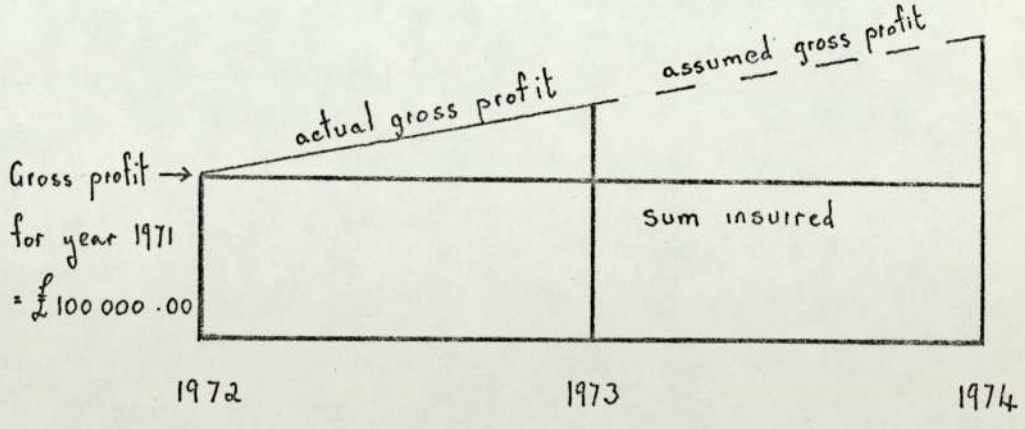

Fig. 7 Graphical extrapolation predicting profits prior to affecting insurance[2.41]

Source - Architects Journal Insurance Handbook Section 2 Property.

For gross profits to be fully covered by insurance, it must be assumed that fire occurs on the day before the policy is due for renewal and that the sum insured is the anticipated gross profit two years in advance of the date when the insurance was taken out. To ensure adequate cover, policies usually contain a declaration clause, so that at the end of each year of insurance an auditor's certificate showing the gross profit is submitted. The premium will be recalculated and if "over insurance" has occurred then a refund of up to 50% will be made.[2.41]

The installation of a system of automatic fire defence can reduce the premiums payable under a consequential loss policy by a considerable amount. This research will go on to show that in the four case studies in Appendix C, the reduction in consequential loss premium varied from 61.5% to 79%, compared with a reduction of between 67% and 89% in the direct fire loss premium, as a result of the installation of a sprinkler system.

Chapter 2

NOTES

2.1 British Insurance Association, Insurance Facts and Figures, 1971 (London : British Insurance Association) p. 5.

2.2 R. L. Carter, Economics and Insurance (Stockport : P. H. Press Ltd, 1972) p. 10.

2.3 Infra., p. 17

2.4 Great Britain, The Monopolies Commission, Fire Insurance - Report on the Supply of Fire Insurance (London : Her Majesty's Stationery Office, 1972) p. 3.

2.5 Ibid., p. 3.

2.6 Ibid., p. 5.

2.7 Ibid., p. 3.

2.8 Carter; op. cit; p. 134.

2.9 The Monopolies Commission, op. cit; p. 12.

2.10 J. A. S. Neave, "Reinsurance today; a general survey". Journal of the Chartered Insurance Institute, Vol 63 (1966) p. 48.

2.11 The Monopolies Commission, op. cit; p. 13, and Appendix 8.

2.12 Ibid., p. 13.

2.13 Ibid., Appendix 12.

2.14 Ibid., p. 17.

2.15 Ibid., p. 43.

NOTES

2.16 Ibid., p. 44.

2.17 Carter; op. cit; p. 11 - The FOC was formed to regulate premium rates at a time when price cutting was bringing about the failure of many Insurance Companies.

2.18 The Monopolies Commission, op. cit; p. 21-22 and Appendix 7.

2.19 Fire Offices' Committee, Standards of Construction I to V with amendments (London : Fire Offices' Committee, 1959)

2.20 Fire Offices' Committee, Rules for the Construction of Buildings Classes I, II and III (London, Fire Offices' Committee, September, 1972) pp. 1-11.

2.21 Fire Offices' Committee, Rules for Automatic Sprinkler Installations, 29th edition with amendments, (London : Fire Offices' Committee, 1968).

2.22 Fire Offices' Committee, Scale of Allowances for Ordinary Fire Extinguishing Appliances, (London : Fire Offices' Committee, 19th June 1970).

2.23 The Monopolies Commission; op. cit; p. 23.

2.24 A. R. Doublett, "Current Trends in the Fire Department", Journal of the Chartered Insurance Institute, Vol 64 (1967) p. 21.

2.25 Ibid., p. 22.

2.26 The Monopolies Commission; op. cit; p. 27.

NOTES

2.27 T. C. Howes, "Problems of Full Value in Relation to Average". Journal of the Chartered Insurance Institute, Vol 65 (1968) p. 47.

2.28 N. C. Strother Smith, "Preventing Fire in the Seventies", Journal of the Chartered Insurance Institute. Vol 69 (1972) p. 39.

2.29 Ibid., p. 40.

2.30 The Monoplies Commission; op. cit; pp. 46-48.

2.31 Ibid., p. 49.

2.32 Ibid., p. 28.

2.33 Ibid., p. 52.

2.34 Ibid., p. 51.

2.35 Ibid., p. 52.

2.36 Ibid., p. 60.

2.37 A. Silcock, "Protecting Buildings against Fire - Background to Costs", The Architects' Journal Information Library, (18th December, 1967) pp. 1515-1518.

2.38 Fire Prevention Association, Fire Prevention Design Guide - A handbook for architects, (London : Fire Protection Association, 1969) p. A. 21.

2.39 W. M. Hogg. "Investigating and reporting on the business-interruption risk in industry and commerce", Journal of the Chartered Insurance Institute, Vol 69 (1972) p. 131.

NOTES

2.40 "A. J. Insurance Handbook - Section 2 Property", The Architects' Journal Information Library, (22nd November, 1972). p. 1205.

2.41 Ibid., p. 1206.

Chapter 3

Automatic Fire Defence Systems

Detector Systems - False Alarms - Maintenance - Fixed Automatic Extinguishing Systems - Sprinkler Installations - Water Supplies - Maintenance.

Systems of fire defence capable of automatic operation in the event of fire include a wide range of fixed equipment which can, however, be grouped into two categories. Systems that automatically detect and send an alarm to the fire brigade and those that will detect and control or extinguish a fire. Frequently the Automatic Fire Defence of a building will include a combination of both systems. The area of automatic detection is one that has been growing rapidly as a result of technological developments that have occurred during the past twenty-five years and is the area where a very wide choice of equipment is available. Fixed automatic extinguishing systems have so far been dominated by sprinkler installations using water as the extinguishing agent and the National Fire Prevention Association[3.1](NFPA) regard automatic sprinklers as the most effective means of automatically controlling fires in buildings. The use of carbon dioxide, dry chemicals, high-expansion foam and halogenated agents such as bromochlorodifluoromethane (BCF) have been used to protect areas where water would not be suitable, such as computer and electrical installations and flammable liquid storage, but outside of these areas their application to date has been limited[3.2].

Leworthy[3.3] states that there are seven stages in the development of a fire during which automatic detection can occur. Many of the stages overlap and, although detectors are being manufactured or

research is being undertaken in all stages in the development of fire, it is usual to find companies marketing detectors in only Stage II and Stage VII of the areas shown below:-

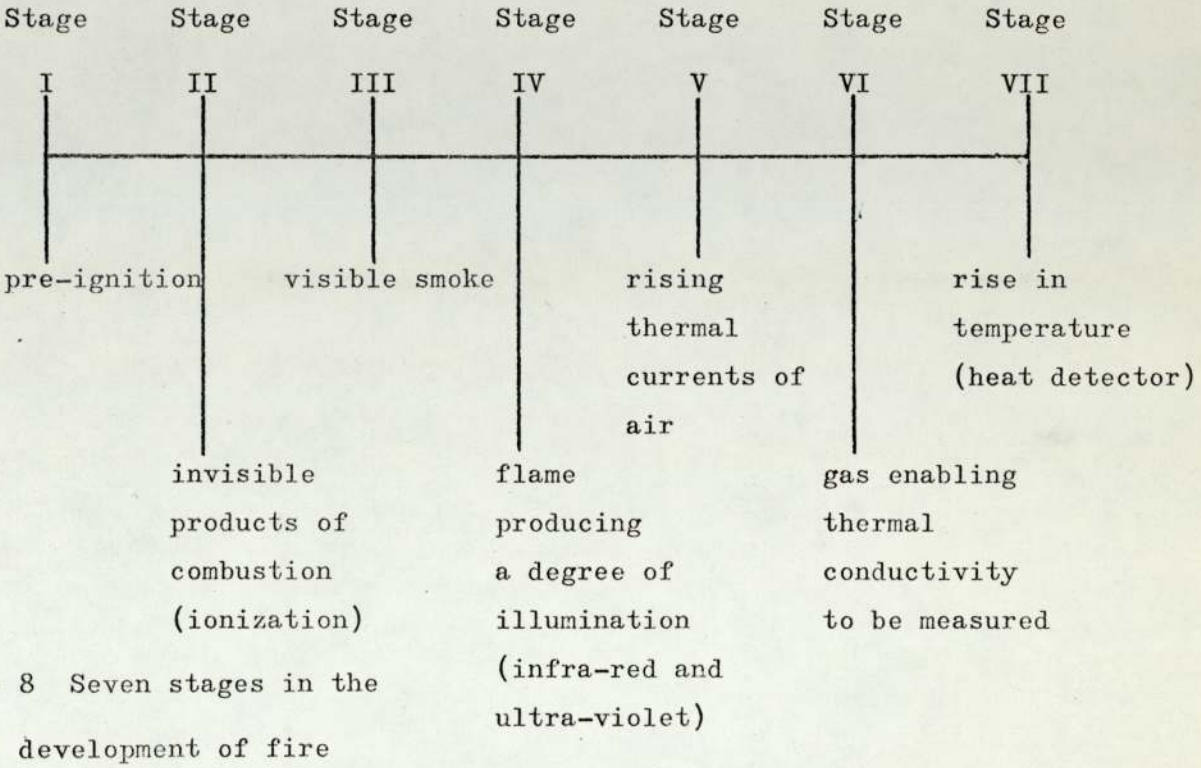

Fig. 8 Seven stages in the development of fire

For a company to obtain a reduction in its insurance premium from a tariff insurance company as a direct result from the installation of an automatic detector system, it is necessary for the installation to comply with the Rules of the Fire Offices' Committee for Automatic Fire Alarm Installations[3.4].

Not all detectors are approved by the FOC and care must be taken in selecting an FOC approved detector which is also suitable for the conditions under which it will operate. The majority of the FOC approved detectors are either ionization smoke detectors (Stage II) or heat detectors (Stage VII).

Although four manufacturers market ionization detector systems which are FOC approved [3.5], three of the systems use detector heads manufactured under licence from the Swiss patentee "Cerberus".

The FOC[3.5] has approved 27 systems of heat detection, not all of which are in current manufacture. The approved systems are installed by 13 companies and a large number are of similar design being manufactured under licence from the various patentees. The systems can be broken down into fixed temperature and rate of rise detectors and are considered in more detail later in this Chapter[3.6].

As can be seen below the FOC does not, at the present time, give approval to any detector systems in Groups I, III, IV, V or VI.

F.O.C. APPROVED DETECTOR INSTALLATIONS

Stage in the development of the fire	Type of detector	Number of manufacturers and/or installers marketing FOC approved systems
I	Pre-ignition	None
II	Invisible products of combustion-ionization	4
III	Visible smoke	None
IV	Flame detector - infra red	None
V	Rising thermal currents of air	None
VI	Gas enabling thermal conductivity to be measured	None
VII	Rise in temperature heat detectors	13

Fig. 9 F.O.C. approved detectors within the various stages in the development of fire.

The pre-ignition detectors give warning of a hazardous state before ignition occurs and are of particular use in connection with the overheating of plant, leakage of inflammable liquids and the detection of conditions where explosions could occur. Because of their specialist nature, they are unsuited for automatic detection covering a complete building but may be used in conjuction with automatic detectors.

Once ignition has occurred then detection should be as rapid as possible. The ionization smoke detector is the most widely used of the "fast acting detectors". It will detect smoke from polystyrene, polyurethane and cork[3.7] and will, in general, detect smouldering material before any flame or heat is generated. Because of their sensitivity, ionization detectors should not be used in areas where the products of combustion are to be expected, although they will not normally detect fumes from burning alcohol or from burning gas used for heating or cooking. Fresh tobacco smoke can actuate ionization detectors but under normal conditions tobacco smoke usually reaches ceiling level after it has coalesced to form large particles[3.8]. The detectors use a highly sensitive radio active element but the level of radioactivity, according to one manufacturer, is no more than that of a luminous wrist watch. The detectors are subject to statutory safety requirements during manufacture and transit to the site because of their radioactive content[3.9]. Once installed they are exempted from statutory control by the Radioactive Substances (Fire Detectors) Exemption Order, 1967*.

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*In the event of loss or damage to ionization detectors, either by accident or resulting from fire or a malicious act, the damage must be reported to the police and in addition in the case of a factory to the Factory Inspectorate and for other buildings, to the Department of the Environment.

Certain fires are preceded by the emission of dense vapours before there is any combustion. Where these conditions are likely to be met a visible smoke detector which works on the principle of light scattering or light obscuring has been found to operate as a "fast acting detector". Those manufactured on the light scattering principle make use of the "Tyndell Effect" and will detect the presence of vapour or of particles of any composition in its sampling chamber providing there are sufficient particles of suitable size. This type of detector is of particular use for the protection of electronic data processing equipment.

Flame detectors work on the principle that the radiant energy emitted by flames will actuate infra-red or ultra-violet detectors. Of the two, infra-red detectors have so far been by far the most successful and although ultra-violet detectors are marketed, they have not been particularly successful. One of the leading detector companies is of the opinion that ultra-violet detectors could not be recommended because the techniques were not considered to be adequately proven or sufficiently reliable. Infra-red detectors, although of comparatively recent development, are particularly useful for protecting risks where the roof of the building is a considerable distance from the ground as in high-bay warehousing or aircraft hangers. Care must be taken to prevent false alarms caused by other radiation sources such as the sun, tungston filament lamps or reflection off water but this can be overcome by designing the detector to respond only to the flicker frequency of radiation emitted by flames and careful siting. Tests conducted by the Fire Research Station on high piled storage[3.10], where both infra-red and ionization detectors were used in conjunction with a sprinkler installation, showed that the average time of detection by infra-red detectors in advance of the operation of the first sprinkler was almost five minutes. In three out of the four tests, the infra-red detector had a faster detection time than the

ionization detectors.

To-date, the FOC has not approved any detectors which operate as a result of rising thermal air currents or from the measurement of thermal conductivity; nor does it seem, at the present time, that measurement of thermal conductivity would have any advantages over other proved methods. Measurement of thermal air currents, however, includes two groups of detectors with a possible use in the future; one being the ultra-sonic detector and the other the laser beam detector. Ultra-sonic detectors work on the Doppler effect and have been used as burglar alarms and could also double as fire alarms[3.11]. To date, the limits within which it can be used as a fire alarm have not been determined and at present the principle is not considered to be adequately proved or sufficiently reliable. The detector works on the accoustic effects of fire and it is possible for causes unconnected with fire to simulate the effect which results in false alarms.

A great deal of research work has been undertaken in recent years by the Fire Research Station into the use of laser beams as a method of detection[3.12,3.13]. The laser is capable of detecting both temperature changes and smoke and works on the principle of projecting a narrow beam at ceiling height from a small helium/neon laser. Rising thermal currents, caused by a fire, change the refractive index of the atmosphere and oscillate the beam and set off an alarm in the photo-electric cell receiver. The cell receiver will allow slow oscillation of the beam to occur without actuating the alarm. Smoke and heat spreads out when it reaches a ceiling and it is claimed that one beam will cover a 6 metre wide band or a total area of up to 1100m^2 depending on the length of the beam. Correspondence with the company, that has taken up the system commercially, indicated that the cost would be much less than for normal point detectors but at the present they

were not able to give more accurate cost information as the system was still in the development stage. The cost per square metre of floor area protected is likely to increase as the size of rooms within a building is decreased because full use cannot be made of the width and length of the beam. However, Lawson has suggested[3.14] that where a building is sub-divided into a number of rooms, the laser beam could be arranged to traverse the building after holes had been drilled through the walls.

The last stage in the detection of fire results from the rise in temperature. Heat detection is the oldest and probably the most widely used method and the area containing the majority of the FOC approved detectors. Heat detectors are divided into two groups and are covered by BS 3116 : 1970[3.15]. Part I of the Standard covers point detectors which are by far the largest and most widely used group and work on one of the following principles:-

(a) expansion of metals (bimetallic) - this type of detector of which a large number are FOC approved makes use of the expansion of metals when heated, to make or break an electrical circuit.

(b) fusion of solids - a widely used and simple form of fixed temperature detector which uses a fusible metal alloy that will melt when a certain temperature is reached to form a contact which actuates the alarm. There are a number of FOC approved detectors of this type.

(c) changes in electrical characteristics - this type of point detector usually contains a semi-conducting material whose electrical resistance changes rapidly at the required operating temperature.

(d) thermoelectric - detectors in this group usually have two sets of thermocouples mounted in a single unit, one set being exposed to convection and radiation from the fire and the other set shielded. A voltage is produced when a temperature difference occurs between the two thermocouples.

Part 2 of B.S. 3116 : 1970[3.16] covers line detectors, which although a smaller group can be of particular use being both unobtrusive and resistant to vibrations. At the present time, none of the line detectors are FOC approved. Approval of one, based on the expansion of liquids, was withdrawn by the FOC in 1972 and its manufacture has now ceased but a number are still marketed which work on one of the following principles:-

(a) changes in electrical characteristics - in one type of detector a semi conducting material is used as a filler between two metal conductors, the resistance of the material changing rapidly at the desired operating temperature; in another type the outer tube and a central wire are the conductors with the semi conducting material between.

(b) expansion of liquids or gases - a tube containing a liquid or a gas which will expand on heating is so designed that it will displace a diaphragm which closes contacts to complete an electrical circuit.

(c) fusible solids - fixed temperature thermostatic cable 4.76mm in diameter consisting of two tensioned steel cables held apart by a heat sensitive covering has been widely used in the United States [3.17]. When the rated temperature is reached, the covering material melts allowing the two wires to come into contact with each other, actuating the alarm. The material is

available in a number of different temperature operating grades and is suitable for installations where higher than normal ambient temperatures are expected.

Heat detectors are designed to operate in one of two ways, either when a certain temperature is reached, known as "fixed temperature" detectors, or when the temperature increases at a rate greater than some predetermined value, known as "rate of rise" detectors. In the United States it is usual to find that heat detectors are of the fix temperature type[3.18]. In the United Kingdom a high proportion of the FOC approved heat detectors work on "the rate of rise" principle, but this type of detector must also operate at a predetermined temperature to obtain its approval and therefore combines both principles. Detectors working solely on the "rate of rise" principle are no longer approved by the FOC because although they will detect a fire which developes rapidly, there is a possibility that a slow growing fire will not be detected at an early enough stage. At the present time all the FOC approved heat detectors are point or spot detectors working on either the expansion of metals or the fusion of solids.

In spite of the very wide choice of detectors, the majority being installed at the present time are either ionization or heat detectors. Both types of detectors are frequently used together in protecting a building. In Case Study No. 3 - Appendix C[3.19], ionization detectors are installed throughout the general areas with heat detectors in the kitchen, boilerhouse, rest rooms and toilets where the products of combustion are liable to cause false alarms in ionization detectors. The use of visible smoke detectors is usually confined to areas where dense smoke is likely to occur as in computer installations, whereas infra-red detectors are used

in buildings where the floor to ceiling height is in excess of 10.7 metres.

The FOC rules for automatic fire alarm installations lay down the maximum floor area which one detector can cover and also the maximum height of the detector above the floor level. The rules also state the maximum distance between detectors both in corridors and general areas.

The installation cost of each ionization detector is between £50 - £80. This is considerably more than heat detectors, where the cost is between £20 - £25. However, with a maximum coverage of $92m^2$, ionization detectors will protect a very much larger area than "rate of rise" detectors or "fixed temperature detectors" where the maximum area protected is $50m^2$.

Many buildings are divided into a number of rooms, the majority of which are considerably smaller than the maximum permitted area covered by a detector. In Case Study No. 3 Appendix $C^{3.19}$, the floor area of $1594m^2$ is protected by 28 ionization and 7 heat detectors. The heat detectors are protecting an area of $109m^2$ so that the average area protected by each ionization detector is $53m^2$ compared with a maximum permitted coverage of $92m^2$. The cost of protecting large undivided areas is very much lower per square metre of floor area than where the space is divided into a number of small rooms. The cost of a detector system is also affected by the shape of the room and obstructions such as deep ceiling beams. This will mean that the maximum permitted coverage of a detector system can only be used in a minority of cases.

An essential feature of any automatic detection system is the immediate communication of an alarm to the fire brigade. Advantages,

disadvantages and costs of methods of communication, which apply equally to sprinkler installations, are considered in more detail in Chapter 4[3.20]. The discounts offered by the tariff insurance companies for the installation of FOC approved detectors vary according to the classification of the installation. Installations are classified A, B and C[3.21] depending upon the height of the ceiling or roof to be protected, the type of alarm and the probable time of the first attendance by a trained fire brigade as shown in Fig 10. The discounts vary from 7½% to 12½%. In addition to complying with the previously mentioned FOC requirements, it is also necessary to provide fire extinguishing appliances throughout the premises in accordance with items 3 to 6 of the FOC Scale of Allowances for Ordinary Fire Extinguishing Appliances[3.22]. Unless appliances are provided, the FOC will not allow any reduction of the insurance premium.

All automatic systems of detection are subject to false alarms and the proportion of false calls to fire calls is high. Fry and Eveleigh [3.23] in a study covering the 5441 false alarms which occurred in 1968 from detector systems to Public Fire Brigades, whether directly linked or not, found that the proportion of false calls to fire calls was 11 to 1. The reasons for the occurrance of false calls are numerous, but over 25% are attributed to ambient conditions, almost 50% to mechanical and electrical problems and approximately 17% from faults in the communication system. The very high proportion of false calls to fire calls throughout the country in one year is similar to the ratio of false calls to fire calls for one city brigade between 1960 and 1970.

CLASSIFICATION OF AUTOMATIC FIRE ALARM INSTALLATIONS

CLASS OF INSTALLATION	MAXIMUM HEIGHT OF CEILING OR ROOF OF ANY ROOM OR COMPARTMENT	METHOD OF COMMUNICATING ALARM	ATTENDANCE TIME BY FIRE BRIGADE	DISCOUNT BY TARIFF COMPANIES
A	9.0m for Grade 1 heat detectors 7.5m for Grade 2 heat detectors 6.0m for Grade 3 heat detectors or 10.5m for smoke detectors except that up to 10% of the total area of ceiling or roof may exceed the above limits - but not more than 10.5m for heat detectors.	(a) Local alarm bells - at least one weatherproof bell fitted on the outside wall of the premises. and (b) either (i) a direct connection to a manned Public Fire Station or through an FOC approved Central Fire Alarm Depot or a public Fire Brigade Control. or (ii) a direct connection with a permanently manned watchroom of a private Fire Brigade.	At least one pumping appliance within a maximum time limit of five minutes	12½%
B	all as Class A above. Installations with a Class A method of communicating the alarm may be increased as follows:- 13.5m for Grade 1 heat detectors 12.0m for Grade 2 heat detectors 10.5m for Grade 3 heat detectors and up to 10% as above but not more than 15.0m for heat detectors.	(a) Local alarm bells - as Class A and (b) a direct connection or through an approved FOC Central Fire Alarm Depot or through a Public Fire Brigade Control to a Public Fire Station manned by whole-time personnel or part-time retained personnel alerted by sirens and alarm bells.	At least one pumping appliance within a maximum time limit of ten minutes.	10%
C	all as Class A above.	(a) Local alarm bells - as Class A and (b) either (i) connection by means of automatic extension bell to two of the following - owner, manager, engineer, forman or employee living within 550m distance of the control unit at the premises equipped with an exchange telephone. (ii) one connection as above where there is a night watchman on the premises	At least one pumping appliance within a maximum of ten minutes after the call has been received	7½%

Fig 10 Classification of automatic fire alarm installations.

3.21

Source - Rules of the Fire Offices' Committee for Automatic Fire Alarm Installations

FIRE CALLS AND FALSE ALARMS - AUTOMATIC DETECTORS 1960 - 1970

Year end 31st March	Fires	False Alarms		Total	Ratio of ire calls to false alarms
		Good Intent	Malicious		
1960	3	25	-	28	1: 8
1961	3	32	-	35	1:11
1962	2	36	-	38	1:18
1963	6	50	-	56	1: 8
1964	4	49	-	53	1:12
1965	1	40	-	41	1:40
1966	8	52	2	62	1: 7
1967	7	87	-	94	1:12
1968	11	82	3	96	1: 8
1969	14	154	1	169	1:11
1970	20	150	3	173	1: 8

Fig. 11 Fire calls and false alarms, automatic detectors

Average ratio 1 : 9.7

During the eleven years from 1959, the number of detector systems had increased steadily until by 1970 there were 96 systems with direct links to the fire brigade. During the year ending 31st March, 1970 the 96 detectors gave 150 false calls and 20 fire calls, which is a high proportion of fire and false calls compared with the number of buildings where detectors have been installed. Any increase in the number of detector systems is almost certainly going to be accompanied by an increase in false calls. The possible increase in false alarms was not viewed with any concern by the Divisional Officer of a neighbouring City Brigade. He was of the opinion that false calls to buildings equipped with automatic detectors, provided that they were not occurring continuously, enabled his men to obtain worthwhile practice in familiarising themselves with buildings which were usually within the higher risk categories. The Divisional Officer, however, objected to false calls to domestic premises where they learnt little or nothing.

He also objected to false calls to premises fitted with detectors where electrical faults, which had not been rectified, were the cause of the alarm. The Fire Brigade will, in all probability, charge for false calls* in cases where the building owner was aware that the system was faulty and where nothing had been done to rectify the defect.

The high proportion of false calls is unlikely to be due to lack of servicing or maintenance because there is a requirement [3.24] that all FOC approved installations must be examined and tested by the Installing Engineers every three months. Servicing is usually by replacement of detectors every twelve months and service agreements are normally "open ended"; being renewable by either party every three months. The degree of exposure and the nature of the atmosphere within the building will affect the ultimate life of the system. With regular servicing, particularly by replacement of detectors, the life of the installation should be indefinite in warm dry atmospheres. In cases where detector systems are rented it is usual to find the cost being amortised over 14 years, but this is for accounting purposes and has nothing to do with the ultimate life of the system.

The premium discounts resulting from the installation of automatic detector systems were considered, by a number of the people interviewed in the course of this study, to be too low particularly when compared with the discounts for sprinkler installations. However,

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*Charges resulting from false alarms, where the equipment was known to be faulty and where no attempt had been made to rectify the detect, can be as high as £20.00 per visit.

although detectors have advantages in a number of buildings*; their main disadvantage is that the fire is not tacked in many instances, particularly in unoccupied buildings, until the fire brigade arrives. The Chief Fire Surveyor for one tariff company said that although detectors may give shorter warnings, by the time the brigade arrives it is very likely that the building will be full of smoke. Time can then be lost in locating the fire, particularly in a large building, even where the detector system is split into zones and a flashing neon light is fitted to the base of the detectors. If the detector system is also an extinguishing system, then the fire is frequently extinguished or held in check until the brigade arrives.

Fixed automatic extinguishing systems, as mentioned previously[3.26], have been dominated by sprinkler installations using water as the extinguishing agent. The FOC has been criticised[3.27,3.28] for failing to give allowances for installations other than sprinklers. This can lead to a situation where sprinklers are installed in order to obtain a premium discount, whereas specially designed and more suitable systems of fire control would not be considered because of the less favourable financial incentives. The use of carbon dioxide gives a small reduction in premium for the protection of particularly hazardous machinery under the Textile Tariff[3.29] and in the manufacture of paint a similar discount would be obtained for protecting varnish making equipment. However, these are isolated examples and a more general use of fixed

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*The Holroyd Report[3.25] recommended that serious consideration should be given to making automatic detectors linked to the fire brigade mandatary in premises such as hospitals, hotels, old peoples homes and residential schools where they would reduce the risk to life. Detectors also have a distinct advantage in museums, libraries and art galleries where water or chemicals could have a disastrous effect on the contents.

automatic extinguishing systems other than sprinklers will obtain little or no reduction in premium. During the course of their enquiry, the Monopolies Commission[3.30] obtained the opinions of a number of interested parties including the buyers of fire insurance individually, as well as through the Association of Insurance Managers in Industry and Commerce and in a few cases through trade associations representing particular trades or industries. They found a frequently quoted view was that the tariff rating structure did not give proper incentives for taking fire precautions and also:

> "that innovation was inhibited because the FOC was apparently unwilling to make any allowance in respect of new or alternative systems until they had been proved successful in practice, and that this was unlikely to happen because such systems would not be installed if they attracted no allowance[3.31]"

In additon the view was expressed that the FOC was cumbersome and slow in reaching decisions on matters of this kind.

The FOC in answering the criticism that undue emphasis was placed on sprinklers replied that:

> "a sprinkler system constitutes the most effective, most generally applicable and best proved fire prevention yet devised[3.32]"

According to the FOC, the number of occasions when a sprinkler installation was inappropriate or dangerous was negligible.

Fixed automatic extinguishing systems using carbon dioxide, dry chemicals, high expansion foam and BCF are all more expensive per square metre of floor area protected than sprinkler installations with good water supplies. It is therefore difficult to foresee any

change in the present situation where the installation of sprinkler systems is predominant, particularly if discounts for other systems remain so low.

The automatic sprinkler installation using water as the extinguising agent has remained unchanged in principle since the first crude commercial installation was developed in America* by Henry Parmelee in 1878[3.33] although there are earlier examples of attempts to develope an automatic system dating back as far as 1673[3.34]. The principle used in the Parmelee system and later developed by Grinnell in America during 1882 was to carry water to every part of the protected building in pipes suspended from the ceiling or roof. The water being held in the pipework by automatic valves spaced at regular intervals. When a fire occurred, the subsequent rise in temperature caused the strut holding the valve to collapse allowing water to discharge over the fire. Although there have been substantial developments in the automatic valves and control mechanism, the Grinnell System of 1882 is in principle the same as systems being installed today.

The water in the installation must never be allowed to freeze and for this reason three basic systems have been developed:-

i) a wet system where the pipework is filled with water at all times. This type of system is used in buildings which will be heated throughout the year or in buildings in areas where frost is unknown. The wet system is preferable to the other two because discharge of water occurs as soon as the sprinkler operates and the initial cost is slightly lower. According to the N.F.P.A.[3.35] 75% of all systems are of the wet type.

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*The first commercial installation in the United Kingdom was in a cotton mill at Bolton during 1882[3.34].

ii) a dry system which is used in buildings in Scandinavia and parts of Canada, North America and Russia where frost is likely during a large part of the year. To prevent the water from freezing it is held back to a heated location by an automatic valve and the air pressure in the pipework. When the sprinkler head operates, the discharge of air through the head operates the automatic valve and allows water to enter the system. Sprinkler heads on a dry system should be fitted in an upright position to prevent water being trapped in the system when it is drained down after operation.

The delay in the discharge of water from a dry system compared with a wet system means that on average 5 more sprinkler heads open on this type of system than on a wet system[3.36]. Baldwin and North[3.37] found that on average twice as many heads opened in a dry system as in a wet system. The dry system taking about half as long again to operate, compared to the wet system. They suggested that it might be more economical to install a wet system and prevent it from freezing or alternatively to use a dry system in conjunction with a detector system. This might be preferable to allowing the fire time to develope and then having to use a larger volume of water to control it, which could result in both greater fire damage and excessive water damage.

iii) an alternate wet and dry system is used in areas where freezing occurs for only part of the year. During the summer, the system is filled with water but in the autumn it is drained and the pipework filled with compressed air being refilled with water the following spring, after the possibility of frost has passed. This system is widely used in the United Kingdom for the protection of buildings which are unheated during the winter months.

Because of quicker action, a wet system is preferred to a dry system and in addition the initial costs are lower. The difference in cost between a wet system and an alternate wet and dry system was estimated by one manufacturer to be approximately £400.00 because of the necessity to provide additional control mechanism. The running costs of alternate systems are also higher than wet systems because of the labour involved in draining down and later refilling the system every winter.

All three types of installation may be fitted with either Quartzoid bulb or soldered sprinkler heads. The range of operating temperatures of soldered sprinklers is determined by the fusible solders available whereas there is no such limitation with the bulb types which are filled with liquids operating at various temperatures and colour coded as shown below:-

RATING OF SPRINKLER HEADS

Solder sprinkler heads		Glass bulb sprinkler heads		
Recommended rating of sprinkler head	Maximum Room Temperature	Recommended rating of sprinkler head	Maximum Room Temperature	Colour of bulb filling
72°c	38°c	57°c	38°c	Orange
93°c	60°c	68°c	49°c	Red
141°c	107°c	79°c	60°c	Yellow
182°c	149°c	93°c	74°c	Green
227°c	191°c	141°c	121°c	Blue
		182°c	160°c	Violet
		227°c	204°c	Black
		260°c	238°c	Black

Fig. 12 Recommended rating and maximum room temperatures of solder and glass bulb sprinkler heads[3.38,3.39].

Most sprinkler manufacturers market both the glass bulb and the solder-link type of sprinkler head. The solder type of sprinkler head is the older and is more widely used in the United States whereas in the United Kingdom the glass bulb type is generally preferred. The advantage of the glass bulb type, apart from the greater range of operating temperatures, is its freedom from the effects of corrosion. Current American sprinkler heads using solder-link or pellets are designed to reduce to a minimum the effects of corrosion resulting from atmospheric pollution. Solder sprinkler heads on occasion suffer from cold flow[3.40], which is a break down of the material initially caused by excessive temperature. The process once started may lead to failure of the link many years later as a result of the continued yield of the solder. Both solder and glass bulb sprinkler heads can be seriously affected as a result of being painted. Paint on a solder sprinkler head can result in the partial release of water. The release of water may be insufficient to fight the fire but allows the head to cool down and prevent the paint from burning and releasing the full flow of water. Despite the implied criticism of the solder type of sprinkler head it can be seen from the following list published by the NFPA[3.41] that heads which are well designed and maintained have in many instances a life in excess of 50 years.

SPRINKLERS OF EARLY MANUFACTURE

KEY = O : Obsolete; Q = Questionable; R = Considered Reliable

Associated B	1914	R	J. Kane 4	1902	Q
Cataract A	1906	O	J. Kane 4½	1902	Q
Cataract B	1907	Q	Lapham B	1911	Q
Clayton	1906	O	Manufacturers B	1903	Q
Esty 6	1903	Q	Manufacturers C	1907	Q
Evans B	1914	R	Nancy A	1922	R
Garrett	1906	Q	Neracher 5	1902	Q
Garth (Canadian)	1905	O	Neracher 6	1902	Q
Garth A	1914	O	New York	1911	O
Globe Garrett A	1911	Q	Niagara-Hibbard A	1902	Q
Globe B	1914	R	Niagara-Hibbard B	1904	Q
Grimes C	1925	R	Niagara B	1912	R
Grinnell A.B.C.D.	1882		Phoenix A	1905	O
(Metal Disc.)	1900	O	Reliable A	1921	R
Grinnell A	1903	R	Rockwood A	1906	O
(Glass Disc - improved)			Rockwood B	1906	R
Grinnell Silica Bulb	1923	R	Rockwood C	1910	R
Hibbard 4	1901	O	Rockwood E	1934	R
Hibbard H & 1	1911	R	Rindell Spence A	1913	O
Hodgman A	1920	R	Simplex	1902	O
Ideal A	1914	O			
Independent A	1916	R	Standard	1902	O
International 1	1900	O	Star A	1925	R
International B	1906	Q	USB	1923	R
International C	1927	R	Viking A	1921	R
J. Kane 3	1900	O	Viking B	1935	R
			Vogel	1904	Q
			Witter E	1906	Q

Fig. 13 Automatic Sprinklers of Early Manufacture

Source - Table 16 - 5B Fire Protection Handbook - NFPA[3.41]

The FOC issues a list of "Approved Sprinklers"[3.42] which is revised periodically; the one which came into use on the 1st March, 1973 includes the names of twenty manufacturers, all except one being either European or American*. A number of the United Kingdom manufacturers are also installers, whereas two of the companies together with the remaining European and American manufacturers either have one appointed installer or alternatively allow a number of firms to install their equipment. The Chief Sprinkler Surveyor of one tariff company was of the opinion that much tighter control was required by the FOC over firms undertaking sprinkler installation. He would like to see each manufacturer limited to a maximum of two installation companies. He pointed out that many of the designs submitted by installers were subject to modification before the tariff insurance company would give their approval. He was also of the opinion that on a number of occasions a tender which initially appeared to be the lowest was sometimes increased by a considerable amount as a result of amendments required by his department.

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*The manufacturers are from the following countries:-

America	- 8	
Italy	- 1	
Netherlands	- 1	(one additional Dutch company is also listed but this is a subsidiary of an American company and does not operate in the U.K.)
Germany	- 2	
United Kingdom	- 7	(including at least three companies which are members of the same group)
Australia	- 1	

The size and positioning of the sprinkler heads together with the size of pipework will depend upon the classification of the hazard which is determined by the occupancy. To obtain the insurance discount given by tariff companies as a result of the installation of a sprinkler system, not only must the materials used be FOC approved but in addition the installation must comply with the current edition* of the Rules for Automatic Sprinkler Installations[3.43] which groups building occupancy into hazard classification as shown in Fig. 14. In addition to classifying the various hazards, the Rules state the density of discharge of water, the spacing and location of sprinklers and the necessary components applying to each hazard classification.

A large section of the Rules are, however, concerned with water supplies. The water supply must not only be automatic and thoroughly reliable it should also be free from freezing or drought conditions that could seriously deplete the supply. The supply of water is grouped into three categories as shown in Fig 15 and the insurance discounts for sprinkler installations are subject to adjustment by the tariff companies depending upon the category of the water supply. In the Case Studies included in Appendix C it was possible, in each instance, to obtain a Grade III** supply from the town main. The cost of connection to the water main and the work outside the curtilage of the site varying from £120 to £450. A Grade III supply is satisfactory for all the occupancy risks detailed in the Case Studies.

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*The 29th Edition of the Rules for Automatic Sprinkler Installation's apply to all sprinkler installations on or after the 1st January, 1969.

**The discount for the provision of a superior water supply (Grade 1) in place of a Grade III supply amounts to between 15-17½%, this discount is in addition to the Grade III discount, which for the occupational risks relating to the Case Study buildings varies from 32½% to 40%.

CLASSIFICATION OF OCCUPANCIES

CLASSIFICATION	USE	EXAMPLES OF OCCUPANCY
EXTRA LIGHT HAZARD	non-industrial occupancies where the amount and combustibility of the contents is low	hospitals - hotels - libraries - museums - nursing homes office buildings - prisons - schools, colleges etc.
ORDINARY HAZARD Group 1 (Light ordinary hazard)	commercial and industrial occupancies involving the handling, processing and storage of mainly ordinary combustible materials unlikely to develope intensely burning fires in the initial stages.	abrasive wheel and powder manufacturers - butchers slaughter houses - cement works - creameries and wholesale dairies - jewellery factories - restaurants and cafes.
Group II (Medium ordinary hazard)		bakers and biscuit manufacturers - structural engineering work and light metal workers - confectionery manufacturers - laundries - motor garages - shops employing less than 50 persons.
Group III (High ordinary hazard)		aircraft factories - boot and shoe manufacturers - broadcasting studios - brush factories - carpet manufacturers - clothing factories - shops and departmental stores with more than 50 employees.
Group III Special		film and TV studios - flax, jute, hemp and cotten mills - distilleries.
EXTRA HIGH HAZARD Process risks	commerical and industrial occupancies having abnormal fire loads:- (a) where the materials handled or processed are mainly of an extra hazardous nature, likely to develope intensely burning fires. (b) involving high piling of good.	aircraft hangers - foam plastics and foam rubber manufacturers - tar distillers - wood wool manufacturers.
High piled storage risks		

Fig. 14 Hazard classification of sprinkler installations according to occupancy[3.44]

CLASSIFICATION OF WATER SUPPLIED

Category of Supply	Source of Supply	Basic Requirements	Paragraph of Rules applicable
Grade III	Town main	(a) must be capable of supplying minimum pressure at all times and preferably be fed from both ends. (b) only mains fed from both ends are acceptable for Ordinary Hazard Groups III & Group III special or extra high hazard.	2500-2516
	Automatic tank	must be adequately housed and protected against frost	2541-2549
Grade II	One superior * water supply	there is no limitation as to the number of sprinklers which can be supplied	2221-2224
Grade I	Duplicate water supplies	(a) a duplicate supply must be capable of providing the same pressure and rate of flow and have the same capacity as required for the primary supply. (b) a pressure tank is acceptable for extra light and ordinary hazard as one source.	2230
	One superior* water supply	the total number of sprinklers to be supplied is limited to 2000	2221-2224

Fig. 15 Water supply requirements in accordance with the 29th Edition of the Rules for Automatic Sprinkler Installations[3.45]

*A superior water supply be either:-

(a) a town main which is:-
- (i) fed from both ends by mains of required capacities.
- (ii) provided with duplicate connections.
- (iii) mains at each end referred to in (i) above must not be directly dependent on a common tank main.
- (iv) town main must be fed from more than one source.

(b) elevated private reservoir or gravity tank which:-
- (i) must be under sole control of owner of installation.
- (ii) must be of certain capacity.

(c) automatic pump supply

(d) pressure tank

A Grade III supply would not however be normally accepted for an "Extra High Hazard" risk.

The site storage of water and the provision of automatic pumps is the usual method of obtaining either a Grade 1 supply in cases where the town main is not considered to be a superior supply or a Grade III supply where the water pressures are inadequate. Figures obtained from one study, which is not included in the Case Studies in Appendix C, relate to a saw mill situated in an area where lack of pressure occurs during "peak hours". To overcome the loss of pressure it was necessary to provide a steel storage tank together with automatic pumps. The cost of the installation being as follows:-

Cost of sprinkler installation	£3,876.00
Provision of storage tank and pumps	£2,750.00

During the course of conversation with a sprinkler engineer a figure of between £2,000 and £5,000 was quoted as being the normally expected cost of storage of water and provision of pumps where a Grade III supply could not be obtained from the main. In addition to the extra capital cost, it is also necessary to provide space on the site for the tanks and a small structure to house the pumps.

The adequacy of the water supply is the one factor that has the greatest single effect on the initial cost of otherwise similar installations. At the present time the ability of a town main to provide a satisfactory supply is largely a question of the location of the building and the occupational hazard involved. The supply of water and the rules relating to its supply are far from uniform and because of the steady increase in demand by industrial and domestic users, there has been a tendency for main pressures to fall in recent years. In general, however, the towns main is reliable unless the building

site is higher than the general level of the town or a high rise building is involved, in these cases it may be difficult to obtain sufficient pressure and therefore necessary to install pumps. There are, however, areas in the country, particularly in the Midlands where the pressure in the town mains is low, in a large number of instances it is necessary to provide an alternative supply or resort to storage of water on site.

The Fire Services Act, 1947[3.46] states that it is the duty of the Fire Authority to provide water for firefighting but this does not extend to the provision of water for sprinkler installations. The supply of water for sprinkler installations is at present covered by Section 27 of the Water Act, 1945[3.47], which gives the water authority power to supply water if it is within their limits of supply. However, water authorities are not required to give a supply if their existing obligations to supply water for any purpose or their probable future requirements for domestic purposes are likely to be endangered, without having to construct new waterworks at an unreasonable expense. The existing water authorities of which there are a considerable number will be replaced in 1974 by Regional Water Authorities under the provisions of the 1973 Water Bill[3.48]. It is to be hoped that the Regional Water Authorities, of which there will be 9 covering the whole of England*, will be able to utilise the resources within their area to a greater extent which will lead to an increase in town mains

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*North West Water Authority, Northumbrian Water Authority, Yorkshire Water Authority, Anglian Water Authority, Thames Water Authority, Southern Water Authority, Wessex Water Authority, South West Water Authority and Severn - Trent Water Authority.

pressure and a more satisfactory supply in many areas of the country. The cost of maintaining the connection and pipework outside the curtilage of the site is the responsibility of the Water Authority. At present a number of the water authorities make a charge per annum for the connection to a sprinkler installation but this is dealt with in more detail in Chapter 4[3.49].

The cost of maintaining a sprinkler installation is comparatively low. Provided the system is well maintained, it should have a life in excess of twenty years and there are records of installations which have performed satisfactorily for 50 years and are still functioning satisfactorily. Fig. 1[3] shows that sprinkler heads which were designed in the 1920's and in some instances earlier are still considered to be reliable. In National Fire Code 13A[3.50] it is suggested that all sprinklers that have been in service for 50 years should be replaced without testing. In dry corrosive free atmospheres the pipework of a wet system will need little maintenance, apart from periodic painting. In an alternate wet and dry system it is possible for corrosion to occur inside the pipework. The most vulnerable part of a system being the screwed connections and although painting helps to cut cown corrosion, it is likely to occur, even where the Water Authority insists on the use of galvanised pipework. Corrosion occurs because the usual procedure is to put a screw thread on the pipe after it has been galvanised and rust occurs on the screw thread. Rusting joints can be avoided by the use of welded flange joints. The most important item of maintenance is keeping the sprinkler heads clean and free from corrosion and dust. As mentioned previously care must be taken to ensure that the sprinkler heads are not painted when redecoration is undertaken.

The American National Fire Code 13A[3.51] recommends that a sprinkler

system should be inspected at least four times a year, preferably at regular intervals. Leworthy[3.52] has suggested that all alarm and back pressure valves should be dismantled and thoroughly overhauled every three years. In addition the system should be cleaned out and sediment in the pipework removed every six years. The views expressed by both tariff insurance company sprinkler surveyors and the representatives of three sprinkler manufacturers was that four visits per annum was excessive and that in general visits rarely exceeded two each year and were often less. It is of course essential to visit a wet and dry installation at least twice a year when it is being filled and later drained off.

In the Case Studies in Appendix C it has been assumed that two visits a year would be necessary and that every five years a more extensive inspection together with draining off and flushing out sediment would be undertaken. The average cost of each inspection was estimated by one sprinkler manufacturer to be £25 and this figure has been used in the Case Studies. During the first year after installation, servicing and any maintenance is undertaken by the installing company and it is normal to find that there is no charge for any work which has to be undertaken during this time. Burtner[3.53] when examining the economics of a fire protection programme in the United States used a figure of 2% of the capital cost of the installation as being the annual cost of maintenance.

The percentage used by Burtner is slightly higher than the figure considered appropriate in the United Kingdom and used in this investigation.

NOTES

3.1 G. H. Tryon, ed; Fire Protection Handbook, 13th ed; 1969. (Boston : National Fire Protection Association) p. 16/2.

3.2 Infra; pp. 54-55

3.3 L. R. Leworthy,"Fire alarms communication and control", The Architects' Journal Information Library (22nd July 1970) p. 209.

3.4 Fire Offices' Committee, Rules for Automatic Fire Alarm Installation 11th edition with amendment 1. (London : Fire Offices' Committee, 5th July, 1973) pp. 1-12.

3.5 Fire Offices' Committee, List of Approved Automatic Fire Alarm Systems. (London : Fire Offices' Committee, 5th July, 1973) pp. 1-2.

3.6 Infra; pp. 46-48

3.7 E. F. O'Sullivan, B. K. Ghosh and R. L. Sumner, Experiments on smoke detection; part 3 : fires in expanded polystyrene, polyurethane and compressed cork. (Fire Research Station: Fire Research Note No 845, October 1970).

3.8 "Fire detector systems - the range of choice", Fire Prevention, No 91 (July, 1971) p. 20.

3.9 E. W. Marchant, ed; Fire and Buildings. (Lancaster : Medical and Technical Publishing Co. Ltd., 1972) p. 82.

3.10 R. A. Young, Fire tests with sprinklers on high piled stock. (Fire Research Station : Fire Research Note No 814) pp. 16-18.

3.11 E. W. Marchant, ed. op. cit., p. 84.

NOTES

3.12 E. F. O'Sullivan, B. K. Ghosh and J. Turner, Experiments on the use of a laser beam for fire detection, (Fire Research Station, Fire Research Note No 823, October, 1970) pp. 1-8.

3.13 D. I. Lawson, A laser beam fire detection system, (Fire Research Station, Fire Research Note No 824, April, 1970) pp. 1-14.

3.14 Ibid., p. 11.

3.15 British Standard 3116 : Part 1 : 1970, Automatic Fire Alarm Systems in Building; part 1 : Heat Sensitive (point) Detectors. (British Standards Institution).

3.16 British Standard 3116 : Part 2 : 1970, Automatic Fire Alarm Systems in Building; part 2 : Heat Sensitive (Line) Detectors. (British Standards Institution).

3.17 G. H. Tryon, ed., op. cit, p. 14/24.

3.18 G. H. Tryon, ed., op. cit, p. 14/23.

3.19 Infra; Chapter 8, p.169. - case study summary.

3.20 Infra; Chapter 4, pp. 75-81

3.21 Fire Offices' Committee, Rules for Automatic Fire Alarm Installations; op. cit., pp. 2-4.

3.22 Fire Offices' Committee, Scale of allowances for ordinary fire extinguishing appliances, (London : Fire Offices' Committee, June 1970).

Chapter 3

NOTES

3.23 J. F. Fry and Christine Eveleigh, The Behaviour of Automatic Fire Detection Systems (Fire Research Station : Fire Research Note No 810, March 1970) p. 6.

3.24 Fire Offices' Committee, Rules for Automatic Fire Alarm Installations; op. cit. p. 11.

3.25 Great Britain, Home Office and Scottish Home and Health Department; Report of the Departmental Committee on the Fire Service - Sir Ronald Holroyd, chairman (London : Her Majesty's Stationery Office, May 1970) p. 20, parag. 172.

3.26 Supra., p. 40.

3.27 K. J. Benn, "Sprinkler discounts : the hit or miss of fire protection," Policy Holder Insurance Journal, (24th December, 1971), pp. 2281-2282.

3.28 Great Britain, The Monopolies Commission, Fire Insurance - Report on the supply of Fire Insurance, (London : Her Majesty's Stationery Office, 1972) pp. 77-78.

3.29 Ibid., p. 24.

3.30 Ibid., p. 74.

3.31 Ibid., p. 78.

3.32 Ibid., p. 86.

3.33 G. H. Tryon, ed. op. cit. p. 16/2.

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NOTES

3.34 Fire Protection Handbook (Manchester : Mather and Platt. 1969) p. 4.

3.35 G. H. Tryon, ed. op. cit. p. 16/38.

3.36 Ibid., p. 16/13.

3.37 R. Baldwin and M. A. North, The Number of Sprinkler Heads Opening in Fires. (Fire Research Station : Fire Research Note No 886. August, 1971) pp. 7-10.

3.38 Fire Protection Handbook; op. cit., p. 7.

3.39 L. R. Leworthy, "Automatic sprinkler installations" The Architects' Journal Information Library. (3rd September, 1969) p. 587.

3.40 Fire Protection Handbook; op. cit. p. 7.

3.41 G. H. Tryon, ed. op. cit. p. 16/101.

3.42 Fire Offices' Committee, Automatic Sprinkler Installations - List of Approved Sprinklers. (London : Fire Offices' Committee, 1st March, 1973) pp. 1-4.

3.43 Fire Offices' Committee, Rules for Automatic Sprinkler Installations 29th edition with amendments 1-14. (London : Fire Offices' Committee, December, 1968) pp. 1-141.

3.44 Ibid., pp. 1-8 & Amendment - Classification of Occupancies.

3.45 Ibid., pp. 21-58.

3.46 Great Britain, Fire Services Act, 1947. 10 & 11 Geo. 6, ch41. pp. 12-13.

3.47 Great Britain, Water Act, 1945. 8 & 9 Geo. 6. ch42. pp. 29-30

NOTES

3.48 Great Britain, Water Bill (London : Her Majesty's Stationery Office - 8th May 1973) pp. 2-6.

3.49 Infra., pp. 84-86.

3.50 National Fire Protection Association, National Fire Code 13A - Care and Maintenance of Sprinkler Systems, 1972-73 (Boston : National Fire Protection Association) p. 13A-11.

3.51 Ibid., p. 13A-7.

3.52 L. R. Leworthy, "Automatic sprinkler installations". op. cit. p. 593.

3.53 Carrol E. Burtner, "The Economics of a Fire Protection Program". Fire Technology (February, 1966), p. 9.

Chapter 4

Costs related to the installation of automatic fire defence systems

Incidental Costs; Fees, Financing, Executives Time and Loss of Production - Systems of Direct Communication - Increase in Rateable Value - Water Rates and the Cost of Water - Damage from Water - Sprinkler Leakage Policies.

Before the economic viability of a system of automatic fire defence can be assessed, consideration must be given to the annual and other incidental costs that will be occasioned by its installation.

An automatic fire defence system will increase the cost of construction and because professional fees are based on the total cost of the building work, will lead to an increase in fees paid to architects, quantity surveyors and engineers or specialist consultants for new building work and alteration works to existing buildings. The capital cost of installation has been increased in the Case Studies in Appendix C by 10% to cover the cost to the client of professional services[4.1,4.2].

The installation must also be financed during the course of construction and if the work is carried out under the RIBA Standard Form of Building Contract, it is usual to find that the work is financed by a series of payments at monthly intervals. In the Case Studies it has been assumed that the loss of interest on money paid to the contractor before completion of the work will be at a rate of .833% per month, which is the equivalent of 10% per annum.

The decision whether a system of automatic fire defence should be installed or not will involve the company in the cost of their

executives time in arriving at the decision. No attempt has been made to put a value on the likely time involved because it will depend to a large extent on the executives attitudes to fire prevention and also the fire history of the company. One cost that could, however, be calculated is loss of production during the course of installation. This would only apply to an installation in an existing building and could be estimated by including the cost of additional payments to allow the work to be undertaken outside of normal working hours. No attempt has been made to assess the effect of loss of production in the Case Studies as three are concerned with new buildings and only Case Study No 2 is based on an existing building. In Case Study No 2 it would be possible to install an automatic fire defence system without any significant disruption to production.

All the foregoing costs will occur once only and can be regarded as part of the capital cost, whereas many of the other costs recur annually and consequently may have a far greater effect on economic viability.

Direct communication of the alarm to the fire brigade is an essential part of an automatic detector system if a discount is to be obtained. A direct link from an automatic sprinkler system to a manned fire station allows a further discount of 5% off the insurance premiums, this discount being in addition to the normal sprinkler installation discounts.

There are a number of ways in which the alarm can be communicated but at the present time all those which are approved by the Fire Offices' Committee make use of a G.P.O. telephone line. The least complicated system approved by the FOC is a direct line from the building to a fire brigade or private fire brigade. This system

is efficient but can be expensive if the building is any distance from the fire station, which must be manned at all times. An alternative that applies in certain densly populated areas is a direct line to a commercial central station (fire alarm depot).

The G.P.O. line rental can reduce the premium saving to a negligable figure if the building is very far from the manned fire station or commercial central station. The charges are annual and the cost is based upon the distance of the building from the station measured in a straight line as shown below:-

G.P.O. RENTAL CHARGES

Distance from building to manned fire station or commercial central station	GPO rental charge per annum	Distance from building to manned fire station or commercial central station	GPO rental charge per annum
within 1 furlong	£5	$1\frac{3}{4}$-2 miles	£ 48
1-2 furlongs	£10	2 -$2\frac{1}{2}$ miles	£ 54
2-3 furlongs	£15	$2\frac{1}{2}$-3 miles	£ 62
3-4 furlongs	£20	3 -4 miles	£ 74
4-6 furlongs	£27	4 -5 miles	£ 90
6 furlongs to 1 mile	£32	5 -6 miles	£106
1-$1\frac{1}{4}$ miles	£36	6 -8 miles	£130
$1\frac{1}{4}$-$1\frac{1}{2}$ miles	£40	8 -10 miles	£162
$1\frac{1}{2}$-$1\frac{3}{4}$ miles	£44	10-12 miles	£194

Fig. 16 G.P.O. rental charges per annum for direct line from building to fire station

Source: G.P.O.

In addition to the annual rental charge there is also an initial installation charge of £5 if the distance is less than half a mile and £15 for distances beyond half a mile.

At the present time there are eleven FOC[4.3] approved commercial

stations situated in the major cities* all of which are constantly manned. When an alarm signal is received the nearest fire brigade is alerted. Most of the stations receive direct lines from subscribers but one company uses a ring main through the G.P.O. lines which carry no other traffic and connect up to 10 subscribers on a ring. The signal from each subscriber has a different code and the circuit is tested every 4 hours. If a break or fault occurs signals are still transmitted from the central station down each side of the ring to the break. As Leworthy[4.4] points out only when the fault is on the subscriber's premises is there a risk that the building will be out of contact until the fault is rectified. Apart from ensuring a high continuity of service, the use of a ring main also reduces the rental cost by a substantial amount which enables long distances to be covered at an economical rate. Fig. 18 shows the fire detection area covered by the Liverpool and Manchester central stations which extends for a radius of approximately 30 miles. The network shown on the map extending from Cheshire to the West Riding of Yorkshire also includes intruder alarms where a greater distance can be covered.

The rental charge per annum will depend upon the distance of the building from the central depot and also on the number of subscribers on the ring main. Where there are 10 subscribers the charges would be as shown in Fig 17.

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*The FOC approved depots are situated in Birmingham(2), Dublin(1), Liverpool(1), London(3), Manchester(2), Newcastle(1) and Nottingham(1).

RENTAL CHARGE PER ANNUM FOR CONNECTION TO CENTRAL DEPOT

Distance from building to "Central Depot"	Rental charge per annum £
10-12 miles	35
17 miles	50
20 miles	60

Fig. 17 Rental charge per annum for ring main connection to Commercial central depot

Source: Commercial Company

The above rates are very much lower than the annual rental for a direct line via G.P.O. line where a distance of 10-12 miles would cost £194.00.

The company operating the ring main system has central stations in Birmingham, Nottingham and London as well as Liverpool and Manchester. In addition to the ring main method of communicating an alarm, the company also operates a water flow and valve supervision system. The system was developed in the United States[4.5] and in the event of movement of water caused by leakage or loss of water pressure, a trouble signal is transmitted to the central depot. Trouble signals are also transmitted if any of the control valves are accidentaly or maliciously closed thereby affecting the efficient operation of the system. A valve which is closed can remain undetected for a considerable length of time. Should a fire occur during this time, the system would fail to operate. Closed sprinkler control valves are the most frequent cause of the failure of sprinkler installations, being responsible for 36% of the unsatisfactory sprinkler performances reported in the United States between 1925 and 1964[4.6].

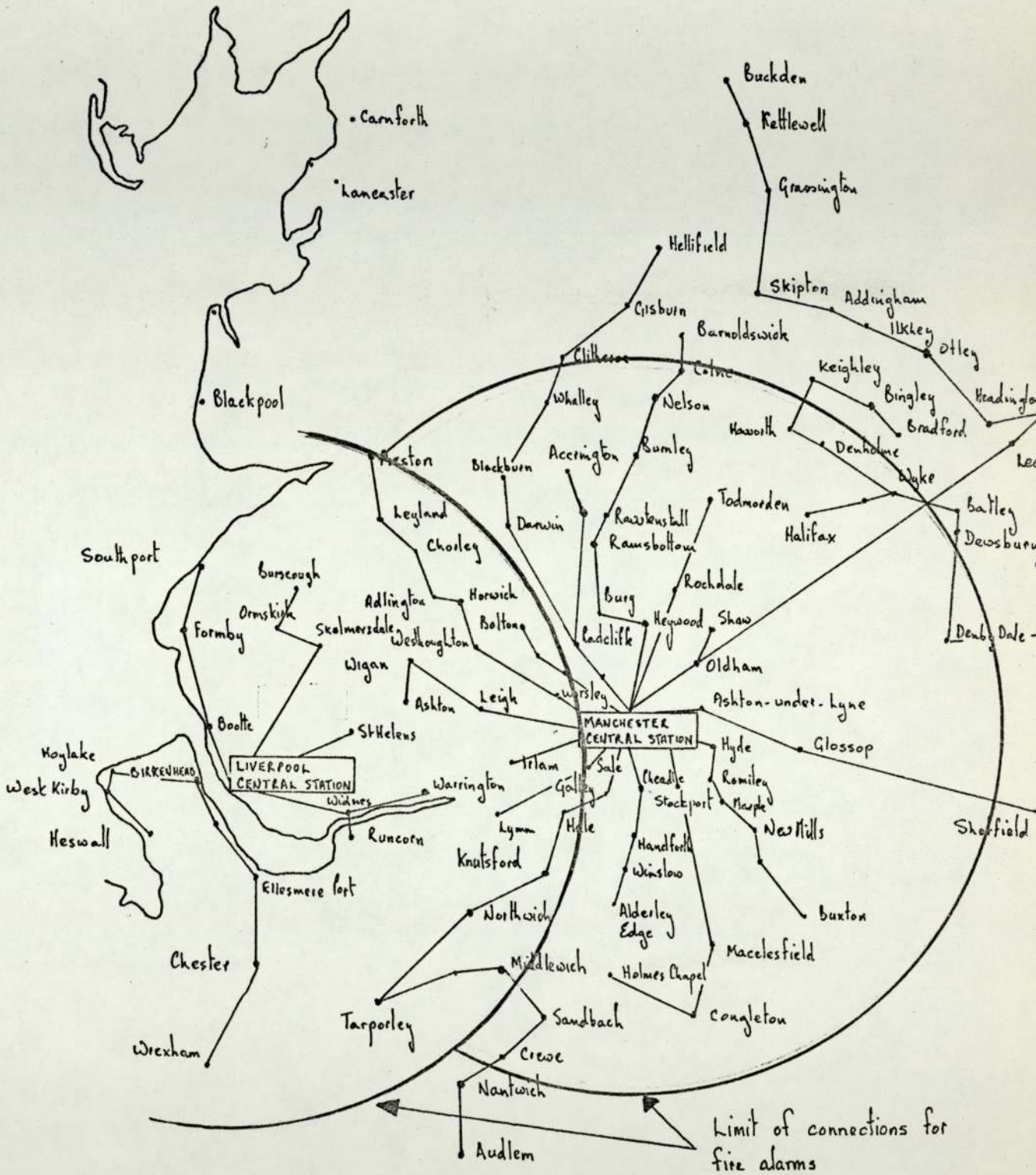

Fig: 18 Fire and Intruder Alarm connections to the Liverpool and Manchester Central Stations (Approved Central Fire Alarm Depots).

An alternative system also developed by a commercial company enables alarm signals to be routed from the building via a local unmanned fire station to a centrally manned control. The system has been developed primarily for use in county brigade areas where there are many fire stations which are not manned for 24 hours a day. Use is made of the Fire Brigade's private multiplex communication system for routing the signal from the unmanned station to the central control and the system is known as VFA (Voice Frequency Remote Control System 'A'). The main advantage of the use of VFA appears to lie with the fire authority who are able to reduce the number of fire station with control rooms which are manned for 24 hours a day. In Case Study No. 4, the fire station is less than one mile from the building. This station is, however, unmanned at night and the signal is routed to the county brigade headquarters which is 21 miles away. The cost per annum of the VFA system in Case Study No 4 amounts to £160.00. Of the two remaining systems, one known as the Auto Dialler has been widely used in the past and it has been estimated that some 1400 systems of automatic fire detection have their alarm signals transmitted by this method[4.7]. The Auto Dialler is not, however, recognised by the FOC because although the building is connected directly to the telephone exchange it is necessary for the operator to relay the alarm to the fire station. A 999 call made by an individual will be repeated until the exchange accepts the call. Where the call is made automatically many things can go wrong, from an engaged line to a misrouted call or other technical fault[4.8]. The other system is known as the ABC system (Alarms by Carrier) and has recently been undergoing tests in the Bradford area. The system, which accepts signals from automatic apparatus and transmits them to the fire brigade, is electronically tested every 3 seconds. The Fire Offices' Committee has agreed in principle that if this system is provided by the Post Office,

it may be used in conjunction with automatic fire alarm equipment[4.9]. During the course of conversation with a Post Office Official it was learnt that the Post Office hope to introduce the system in "certain conurbations" during 1975 and that they regard the system as a replacement of the Auto Dialler rather than as an alternative to the ring main system. The ABC system should enable an alarm from a building, situated outside an area served by a central depot, to be communicated to the fire brigade at an economical rental, even where distances of up to 20 miles are involved.

The installation of a system of automatic fire defence is considered to enhance the annual letting value of a building and is regarded by the Inland Revenue as rateable plant. The rateability of automatic fire defence systems was first codified by Section 24 of the Rating and Valuation Act, 1925 the provisions of which are now to be found in Sections 21 and 22 of the General Rate Act, 1967. Under Section 24, the Minister was given power to particularise by means of statutory order the specific items of plant which shall be rateable[4.10]. Two orders were subsequently issued, the latest of which is the Plant and Machinery (Rating) Order 1960[4.11]. This order under Table 1B section (H) includes "Protection from fire" and lists the following:-

Tanks; pumps; hyrants; sprinkler systems; fire alarm systems; lighting conductors.

Valuation of plant, which is rateable under Section 21 of the General Rate Act 1967, involves an estimate of the amount by which the value of the hereditament as a whole has increased due to the presence of the item of plant. Gibson and Jackson[4.12] point out that plant should never be valued in isolation and that it only has a value

to the extent that it may reasonably be expected to contribute to the value of the whole. In addition, the value of the hereditament as a whole is its value in its existing physical state and for the purpose for which it is used. It relates to the annual rent at which the hereditament might be expected to be let at the present time and immediate future, rather than the long-term future. Finally it should be noted that with industrial hereditaments, assessment is made of net annual value and the tenant is assumed to bear the cost of all repairs and maintenance[4.13].

The most commonly used method of assessing the increase in rateable value as a result of the installation of a system of automatic fire defence is the "contractor's basis of valuation". Mark Wilks[4.14] has stated that in 99 cases out of 100, plant and machinery is valued on the contractor's basis and this view was also held by three Valuation Officers each of whom was concerned with a district where one of the Case Study buildings in Appendix C was situated. The contractor's basis of valuation is applied where there is no rent or rental evidence. It is based on the assumption that if there had been a rent, it would have been arrived at by taking an acceptable rate of interest on the cost of the automatic fire defence system as representing the annual value. In Case Study No. 1, the cost of the sprinkler installation amounted to £6,150.00 and an acceptable rate of interest was 5%[‡]. The increase in the net annual value amounted

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[‡]So far as commercial properties are concerned the established rule for many years has been to use 4% on the value of land, 5% in the case of buildings and rateable plant and machinery to calculate net annual value. Occasionally 6% has been used for plant items having a short economic life[4.15]. The rate of 5% for rateable plant and machinery was upheld in the case of Birchenwood Gas & Coke Co Ltd V Hamphire (1959) 152 RIT 226.

therefore to £307.50.

Section 20 of the General Rate Act. 1967 requires rating valuations to be made on the basis of "tone of the list". The current list came into force on the 1st April, 1973 and replaced the list dating from the 1st April, 1963. Prior to the 1973 list comming into force, all plant and machinery was valued at price levels current in 1962*. From the 1st April, 1973 until a new list is introduced, all cost of automatic fire defence will be valued at price levels ruling in 1972.

The Central Fire Liaison Panel has for sometime been concerned that systems of automatic fire defence should be regarded as rateable plant, particularly in the light of increased material fire damage and government and insurance incentives for industry to install fire defence. In October, 1972 the Panel made the following submission to the Secretary of State for the Environment:-

> "The Panel believes that the increases in rateable valuations which follow the installation of fire protection systems represent a factor which tends to frustrate the efforts being made to persuade management of the good financial sense of protecting their premises against fire. The Panel would, therefore, like to submit that there is a strong case for exempting from the normal rating regulations, equipment installed to protect property against fire[4.16]."

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*The price levels to be adopted are those that reflect the ruling prices during the year before the lists come into force.

The removal of automatic fire defence equipment from the rating regulations could be achieved, if the Minister thought fit, merely by issuing a revised Plant and Machinery (Rating) Order which omitted section (H) from Table 1B.

The increase in the net annual value of a building following the installation of a system of automatic fire defence, may also lead to an increase in the water rates. The cost of supplying water to a building, where a sprinkler installation has been installed, varies considerably between the different water authorities. In some areas there may not be an additional charge, whereas in other water board areas there will be an increase in the water rates as well as a charge per annum for each water main connection to a sprinkler installation, together with a charge for every 100 sprinkler heads or part of 100. The wide variation in charges made by six Water Boards in the North West for the supply of water is shown in Fig. 20. The different charges when applied to a hypothetical sprinkler installation costing £8,000.00*, increase the annual cost of water from between £4.00 and £24.87 as shown in Fig. 19.

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*The hypothetical installation is assumed to have 400 sprinkler heads and one 150mm connection to the water supply. The increase in net annual value being £400.00.

VARIATION IN COST OF WATER

Water Board Area	Annual cost due to increased water rates and charges for water
A	£ 9.00
B	£14.00
C	£ 4.00
D	£ 7.80
E	£15.15
F	£24.87

Fig. 19 Estimation of annual cost of water supply for different Water Boards

It is to be hoped that when the Water Bill comes[4.17] into force there will be a degree of standardisation in charges as all the Water Boards, whose charges are shown in Fig. 20, are within the same regional area.

Considerable damage can result from the accidental leakage of water due to a fractured sprinkler pipe or sprinkler head. In addition, damage caused by water after a fire has been extinguished may result in considerable loss unless the water is turned off immediately. Where the system is directly linked to the fire authority, any movement of water resulting from the activation of a sprinkler head or the fracturing of a pipe will alert the authority and result in prompt attention to the water supply. Where the system is not directly linked then it is possible for considerable water damage to occur, particularly in unoccupied and isolated buildings where the alarm bell may be

COST OF SUPPLYING WATER TO SPRINKLER INSTALLATIONS IN BUSINESS, TRADE OR MANUFACTURING PREMISES

Water Board	Water Rates	Rate in the £1 for 1973	Charge for water main connection	Charge for sprinkler heads	Comment
Water Board Area A	Based on 50% of the Net Annual Value Provided that, in respect of any hereditament, the Net Annual Value of which exceeds £3,000, the Water Rate shall be limited to a charge calculated on a Net Annual Value of £3,000.	6.25p	£5.00 per annum	£1.00 per annum for each 100 (or part 100) sprinkler heads.	Level of NAV will generally exclude industrial premises from an increase in water rate. Case Study No. 3 in Area A.
Water Board Area B	No Charge	-	£2.00 per inch diameter of each connection - per annum	50p per annum per 100 or part 100 sprinkler heads or drenchers	Cost of connection Reduced to £1.50 per inch diameter where head in mains is inadequate.
Water Board Area C	No Charge	-	No Charge	£1.00 per annum per 100 or part 100 sprinkler heads	
Water Board Area D	Based on 30% of the Net Annual Value	6.5p	No Charge	No Charge	Case Study No 2 in Area C
Water Board Area E	Based on 100% of the Net Annual Value	2.5p	£3.47 per annum	87p per annum per 100 or part 100 sprinkler heads	Case Study No 1 in Area E
Water Board Area F	Based on 100% of the Net Annual Value	4.48p	£3.47 per annum	87p per annum per 100 or part 100 sprinkler heads	Case Study No 4 in Area F

Fig. 20 Cost of water supply - Six Water Boards in the North West Source - Case Studies

unheard for a considerable length of time.

One method of preventing excessive water damage is by the use of a pre-action system. Pre-action systems[4.18] incorporate a method of automatic detection and operate by the action of a heat or smoke detector which opens the valve and allows water to enter the system. A pre-action system is not initially dependant on the fusing of a sprinkler head and can be used in areas where freezing conditions might be expected. The pipework is normally dry but the system has an advantage over a normal dry installation in that the water valve is opened in a shorter time when operated by the more sensitive detectors than by a sprinkler head.

One system developed in the United States contains a refinement of the pre-action principle and enables the water to be shut off after the fire has been extinguished[4.19]. Should the fire rekindle then the system is reactivated and will continue re-cycling as long as the fire persists. The system is marketed under licence by one company in the United Kingdom and has been approved by the FOC. Conventional automatic detectors are used to control solenoid valves which in turn control the supply of water. When the fire temperature falls, the detector circuit closes the solenoid valves which in turn shuts off the water supply. If the fire temperature subsequently rises then water is allowed to flow into the system again. The difference in operating temperatures between the detectors and the sprinkler heads allows sufficient time for the pipework to be charged with water before the sprinkler heads operate.

Damage by water which results from extinguishing a fire is covered by the fire insurance policy. However, accidental damage to the installation which results in a pipe or sprinkler head being fractured is not covered by the fire policy and it is therefore advisable to have

separate insurance cover for water damage resulting from such accidents.

The only form of cover for accidental water damage is under a sprinkler leakage policy. Sprinkler leakage insurance provides cover against damage by water, leaking or accidentally discharged from the automatic sprinkler installation[4.20]. The annual cost of the policy depends upon the value of the building and contents at risk and also whether the building is of single storey or multi-storey construction. The insurance of sprinkler leakage is covered by a tariff which lays down rates for commercial and industrial building as shown below:

SPRINKLER LEAKAGE COVER

Risk	Rate per cent	Annual cost per £100,000 of value insured
Building - single storey construction	1d%*+150%	£ 10.42
Contents - within a single storey building	2½p%+150%	£ 62.50
Building - multi-storey construction	1d%*+150%+100%	£ 20.83
Contents - within a multi-storey building	2½p%+150%+100%	£125.00

Fig. 21 The cost of sprinkler leakage cover.

Source. Case Studies

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*The tariff expresses the rate of building cover in "old currency"

The rates in Fig. 21 apply where the full value of the building and contents are insured on a replacement basis. The insured value will normally be the same as for the fire insurance policy and is subject to "average". An alternate method of assessing the insured value is upon a first loss basis. The sum insured being assessed as the maximum amount of damage which is likely to occur as a result of one claim under the policy. The sum is not subject to "average" and will probably be calculated at a rate per cent higher than that used for the calculation of a sprinkler leakage policy based on full value. It may also be calculated on the number of sprinkler heads within the building[4.21].

The standard sprinkler leakage policy contains a number of exclusions, which will apply unless special arrangements are made to extend the policy. The most important are as follows:-

(a) The policy does not cover damage resulting from repairs or alterations to a building or as a result of the sprinkler installation being repaired, removed or extended. Both these exclusions can be waived on the payment of an additional premium[4.22].

(b) Freezing as a result of premises being vacant or unoccupied, or freezing while the premises are in the insured's ownership. Under Condition 4 of the standard sprinkler leakage policy, there is a requirement that the insured takes all reasonable steps to prevent frost or other damage to the intallation. A duty is therefore placed on the insured to prevent frost damage and whether he has taken all reasonable steps may well depend on the precautions that have been taken. Yarnwood illustrates[4.23] the way in which routine maintenance of boilers undertaken during theChristmas holidays, particularly if this coincides with severe weather, can cause problems for the insured. As Yarnwood

points out

> "the onus resting on the insured goes beyond taking steps to prevent freezing; he must also keep the installation, including the automatic external alarm system, in efficient condition". [4.24]

The other exclusions contained in the standard policy relate to heat caused by fire, explosion, the blowing-up of buildings or blasting, earthquake, subterranean fire, riot, civil commotion, war, invasion, act of foreign enemy, hostilities, civil war, rebellion, revolution, insurrection or military or usurped power. These exclusions are either covered by the fire policy, or by its normal extensions,or relate to the usual war risks exclusion clause. One other exclusion refers to any event through the order of the government or of any municipal, local or other competent authority. Yamwood[4.25] questions what liability insurers expect to avoid by this exclusion and suggests that the wording has probably come from other policies and has been needlessly retained.

Of the Conditions in the policy, the most important is Condition No. 4 relating to the prevention of frost damage which has already been discussed. The other Conditions include the giving of notice to the insured of the intention to carry out alterations, the right by the insured to inspect the premises and the need to specifically mention cover for money, securities or documents. All these conditions are similar to those contained in a standard fire policy.

Damage resulting from sprinkler leakage is generally small and is reflected in the comparatively low premium rates illustrated in Fig. 21. However, the annual cost of the policy together with the

increases in rateable value, water rates and charges for water must all be taken into account before the true cost of an installation of automatic fire defence can be assessed.

Chapter 4

NOTES

4.1 Davies, Bellfield and Everest, ed. Spon's Architects' and Builders' Price Book, 1973 (London : EF&N Spon Ltd) p. 63,71,75.

4.2 Davies, Bellfield and Everest, ed. Spon's Mechanical and Electrical Services Price Book, 1973 (London : EF&N Spon Ltd) p. 221.

4.3 Fire Offices' Committee, Rules for Automatic Fire Alarm Installations - List of Approved Automatic Fire Alarm Systems and Approved Central Fire Alarm Depots (London : Fire Offices' Committee, 5th July, 1973) p. 3.

4.4 E. W. Marchant ed., Fire and Buildings (Lancaster : Medical and Technical Publishing Co. Ltd., 1972) p. 90.

4.5 G. H. Tryon, ed., Fire Protection Handbook, 13th ed. 1969. (Boston : National Fire Protection Association) p.p. 16/102 to 117.

4.6 Ibid., p. 16/33.
The NFPA records of 75290 fires between 1925 and 1964 shows that sprinklers were successful in 96.2% of the fires and were only unsuccessful in 2871 or 3.8%. It is of the 2871 fires where 36% failed to be controlled due to closed valves.

4.7 C.M. Jessop and E. D. Chambers, Auto Diallers in the United Kingdom (Fire Research Station : Fire Research Note No. 888, September, 1971) p. 4.

4.8 E. W. Marchant, ed., op. cit., p. 89.

Chapter 4

NOTES

4.9 Great Britain, Home Office, Scottish Home and Health Department, Fire Prevention Guide 1, Fire precautions in town centre redevelopment (London : Her Majesty's Stationery Office 1972) pp. 24-25.

4.10 J. C. Bassett and Clement Wheeler, Bean & Lockwood's Rating Valuation Practice, 6th ed (London : Stevens & Sons Ltd. 1969) p. 211.

4.11 Great Britain, Plant and Machinery (Rating) Order 1960, SI. 1960, No. 122.

4.12 H. Gibson and E. Jackson, The Valuation of Plant and Machinery for Rating (London : The Estates Gazette Limited, 1972) p. 98.

4.13 J. C. Bassett and Clement Wheeler, op. cit., p. 232.

4.14 Liverpool Polytechnic, Valuation for Rating. (June, 1972) Conference Papers. p. 21.

4.15 J. C. Bassett and Clement Wheeler, op. cit., p. 105.

4.16 Letter, Central Fire Liaison Panel to the Secretary of State for the Environment, October 1972 - Fire Liaison Panel Records.

4.17 Great Britain, Water Bill (London : Her Majesty's Stationery Office, 8th May, 1973).

4.18 G. H. Tryon. ed., op. cit., p. 16/52.

4.19 Ibid., p. 16/54.

NOTES

4.20 "Sprinkler Leakage Insurance", The Estates Gazette, Vol. 191, (8th August, 1964) p. 473.

4.21 Ibid., p. 473.

4.22 A. J. Yarnwood "Claims under sprinkler leakage policies", Journal of the Chartered Insurance Institute, Vol. 62 (1965) p. 33.

4.23 Ibid., pp. 35-36.

4.24 Ibid., p. 36.

4.25 Ibid., p. 34.

Chapter 5

Methods of evaluating the economic viability of automatic fire defence systems

The Pay-Back Method - Discounted Cash Flow and its Application - Comparison between Discounted Cash Flow and the Pay-Back Method.

The installation of an automatic fire defence system will, as shown in Chapters 3 and 4, give rise to an initial cost which is greater than the prime cost of the installation. In addition to the increased initial cost, the installation will also result in costs which occur annually. The total of the initial and running costs can reduce the saving in premium resulting from the installation of a sprinkler system or automatic detector system by a considerable amount. Apart from the initial and running costs, any economic appraisal must take into account tax concessions[5.1] and where applicable government grants in assisted areas[5.2].

Savings in premium, which result from the installation of an automatic fire defence system, must have a sum deducted which is equivalent to the current tax level because insurance premiums can be offset against business profits and thereby reduce the company's tax liability.

The most widely used method of financial appraisal has been the payback method. In this method the net capital cost is calculated and net annual savings are accumulated until the accumulated saving exceeds the capital sum. An unpublished survey of 50 companies who had installed sprinkler installations in 1970 was undertaken by Research Services Limited[5.3]. The survey disclosed that 29 of the

firms had made a calculation of the pay-back period whereas 18 firms had not made a calculation and 3 firms were unable to say whether a calculation had been made or not. The report also stated:

> "there are no standard accounting procedures and hence the decisions taken by companies are more likely to be expressions of attitude rather than calculation".[5.4]

Only a minority of the firms questioned took any account of the running costs or effect of taxation, and although 6 companies claimed to have adopted a discounted cash flow technique when calculating the pay-back period, the other 44 appear to have adopted a much less stringent rate of return technique. In fact none of the companies appeared to have considered premium savings net of tax. All companies considered the more favourable gross saving.

A simplified form of pay-back method is used by the Central Fire Liaison Panel[5.5]. Although it serves its purpose admirably because it is simple, its very simplicity is also its weakness. The method does not take account of running costs nor does it make any allowance for loss of interest on capital or deferred payments. The method can, therefore, be criticised for over simplification.

The method of evaluation used by Research Services Ltd.[5.6] was also of the pay-back type. However, in the calculation of the net annual saving, no allowance was made for the opportunity cost of the investment nor for deferred tax or deferred investment incentive payments. A pay-back method which allows for the opportunity cost of the investment and is used to estimate the profit earned in 20 years following the installation of a sprinkler system, has been developed by Clyde M. Wood[5.7] for the "Automatic" Sprinkler Corporation of America. The method does not, however, take account of the deferred

payment of taxation.

The collection of Corporation Tax in the United Kingdom and the payment of regional grants in assisted areas is subject to a considerable time lapse. The deferred time for the payment of tax will depend upon the timing of a company's financial year end and may vary from eighteen months to two years. As a result of changes in the structure of Corporation Tax outlined in Chapter 6[5.8], the Inland Revenue anticipate that they will be able to cut the deferred time to twelve months. Twelve months has also been used as the lapse in time between completion of the installation of a system of automatic fire defence and the payment, where appropriate, of a regional grant.

In evaluating the economics of an automatic fire defence system it is essential that the effect of deferred tax and grant payments are taken into account in order to give a true financial return. A discounted cash flow (DCF) method of financial evaluation has been used in assessing the economic viability of both sprinkler and automatic fire detection systems in the Case Studies in Appendix C. The advantage of the use of a discounted cash flow technique, and the reason why it has been used, is because it takes account of the fact that money available now is worth more than the same amount at some time in the future. Another advantage of discounted cash flow is that it enables deferred payments both of taxation and grants to be taken fully into account. The format used in the Case Studies is an adaption of the layout used in Appendix B of Investment Appraisal[5.9].

Before the figures can be discounted it is necessary to calculate the initial cost which in the case of a sprinkler installation will include some or all of the items shown in Fig. 22.

ITEMS CONSTITUTING THE INITIAL COST OF A SPRINKLER INSTALLATION

1. Cost of installation, pumps and storage of water when necessary.
2. Cost of connection to the water supply.
3. Cost of financing the stage payments during construction.
4. Architects, surveyors and consultants fees.
5. Cost of time spent by management in assessing economic viability.
6. Loss of floor area due to control values and storage of water.
7. Direct link to centrally manned control.

Fig. 22 Items to be considered when calculating the initial cost of a sprinkler installation.

The annual saving in premium will also be reduced by the running costs of the installation, which may include some or all of the following:

RUNNING COSTS OF SPRINKLER INSTALLATION

1. Increase in rateable value.
2. Increase in water rates.
3. Cost of supplying water.
4. Sprinkler leakage insurance.
5. Servicing and maintenance.
6. Annual rental cost of a direct communication link.

Fig. 23 Increased costs resulting from the installation of a sprinkler system.

In the following example the basic information shown in Fig. 24 has been discounted in Tables 1 and 2. In Table 1, the discounted cash flow technique has been used to calculate the net present value (NPV) of the installation over a period of 11 years. In Table 2,

BASIC INFORMATION USED IN DISCOUNTING EXAMPLE, TABLES 1 and 2

Installation of a sprinkler system in a factory manufacturing overalls.

Basic information

		£
1.	Cost of installation (as Fig. 22)	2800.00
2.	Annual insurance premium unsprinklered	922.00
3.	Annual insurance premium sprinklered	185.00
4.	Annual running costs resulting from the installation of the sprinkler system (as Fig. 23)	
	Initial annual cost	97.00
	Annual costs after the first year will include servicing	147.00
5.	Maintenance - £100.00 in the fifth year	
6.	Government grant 20%[5.10]	
7.	100% of the capital cost can be offset against tax liability.[5.11]	
8.	Corporation tax assumed to be 50%.[5.12]	
9.	Discount rate 5%.[5.13]	
10.	No allowance for inflation.[5.14]	
11.	Assumed life of building by present occupier is 11 years.	

Fig. 24 Basic information relating to the installation of a sprinkler system in a factory manufacturing overalls.

Source - Case Study No. 2 Appendix C.

the yield from the investment during the same period has been calculated.

From Table 1 it can be seen that when the cash flows are discounted at 5%, the capital cost is recovered in the second year and that the present value of the investment, assuming an 11 year business life for the building, amounts to £1719.00*. An NPV of £1719.00 may not be as meaningful to management as the yield from the investment, which is seen to be 35.86% from Table 2. Although the yield may have more meaning to a business executive, the NPV method has been used in the case studies because it is considered desirable to compare the financial effects of a number of different manufacturing uses for a particular building. If a common cost of capital is used then one of the variables is eliminated.

The pay-back method used in the United States by Clyde M. Wood has been examined in detail in Appendix A. Although the figures relate to the economics of a sprinkler installation in the United States, it is possible to see the effect of deferred tax payments if a DCF technique of evaluation is used. When the deferment of tax payments is taken into account and the figures are discounted at 5%, the "break-even" point is reduced from the eleventh to the ninth year and the NPV of the increases from $10532 to $12169.

The payback method developed by Clyde M. Wood although more useful as an evaluation technique than a simple payback method, does less than DCF because it does not take deferred payments into account.

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*No attempt has been made to calculate the residual value of the sprinkler installation which will have an effective life far in excess of the assumed 11 year business life.

Overall manufacturer 20% development grant No allowance for inflation				Discount rate 5%		Example of the use of discounted cash flow					
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash Flow‡ £	Discount rate 5%	NPV at 5%
0	2800	640	-	-	-	-	-	(-2160)	(-2160)	1.000	(-2160.000)
1		590	320	2800	1400	530**	-1080	2200	2200	0.952381	2095.238
2		590	295				295	295	295	0.907029	267.574
3		590	295				295	295	295	0.863838	254.832
4		590	295				295	295	295	0.822702	242.697
5		490*	295				295	195	195	0.783526	152.788
6		590	245				245	345	345	0.746215	257.444
7		590	295				295	295	295	0.710681	209.651
8		590	295				295	295	295	0.676839	199.668
9		590	295				295	295	295	0.644609	190.160
10		590	295				295	295	15‡	0.613913	9.209
11		-	295				295	(-295)‡	-	-	-
									Net Present Value		£1719.261

Table 1. Calculation of the net present value of installing a sprinkler system in a factory manufacturing overalls - Based on information contained in Fig. 24.

* Annual premium saving adjusted for maintenance costs.

** Government grant is based on prime cost of installation and fees but does not include the cost of work in connecting to the water main

‡ The negative cash in the eleventh year resulting from the payment of tax must be discounted and deducted from the saving in the 10th year.

CALCULATION OF THE YIELD OF THE CASH FLOWS FROM TABLE 1

Year	Adjusted cash flow figures from TABLE 1	Discount factors at 35%	DCF at 35%	Discount factors at 37%	DCF at 37%
0	(-2160)	1.000	(-2160.000)	1.000	(-2160.000)
1	2200	0.740741	1629.630	0.729927	1605.839
2	295	0.548697	161.866	0.532793	157.174
3	295	0.406442	119.900	0.388900	114.726
4	295	0.301068	88.815	0.283869	83.741
5	195	0.223014	43.488	0.207204	40.405
6	345	0.165195	56.992	0.151243	52.179
7	295	0.122367	36.098	0.110397	32.567
8	295	0.090642	26.739	0.080582	23.772
9	295	0.067142	19.807	0.058819	17.352
10	15	0.049735	.746	0.042933	.644
11					
			24		-32

DCF Rate of Return : $35\% + 2\% \times \frac{24}{56}$

$= 35\% + .86\%$

$= 35.86\%$

TABLE 2 Claculation of the yield from the cash flow shown in Table 1 - Yield 35.86%

K. H. Mathews[5.15] in a letter to "The Accountant", following an article[5.16] on fire insurance premiums, commented as follows:

> "your insurance correspondent would stand a better chance of persuading us (Accountants) to install sprinklers if he refrained from elementary errors in presenting his case. Quite apart from the use of the long-discredited "pay-back period" criterion for investment appraisal he falls into the trap of quoting cost savings gross of tax".

Merrett and Sykes[5.17] consider that payback is seriously deficient as a method of profit appraisal and that it should only be used as a crude screening device to eliminate obviously unacceptable projects. However, they are of the opinion that payback can be used for sanctioning obviously profitable investments involving small outlays, which for the large organisation particularly one with a high fire risk, may well apply to decisions relating to the installation of systems of automatic fire defence. This would certainly not apply to the smaller manufacturer, particularly where liquidity is a problem. In addition, Merrett and Sykes are of the opinion that the payback method does nothing that methods based on discounting cannot do much better.

Chapter 5

NOTES

5.1 Infra., Chapter 7 p. 127

5.2 Infra., Chapter 7 p. 128

5.3 Research Services Ltd., Company Attitudes to Installation of Automatic Fire Prevention/Detection Systems, - Unpublished survey for the Central Fire Liaison Panel, (London : Research Services Ltd., August 1970) pp. 1-162.

5.4 Ibid., p. 4.

5.5 Central Fire Liaison Panel, Fire Defence cost or saving? Fact Sheet 1973 (London : Central Fire Liaison Panel).

5.6 Research Services Ltd., op. cit., pp. 16-17.

5.7 G. H. Tryon ed., op. cit., pp. 16/7-9

5.8 Infra., Chapter 6 pp. 112-113

5.9 National Economic Development Office, Investment Appraisal (London : Her Majesty's Stationery Office, 1971) pp. 21-28.

5.10 Infra., Chapter 7 p. 128

5.11 Infra., Chapter 7 p. 127

5.12 Infra., Chapter 6 pp. 112-113

5.13 Infra., Chapter 6 p. 120

5.14 Infra., Chapter 6 pp. 119-123

5.15 K. H. Mathews, Letter -"Sprinkler Systems and Insurance", The Accountant, (1st March, 1969) Vol. 160 - No. 4915, p. 309.

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5.16 Anon, "Fire Insurance Premiums", The Accountant (15th February, 1969) Vol. 160-No. 4913, pp. 226-228.

5.17 A. J. Merrett and Alan Sykes, The Finance and Analysis of Capital Projects, (London : Longmans, 1963) pp. 228-234.

Chapter 6

Company's cost of capital and the effect of inflation

Sources of Capital - The Cost of Equity - Retained Earnings - Corporation Tax and Proposed Changes in the Tax Structure - Debt Capital - Marginal Cost of Capital - Inflation.

The use of DCF techniques, particularly when the net present value is calculated, involves the estimation of a company's cost of capital. Cost of capital together with the effect of inflation and investment incentives must be considered in any method used to evaluate economic viability.

An estimation of the cost of capital will be dependent on the method of raising the capital and upon the degree of risk to which the capital will be subject. If the Directors of the company who are considering the financial implications of an automatic fire defence system are answerable to their shareholders, then the return should not be less than the rate which would be expected from other forms of investment subject to the same levels of risk. In fact, the same criteria should apply to all business organisations whether or not there is a responsibility to shareholders. The financing of an automatic fire defence system is a cost saving investment and as such can be regarded as risk free, in the sense that there is no risk of a debtor defaulting either in the payment of principal or interest. The loan, however, will still be subject to two unknown factors, one being a possible rise in interest rates and the other a possible fall in the purchasing power of money. Quite frequently these two events occur at the same time because if people are of the opinion that purchasing power is going to fall then they will require a higher rate of interest in

the future to persuade them to part with a given sum of money at the present time.

The average real return which shareholders in the United Kingdom have been able to obtain during the last 45 years has been stated by Merrett and Sykes[6.1] to be slightly in excess of 7% on average equity investments held for ten years or more; this figure is net of all taxes. In order to give its shareholders a 7% return, a company must earn at least 14% net only of corporation tax, if it is assumed that the level of inflation is 3%. The payment of the standard rate of tax on distributed profits reduces the return from 14% to 10% and this is then reduced by a further 3% to allow for the assumed inflation. The return is, however, based on the assumption that the whole of the capital that a company uses is raised by equity financing. Data published in Economic Trends relating to the financing of the 3000 largest public quoted companies in the United Kingdom for the period 1954-1963 have been shown by Merrett and Sykes[6.2] to be made up of the following proportions of capital:-

(a)	ordinary shares,	-	26 %)
(b)	retained earnings,	-	52.4%)
(c)	long term and short term debt capital, (including preference capital)	-	21.6%

Although the proportions of equity to debt capital will depend on the gearing of the company, it is likely that for many firms it will be between 70-80% equity capital to 20-30% debt capital[6.3].

As can be seen from the foregoing the most common method of raising new finance is by the issue of equity but this is also the most expensive form of capital that a company can raise, because, as far

as the investor is concerned he is last in the queue. All other funds have a higher claim upon the company's earnings and therefore his investment carries the highest level of risk. In order to attract the investor, the return from capital raised by the issue of additional equity must be sufficient to maintain dividends at their present level or else attractive enough to persuade the investor that in the future he will obtain a greater return. If the return from the company's capital is going to remain at a similar level to that existing before the equity issue, then existing shareholders will fear that there will be a decline in the value of their holdings and as a result the value of their shares will fall. Additional equity whether raised by the company shareholders in the form of a rights issue, by subscription from the general public or as a result of a share exchange can threaten the earnings of the existing shares because it is liable to lead to an immediate dilution. Any dilution of earnings in the short term must be compensated by long term growth.

The cost of equity before tax is equal to the present earnings yield grossed up for corporation tax and added to a factor which represents the expected growth rate in the company's earnings[6.4]. A company with a 6% earnings yield, subject to 50% corporation tax and an anticipated rate of growth of 5% per annum will have an earnings cost of equity of 17% as shown below:

$$\text{Earnings cost of equity} = \frac{\text{earnings yield}}{(1 - \text{tax rate})} + \text{growth rate}$$

$$= \frac{6}{0.50} + 5$$

$$= 17\%$$

When a company is growing more rapidly it will have a lower earnings yield. Where the earnings yield is in the range of 2.5 down to 1.25 with a correspondingly high price to earnings ratio in the range of

40 to 80 then the expected growth rate will be between 30 to 40% per annum[6.5]. The cost of equity for these firms is very high indeed.

At the present time it would appear that a balanced portfolio should yield between 12% and 13.5% gross from new money and consequently in order to raise additional money from an equity issue it is necessary to earn at least 13% after corporation tax, or a rate at least equal to that being earned by the existing equity whichever is the higher rate. Failure to persuade the market that such rates can be expected will in all probability lead to a considerable sale of the existing equity because of the expected dilution.

In the survey published in Economic Trends[6.6], retained earnings represented the largest percentage of finance and as such are a major source of long term capital. They arise as a result of reinvesting net earnings in the company instead of passing them on in the form of dividends to the shareholders. Under the present system of taxation which penalises short term capital gains, shareholders are often happy to forego dividends if as a result of the sacrifice the company is able to invest the funds to give an increased rate of return. The retention of earnings makes it possible for share earnings to increase which will lead to a rapid increase in the price of the shares. The shareholder now finds that his wealth has increased and as long as he delays the sale of his shares can avoid capital gains tax or alternatively convert the profit into a long term capital gain.

Finance provided by retained earnings has shown a considerable tax saving as compared with the cost of distributing earnings; the reason for this is that under the 1965 Finance Act there was a complete separation between the company and its shareholders. Company profits up to April 1973 were taxed at a rate of 40% and any dividends were

then taxed at the standard rate of income tax. In effect a dividend was taxed twice, whereas money which was retained was only subjected to the 40% rate of corporation tax. If the shareholders subscribe £1000.00 the cost to them will be £1000.00, if on the other hand the £1000.00 is provided out of dividends which should have been distributed to the shareholders then the cost will be £1000.00 less the amount that they would have paid in taxation if they had received the dividends. The standard rate of taxation up to the 1st April, 1973 was 38.75% and this meant that the actual cost to the shareholder was £1000.00 less £387.50 = £612.50.

The effect of retained earnings is illustrated in the following graph published in Capital Budgeting and Company Finance[6.7].

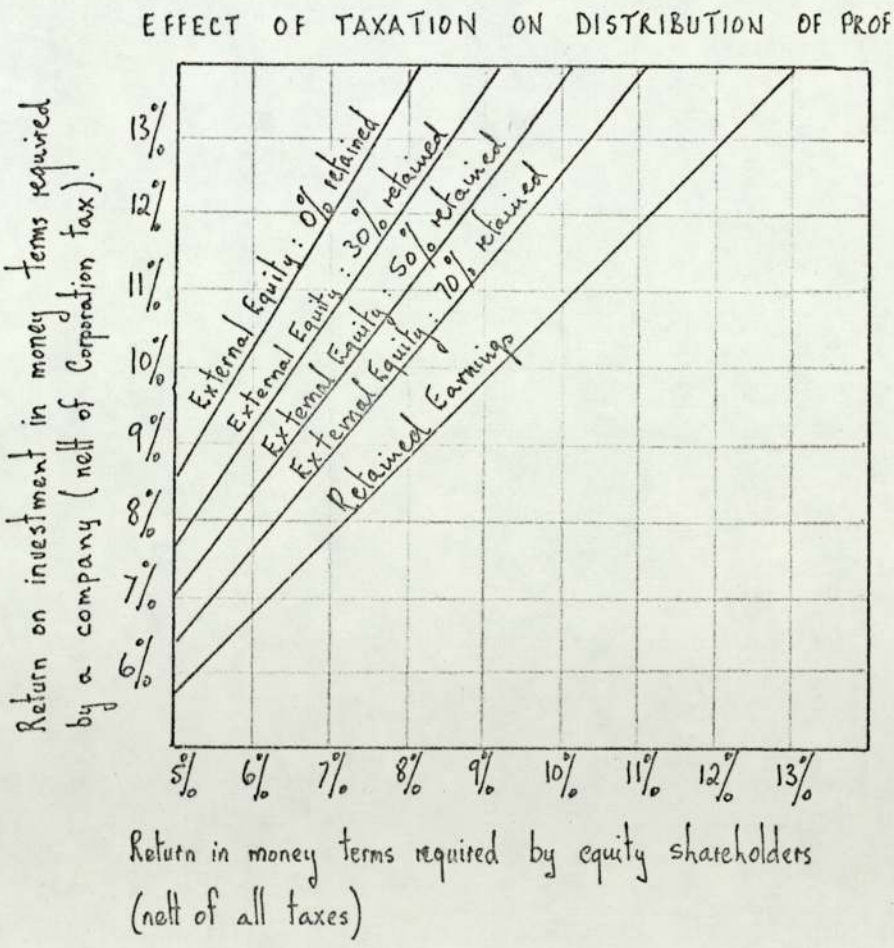

Fig. 25 Cost of external equity and retained earnings.
Source - Capital Budgeting and Company Finance[6.7]

From Fig. 25 it can be seen that a 14% return on an investment, net only of 40% corporation tax, gives a 10% return in money terms where 50% of the external equity is retained. In order to give a 10% return to the equity shareholder in cases where all the earnings are retained, it is necessary to have a return of 11.5% and not 10% as would perhaps be expected. The reason for the 11.5% return is that the large income tax savings resulting from the retention of all the earnings will be slightly offset by the capital gains tax liability resulting from the increase in share value.

Fig. 25 was based upon a standard rate of tax of 41.25% whereas the figure up to the 1st April, 1973 was 2.50% lower, but the information in the figure is considered to be accurate enough for illustration because it assumes a 20%‡ level of capital gains taxation which is only an estimation of the average taxation level.

In the 1971 budget the Chancellor of the Exchequer announced that it was the intention of the Government to reform the structure of corporation tax so as to remove the discrimination against distributed profits. The need for reform in the tax had become apparent because of the way in which it had worked during the preceding five years. The effect of corporation tax has made companies prefer fixed interest finance when they are borrowing and this has consequently lead to a reduction in the supply of equity. On the other hand investors have preferred equity because it has acted as a hedge against inflation.

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‡The capital gains tax to the standard taxpayer is 30% but the figure of 20% is considered by Merrett and Sykes[6.8] to be reasonable because large scale investors such as pension funds and charities must be taken into account and these organisations do not pay tax.

Investment trust companies in particular have had a preference for equity because they were able to take advantage of franked income tax arrangements[6.9]; this enabled them to reclaim tax on franked income resulting from dividends of both ordinary and preference shares when distributed as dividends by the investment trust company. As a result of the tax structure, it did not pay investment trust companies to switch from equities to fixed interest security since this would be unfranked income and subject to corporation tax. The supply of equity was therefore in demand and many firms floating loan stock found that unless a very high rate of interest was offered, the stock was not taken up.

Following the 1971 budget speech a White Paper entitled Reform of Corporation Tax[6.10] was published in April, 1972 and outlined the following changes:-

(a) the company pays corporation tax at a single rate (50 per cent) on all its profits, whether distributed or undistributed;

(b) income tax will no longer be deducted from dividends;

(c) a company distributing profits in the form of dividends, etc. to its shareholders will, in addition, be required by the Inland Revenue to make an advance payment of corporation tax at a rate of (3/7th) of the dividend paid to the shareholders;

(d) advance payments resulting from dividend distribution in an accounting period will be set against the company's corporation tax charge on its profits for that accounting period;

(e) shareholders in receipt of dividends from which advanced corporation tax has been paid will be entitled to a tax credit.

A rate of 50% has been used in the White Paper but it is emphasised that this is purely hypothetical and used for convenience. Until the actual rate is announced in the Finance Act, 1974 it is difficult to assess what its effect will be on a company's cost of capital. However, during the course of conversations with two area managers from leading finance houses, the question as to the likely rate of corporation tax was raised and both were of the opinion that the rate would be 50%. The change in corporation tax will of course lead to a reduction in the return required on distributed profits but at the same time a higher return will be necessary where profits would have been retained.

A comparison of the amount of tax paid per £100.00 earned both before and after the 1st April, 1973, based on an assumed rise in corporation tax from 40% to 50% and the removal of taxation on distributed profits is shown below:

COMPARISON BETWEEN TAX PAYMENTS BEFORE AND AFTER THE 1st APRIL, 1973

Prior to the 1st April, 1973 (a) Corporation Tax - 40% (b) Standard rate of tax - 38.75%			After the 1st April, 1973 (a) Assumed corporation tax - 50%		
£100.00 earned	Tax Paid	Sums retained or distributed		Tax Paid	Sums retained or distributed
(I) All profits distributed	£	£		£	£
-	78.75	21.25			
			£100 earned	50	50
(II) 50% retained & 50% distributed					
-	51.625	48.375			
(III) 60% retained & 40% distributed					
-	49.30	50.70			

Fig. 26 Comparison of the amount of tax paid per £100.00 earned before and after the 1st April, 1973

It would appear that the payment of 50% corporation tax approximates to the retention of 60% equity and distribution of 40% in dividends under the rate of tax prior to the 1st April, 1973. In order to give shareholders a return of 10% net of all taxes it will be necessary to earn a return of 13.5% to cover the additional 10% of corporation tax. There will of course be a rise from 11.5% to 13.5% in cases where all earnings are retained. The only difference between retaining and distributing profits would appear to be the necessity to pay advanced corporation tax, which because of the normal delay in the payment of corporation tax will give retained earnings a marginal advantage.

6.11

By far the cheapest method of raising new capital funds is in the form of long term debt. The only time that long term debt becomes an expensive method of raising capital is when money is scarce and high interest rates must be paid. The raising of debt capital may also lead to restrictions being imposed on the internal management of the company as in the case where capital is raised by mortgage debenture. This applies particularly to small firms borrowing from banks or finance houses. All debt, however, entails a risk to the firms solvency, the firm has a legal obligation to pay interest at an agreed rate and eventually the principal when the debt matures. Any failure can have serious affects on the shareholder's interest.

One of the effects of the introduction in 1966 of corporation tax, because of its discrimination between distributed and undistributed profits, has been to discourage firms from issuing preference shares and also to make them very reluctant to issue ordinary shares. At the same time there has been a marked increase in the issue of loans and debentures. Because of deferred payments of taxation, corporation tax applied to new issues of equity and fixed interest finance from the

beginning of 1965. In the four years prior to 1965, 53.6% of new money was raised by the issue of equities whereas in the following four years the percentage had fallen to 26.8%. During the same time there was a corresponding rise in the issue of fixed interest capital from 46.4% to 73.2%. Fig. 27 shows the percentages of fixed interest and equities issued between 1961 and 1971.

NEW ISSUES OF EQUITY AND FIXED INTEREST FINANCE, 1961 - 1971

	Fixed interest £m			Equities £m				Total
	Convertible	Other	% of total	Preference	% of total	Ordinary	% of total	£m
1961	28.1	120.0	26.5%	2.8	0.5%	408.9	73.0%	559.8
1962	41.0	132.8	42.1%	5.3	1.3%	233.9	56.6%	413.0
1963	35.3	236.2	60.3%	14.7	3.3%	163.9	36.4%	450.1
1964	60.2	173.8	56.6%	10.7	2.6%	168.9	40.8%	413.6
1965	28.1	426.5	90.3%	3.2	0.6%	45.5	9.0%	503.4
1966	38.4	441.0	75.1%	16.4	2.6%	142.5	22.3%	638.4
1967	29.7	313.8	81.5%	5.7	1.4%	72.6	17.2%	421.9
1968	128.3	181.3	45.8%	3.1	0.5%	363.7	53.8%	676.4
1969	231.7	165.7	67.1%	-	-	195.0	32.9%	592.4
1970	101.3	211.6	82.0%	17.2	4.5%	51.9	13.6%	382.0
1971	96.7	273.4	53.4%	12.8	1.8%	310.4	44.8%	693.3

Fig. 27 New issues of equity and fixed interest finance, 1961 - 1971[6.12]

Clarkson and Elliot[6.13] considered that in the tax structure existing up to the 1st April, 1973, debt funding must have maximum emphasis and whether the changes in corporation tax will affect this remains to be seen. At the present time because of the reluctance of investment trusts and investors to switch from equities to fixed interest, as previously outlined, very high rates of interest are being offered by companies when floating fixed interest stock as illustrated below where the interest rates of recent issues of both debentures and loan stock are around 10%.

NEW ISSUES - December, 1972

DEBENTURES	Price	Flat Yield	LOAN STOCK	Price	Flat Yield
BPB Industries $10\frac{1}{4}\%$ 97-2002	$99\frac{3}{4}$	10.3	Cavenham $9\frac{3}{4}\%$ 92-97	93	10.7
Haslemere Est: $10\frac{1}{4}\%$ 98-2003	$99\frac{3}{4}$	10.3	ICFC $8\frac{7}{8}\%$ 92-97	89	10.1
Metro: Est $9\frac{3}{4}\%$ 97-2002	98	10.2	Imperial Tob: $10\frac{1}{2}\%$ 90-95	$100\frac{3}{4}$	10.5
Michelin Tyre $9\frac{1}{2}\%$ 92-97	$95\frac{1}{2}$	10.2	Jessel Secs: $9\frac{3}{4}\%$ 95-2002	$89\frac{1}{2}$	10.9
Pearson Long $10\frac{1}{4}\%$ 97-2002	$100\frac{1}{2}$	10.2	Rank Org: $10\frac{3}{8}\%$ 97-2002	$99\frac{3}{4}$	10.5
Star (GB) $9\frac{7}{8}\%$ 97-2002	$98\frac{3}{4}$	10.1	Slater Walker 9% 91-96	84 xd	10.7

Fig. 28 Yield of new issues - Debentures and Loan Stocks.

Source - Investors Chronicle - 8th December, 1972.

Merrett and Sykes[6.14] when considering a return required from fixed interest capital in 1966 estimated that the average gross of tax interest rate on debt capital to be around $6\frac{1}{2}\%$, which net of 40% corporation tax was equal to 3.9% say 4% in money terms. The figure of 4% when subject to a 3% level of inflation gave a return of 1% in real terms. At the present time it can be seen from Fig 28 that the average long term

interest rate, gross of tax is approximately 10%, but with a proposed increase in corporation tax which may be 50%, this will give 5% in money terms.

The maximum amount of long term debt that a company can raise is normally restricted by lenders to a proportion of the company's net tangible assets, for which there must be a minimum earnings cover in relation to loan interest. In cases where the company has already raised the maximum loans on its existing capital and assets, then any further loans can only be raised as a result of increasing the equity capital. For this reason it is necessary to consider the cost of additional capital as a combination of equity and debt. Where marginal funds are being raised it is the weighted cost of capital that must be considered as shown in the following examples:-

A. Gearing of company 80% equity and 20% debt

Cost of capital	- (0.8 x 13.5%) + (0.2 x 5.0%)
(assuming 50% Corporation tax)	- 11.8%

B. Gearing of company 70% equity and 20% debt

Cost of capital	- (0.7 x 13.5%) + (0.3 x 5.0%)
(assuming 50% Corporation Tax)	- 10.95%
	Say 11.0%

The figures of 11.8% and 11% would apply to investments where a normal level of risk was to be expected; whereas the investment in an automatic fire defence system, particularly a sprinkler installation, is a cost saving investment and also protects the physical assets of the company. Because the investment is risk free, shareholders would expect to receive a lower rate of return than the 7% plus in real terms which has been achieved during the last 45 years[6.15]. Merrett and Sykes[6.16] have

estimated that the figure for risk free investments would probably lie between 2% and 6% in real terms and take the view that 4% would be reasonable. A rate of 4%, together with an assumed rate of 3% for inflation, is equivalent to 7% in money terms. When reference is made to Fig. 23, a return of 9.5%* would be necessary to give a return of 7% and also allow for the increase in corporation tax which has been calculated to be 10%. The weighted cost of capital would now be as follows:-

A. Gearing of company 80% equity and 20% debt

Cost of capital (assuming 50% Corporation Tax) - (0.8 x 9.5%) + (0.2 x 5.0%) - 8.6%

B. Gearing of company 70% equity and 20% debt

Cost of capital (assuming 50% Corporation Tax - (0.7 x 9.5%) + (0.3 x 5.0%) - 8.15%

Say 8.0%

Since 1969 inflation has been increasing rapidly. The Government in October 1972 took measures to reduce it, but it seems clear that the rate of inflation which is acceptable to the Government is one that approximates to the level of inflation existing before 1969, which was around 3% per annum. The high rates of interest currently being charged by Banks and Finance Houses, together with the high rates of interest on long term debt capital reflect the level of inflation and

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*A figure of 9.5% would give shareholders 7% under the previous tax structure of 40% corporation tax when 60% of earnings are retained and 40% distributed. This is equivalent to a 50% corporation tax under the new tax structure[6.17].

consequently this will be reflected in the money cost of a company's marginal capital.

The high rate of interest may well be affected by exoginously determined variables such as patterns of trade, terms of trade, internal and external movements of capital, all of which may be of short or long term duration and consequently will be reflected in the money cost of a company's marginal cost of capital.

The National Economic Development Council have stated[6.18] that although inflation is a complex problem it need not be taken into account when calculating cash flows, because it will have similar effects on both costs and revenue, provided that the cash flows are discounted to the real cost of finance. In Tables 3,4 and 5, the effect of inflation on the net present value of the example of discounting used in Chapter 5[6.19] was found to be minimal. Inflation levels of 3%, 5% and 10% were assumed and the difference in net present value amounted to £1 749, £1 774 and £1 824 respectively. Because the future level of inflation cannot be predicted with any certainty, nor is it likely to be uniform from year to year; the cash flows in the case studies have been discounted to the real cost of capital.

If the effect of inflation is disregarded, the weighted cost of capital for the two previous examples[6.20] must be reduced by the assumed level of inflation as follows:

A. Gearing 80% equity and 20% debt - 8.6% - 3% = 5.6%

B. Gearing 70% equity and 30% debt - 8.15% - 3% = 5.15%

The equity capital was assumed to be subject to a 3% level of inflation, whereas the fixed interest capital reflects a higher level of inflation[6.21] and for this reason a real cost of capital of 5% has been used when discounting the cash flows in the Case Studies in Appendix C and D.

Overall Manufacturer 20% development grant				Discount rate 8%		Level of inflation 3%					
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash Flow £	Discount rate 8%	NPV at 8%
0	2800	640	-	-	-	-	-	(-2160)	(-2160)	1.00	(-2160.00)
1		607	320	2800	1400	530	-1080	2217	2217	0.925926	2052.78
2		625	304				304	321	321	0.857339	275.21
3		644	313				313	331	331	0.793832	262.76
4		664	322				322	342	342	0.735030	251.38
5		568	332				332	236	236	0.680583	160.62
6		704	284				284	420	420	0.630170	264.67
7		725	352				352	373	373	0.583490	217.64
8		747	363				363	384	384	0.540269	207.46
9		769	374				374	395	395	0.500249	197.60
10		793	385				385	408	41	0.463193	18.99
11			397				397	(-397)	-	-	-

Net Present Value £1749.11

Table 3 Calculation of the net present value of installing a sprinkler system in a factory manufacturing overalls[6.19] - Level of uniform inflation 3%

Overall Manufacturer 20% development grant				Discount rate 10%		Level of inflation 5%					
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 8%	NPV at 10%
0	2800	640	-	-	-	-	-	(-2160)	(-2160)	1.00	(-2160.00)
1		619	320	2800	1400	530	-1080	2229	2229	0.909091	2026.36
2		650	310				310	340	340	0.826446	280.99
3		682	325				325	357	357	0.751315	268.22
4		717	341				341	376	376	0.683013	256.81
5		633	359				359	274	274	0.620921	170.13
6		790	317				317	473	473	0.564474	267.00
7		830	395				395	435	435	0.513158	223.22
8		871	415				415	456	456	0.466507	212.73
9		915	436				436	479	479	0.424098	203.14
10		961	458				458	503	66	0.385543	25.45
11			481				481	(-481)	-	-	-

Net Present Value £1774.05

Table 4 Calculation of the net present value of installing a sprinkler system in factory manufacturing overalls[6.19] -

Level of uniform inflation 5%

Overall Manufacturer 20% development grant				Discount rate 15%		Level of inflation 10%					
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash Flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 15%	NPV at 15%
0	2800	640	-	-	-	-	-	(-2160)	(-2160)	1.00	(-2160.00)
1		649	320	2800	1400	530	-1080	2259	2259	0.869565	1964.35
2		713	325				325	388	388	0.756144	293.38
3		785	357				357	428	428	0.657516	281.42
4		863	393				393	470	470	0.571753	268.72
5		789	432				432	357	357	0.497177	177.49
6		1045	395				395	650	650	0.432328	281.01
7		1149	523				523	626	626	0.375937	235.34
8		1264	575				575	689	689	0.326902	225.23
9		1391	632				632	759	759	0.284262	215.75
10		1530	696				696	834	169	0.247185	41.77
11			765				765	(-765)	—	—	—

Net Present Value £1824.46

Table 5 Calculation of the net present value of installing a sprinkler system in a factory manufacturing 6.19 overalls - Level of uniform inflation 10%

Chapter 6

NOTES

6.1 A. J. Merrett and Allen Sykes, Capital Budgeting and Company Finance (London : Longmans, 1966) p. 31.

6.2 Ibid., p. 31.

6.3 Ibid., p. 138.

6.4 G. P. E. Clarkson and Bryan J. Elliott, "Managing Capital Funds" National Westminster Bank Quarterly Review (August, 1970) p. 35.

6.5 Ibid., p. 36.

6.6 Supra, p. 107

6.7 Merrett and Sykes, op. cit., p. 42.

6.8 Ibid., p. 43.

6.9 G. O. Nwankwo, "Taxation, Inflation and Company Finance". The Bankers Magazine, London (November, 1972), p. 197.

6.10 Great Britain, Reform of Corporation Tax, Cmnd 4955 (London : Her Majesty's Stationery Office, April, 1972) pp. 4-5.

6.11 Supra., p. 110

6.12 "A new record for Capital Issues in 1971 - Equity Finance at a High Level". Midland Bank Review (February, 1972) p. 5.

6.13 Clarkson and Elliott, op. cit., p. 40.

6.14 Merrett and Sykes, op. cit., p. 31.

NOTES

6.15 Supra., p. 107

6.16 Merrett and Sykes, op. cit., p. 35.

6.17 Supra., p. 110

6.18 National Economic Development Office, Investment Appraisal (London : Her Majesty's Stationery Office, 1971) p. 11.

6.19 Supra., p. 101

6.20 Supra., p. 119

6.21 Supra., pp. 117-118

Chapter 7

Investment incentives and their effect on the financing of automatic fire defence systems

Variations in Investment Incentives - Taxation Allowances and Regional Development Aid - Legal Definition of Plant - Differing Views on whether systems of Automatic Fire Defence should be regarded as Plant or Part of the Building - Clarification of Border-line Cases in Development Areas - Qualifying Premises.

In March, 1972, the Government issued a White Paper entitled "Industrial and Regional Development"[7.1]. The reason given by the Government for the issue of the paper was their concern that economic performance in the United Kingdom had, for some time, been falling behind that of other major industrialised countries.

Investment incentives have, in the past, been subject to considerable variation both in amount and geographical area to which they apply. Since 1966, incentives have been altered on six occasions and as a result of Britain's membership of the European Economic Community it is unlikely that they will remain unaltered for long. The present policy of regional aid within the E.E.C. is outlined in Appendix B. However, in June 1973, it was announced by the Government that as a result of negotiations with E.E.C. members in Brussels, the regional development incentives applicable at present would, in the immediate future, remain unaltered.

The White Paper[7.1] contained proposals relating to basic investment both on a national as well as a regional basis. It was proposed that throughout the country the tax allowance for plant,

machinery and buildings should be increased and that in addition regional development grants should be available to assist development in certain parts of the country. The tax allowances were to be given on the full capital expenditure, even where part of the expenditure is financed by a regional development grant. It was hoped that the separation of the tax allowances from the grants would enable each to be administered independently, leading to simplicity and greater speed in granting the incentives.

The tax allowances outlined in the White Paper were embodied in the Finance Act, 1972 and are shown below:

TAX ALLOWANCES CONTAINED IN THE FINANCE ACT, 1972

1. All plant and machinery (new and second hand - other than passenger cars) for use in both services and manufacturing.	First year allowance 100 per cent
2. New industrial building and structure.	Initial allowance 44 per cent and writing down allowance 4 per cent.

Fig. 29 Tax allowances relating to machinery, plant and buildings[7.2]

The above allowances for plant apply to the whole country in both manufacturing and service industries. Where a company's profit, for the year in which the capital expenditure occurs, is insufficient to absorb the full tax allowance; then the excess amount can be carried forward indefinately and set against future profits. When a company is entitled to a 100% first year allowance on plant and machinery, any excess of expenditure on the plant over the profits for the year may be carried back and set against the profits for the three preceding years. As previously mentioned, regional development grants are not deducted from the cost of the asset when calculating

the tax allowance.

The proposals in the White Paper relating to regional development grants in the assisted areas are contained in the Industry Act 1972, and shown below:

GRANTS IN ASSISTED AREAS

Area	Plant, Machinery and Mining Works	Buildings
Special Development Areas	22 per cent	22 per cent
Development Areas	20 per cent	20 per cent
Intermediate Areas	-	20 per cent
Derelict Land Clearance Areas (for two years only)	-	20 per cent

Fig. 30 Regional Development Grants in assisted areas[7.3]

The assisted areas are listed in Annex A of the explanatory notes for the guidance of applicants for regional development grants[7.4] issued by the Department of Trade and Industry in October, 1972.

Explanatory Note 26[7.5], under a heading of borderlines between buildings, works and plant or machinery, states that:

> "in general, service installations which are incorporated in the course of constructing a new building or adapting an existing one are regarded as part of the building".

The Note then lists a number of service installations and includes

> "fire and other protection equipment such as sprinklers, dry risers, fire and burglar alarm systems".

The decision by the Department of Trade and Industry to regard sprinkler and automatic fire detection systems as part of the building is the exact opposite to the views held by the Inland Revenue Taxation and Rating Departments both of whom regard such systems as plant.

This decision by the Department of Trade and Industry will not affect the grant in a Development Area, where both buildings and plant obtain the same grant of 20%. However, in the Intermediate Development Areas, the installation of systems of automatic fire defence in new buildings should now be eligible for a 20% grant, whereas if the installation is regarded as plant a grant would not be payable.

The Intermediate Development areas are listed in Annex A[7.4] of the Explanatory Notes and are of particular significance because apart from districts around Edinburgh, Plymouth, Cardiff and Oswestry together with parts of the North Wales Coast and Nottinghamshire, include the whole of Lancashire, Yorkshire and Cheshire outside Development or Special Development Areas.

It is, of course, of financial benefit to a company for the Inland Revenue to continue to regard systems of automatic fire defence as plant, because the first year allowance of 100% can be claimed. If, on the other hand, the installation is regarded by the Tax Inspectors as part of the building then the initial allowance would amount to 44% with a subsequent writing down allowance of 4% per annum. During the course of conversation, five Tax Inspectors from different Districts were asked whether they regarded sprinkler installations as part of the building or as plant. Without exception all said they would regard such installations as plant and that their decision was based on a number of legal opinions.

The legal meaning of plant has been decided by a number of cases the most important of which is Yarmouth v France 1887[7.6], where a horse was held by Lindley L. J. to be plant for the purposes of the Employers Liability Act 1880. Gibson and Jackson[7.7] are of the opinion that any judicial discussion of plant invariably commences with a passage from the judgement of Lindley L. J.:

"in its ordinary sense, (plant) includes whatever apparatus is used by a business man for carrying on his business - not his stock-in-trade which he buys or makes for sale; but all goods and chattels, fixed or moveable, live or dead, which he keeps for permanent employment in his business".[7.6]

This passage was subsequently adopted as a general statement of the meaning of plant by the House of Lords in the case of Hinton v Maden and Ireland Ltd. (1959)[7.8].

Three other tax cases were thought by one of the Inspectors to be of particular interest. In Jarrold v John Good & Son (1963)[7.9] it was held that movable office partitioning was plant and Pearson L. J. observed that the question was:

"whether (it) is part of the premises in which business is carried on, or part of the plant with which business is carried on.

The second case is C.I.R. v Barclay, Curle & Co. Ltd. (1969)[7.10] where a dry dock was held to be plant and the decision in this case expressly overruled the earlier judgement of Finlay J. in Margrett v Lowestoft Water & Gas Co. (1935)[7.11] where a water tower which replaced a gas engine and pumps was held not to be plant.

Gibson and Jackson[7.12] in their summary of the case law relating to plant say that:

"the effect of these authorities is firmly to establish the relevance of the "functional test": an item will qualify as plant (in the context of trade) if it is part of the apparatus with which the trader carries on his business, as opposed to part of the premises in which he trades".

When this definition is applied to the provision of an automatic fire defence system, it would seem necessary to ascertain whether a sprinkler or other system of fire protection is necessary for the trader to carry on his business. If the degree of hazard is high, as in the case of the manufacture of many plastics, where insurance cover may be unobtainable without some form of protection, then the inference is that it is part of the apparatus which the trader uses to carry on his business. In cases where the risk is low and the installation in the building is the exception, as in the case of light engineering, then it would seem problematical whether such protection is necessary for the trader to carry on his business. Up to the present time the tax authorities have always regarded methods of automatic fire defence as plant and the Inland Revenue ruling is that:

> "specialist work of the nature of providing electricity, hot water, ventilation or air and also expenditure on alarms or sprinklers should be plant or machinery".[7.13]

The Inland Revenue also regard the installation of systems of automatic fire defence in existing buildings as qualifying for a 100% first year allowance under Section 45 of the Capital Allowances Act 1968 which states that:

> "alterations to existing building incidental to the installation of machinery or plant for the purpose of the trade is treated as part of the expenditure on the machinery or plant".

The Department of Trade and Industry, as mentioned previously,[7.14] regard systems of automatic fire defence in both new and existing buildings as part of the building. This does not however mean that the installation of a system of automatic fire defence in an existing

building will always qualify for a grant.

Section 23 of the explanatory notes[7.15] is concerned with the adaptation of existing building. Adaptation is regarded as altering or improving the building to make it fit for a given purpose. Repairs, replacement or restoring buildings already occupied by the applicant would not appear to qualify[7.16] and in addition Note 23 states that:

"adaption involves work of more than a superficial nature on the fabric of the building".

The note then goes on to state that the installation of a sprinkler system which involves extensive disruption of walls, floors and ceilings would be regarded as adaptation. It would appear that it is the degree of disruption that will be the deciding factor and presumably the installation of a detector system, where no other work was undertaken, would not qualify for a grant. If the cost of the installation was less than £1000.00 it would certainly not qualify[7.17].

The penultimate paragraph of Note 23[7.18] deals with the capital expenditure of providing services as part of the cost of adapting a building and states that automatic fire defence systems "may" qualify for approval of grant as part of the cost of adaptation "depending on the facts". It would appear, therefore, that a detector system installed in a building, where other work was being undertaken, would qualify for a grant.

The opinion of a Regional Development Grant official was that the installation of a sprinkler system in an existing building, where no other work was being undertaken, would in all probability be regarded as an adaptation of the building and would qualify for

a grant. He was not prepared to say that this would always be so, because the policy of the Department was to decide each case on its merit!

Although the Department of Trade and Industry regard fire protection in new and adapted buildings as part of the building, there are a number of anomolies which were pointed out by the representative of the Department as follows:

(a) work outside the qualifying premises (i.e.: outside the curtilage of the site) does not qualify for a grant. When the connection to a water main is outside the site, the cost will not be eligible for a grant and this would also apply to a pumphouse outside the curtilage of the site.

(b) pipework outside the building, but on qualifying premises, will be regarded as part of the works and provided the value is £100.00 or more will qualify for a grant[7.19]. Pumps in connection with a sprinkler system, which are outside the building but still within the qualifying premises, are regarded as plant.[7.20] Stored water in tanks would also appear to be regarded as plant and in an Intermediate Development Area would not be eligible for grant. However, pumps which are placed inside the building are regarded as part of the building.

(c) pumphouses and associated equipment on qualifying premises are regarded as plant if separated from the building. When the pumphouse is built against the external wall of the premises, then both the pumphouse and the equipment inside are regarded as part of the building.

Qualifying premises, for the purposes of regional development aid, are those housing qualifying activities as defined in Orders II

to XX of the Standard Industrial Classification, which are listed in Annex B[7.21] of the explanatory notes. Orders II to XX cover general manufacturing activities but exclude service industries. Note 13[7.22] states that office work including accountancy and market research together with haulage, sales, distribution and storage even where carried on in the same premises as qualifying activities, would not be eligible for grant. However, the Regional Development Grant Official said that provided at least 50% of the persons on the qualifying premises were employed in manufacturing, then the Department would look with favour on the premises, even where office work, haulage, sales and storage are included. As pointed out in Note 14, the[7.23] question whether any particular premises are qualifying will be decided by the Department of Trade and Industry when application is made for regional development aid.

When the Department decides that the premises are qualifying then the total cost of the work will qualify[7.24] including canteens, offices and warehouses, the only exceptions being sports grounds and pavilions, ornamental features, residential accommodation, buildings for temporary use and those costing less than £1000.00. Should the Department decide that premises do not qualify then the whole of the works would fail to qualify even those areas used solely for qualifying activities.

As long as the Inland Revenue continue to regard systems of automatic fire defence as plant and the Department of Trade and Industry regard such systems as part of the building, then building owners in Intermediate areas will obtain the same concessions as apply in Development areas. The present tax concessions and regional aid enable a high proportion of the initial cost to be recovered within

a short time[7.25]. In a Development area, approximately 70%* of the initial cost of a sprinkler installation can be recovered in the form of tax concessions and grant aid.

*The exact percentage will depend on the cost of work which is eligible for grant and is based on a 50% rate of Corporation Tax[7.26].

Chapter 7

NOTES

7.1 Great Britain, Industrial and Regional Development, Cmnd. 4942 (London : Her Majesty's Stationery Office, March 1972) p. 1.

7.2 Department of Trade and Industry, Incentives for Industry in the assisted areas (London : Her Majesty's Stationery Office, 1972) p. 14.

7.3 Ibid., pp.9-10.

7.4 Department of Trade and Industry, Regional Development Grants (Industry Act 1972) RDG/BEN (London : Her Majesty's Stationery Office, October 1972) pp.16-18.

7.5 Ibid., p. 6.

7.6 Yarmouth v France, CA, (1887), 19 QBD 647; 57LJQB7; 36 WR 281; 4TLR1.

7.7 Herbert Gibson and Edward Jackson, The Valuation of Plant and Machinery for Rating, (London : The Estates Gazette Limited, 1972), p. 24.

7.8 Hinton (HMIT) v Maden & Ireland Ltd., HL (1959), IWLR 875 and 3AER 356; 38 Tax Cases 391.

7.9 Jarrold (HMIT) v John Good and Sons Ltd., CA (1963), IWLR 214 and IAER 141 and RVR 25; 40 Tax Cases 681, 689.

7.10 Barclay, Curle & Co. Ltd., CIR V., HL, (1969) IWLR 675 and IAER 675; 45 Tax Cases 221.

Chapter 7

NOTES

7.11 Margrett (HMIT) v Lowestoft Water & Gas Co.(1935), 19 Tax Cases 481.

7.12 Gibson and Jackson, op. cit. p. 26.

7.13 M. Brumby, private interview, Inland Revenue, Wigan. May, 1973.

7.14 Supra., p. 128

7.15 Department of Trade and Industry, Regional Development Grants, op. cit, p. 5.

7.16 Ibid., p. 5.

7.17 Ibid., p. 4.

7.18 Ibid., p. 5.

7.19 Ibid., p. 5.

7.20 Ibid., p. 6.

7.21 Ibid., pp. 16-18.

7.22 Ibid., pp. 3-4.

7.23 Ibid., p. 4.

7.24 Ibid., p. 4.

7.25 Supra., p. 101.

7.26 Supra., Chapter 6, pp. 112-114.

Chapter 8

The financial return and benefits from the installation of systems of automatic fire defence

Number and Average Size of Sprinklered Buildings - Industrial Buildings; Summary of Case Studies No. 1 and 2 - NPV per Square Metre for various Industrial Uses of Case Study No. 2 - The Shop's Tariff; Summary of Case Studies No, 3 and 4 - Performance of Sprinklers - Structural Protection.

The financial return from the installation of an automatic fire defence system in industrial and commercial buildings is subject to many variables. The adequacy of the water supply, the size of rooms and the distance from the fire station affects either initial or running costs, whereas the location and the use of the building will determine whether or not a government grant can be obtained. However, the most important factors are size and use. Size of building will largely govern its insured value and also the insured value of the contents. Use, apart from determining whether a grant is payable, will affect the rate of insurance per £100 of building and contents insured. A number of buildings are either so large or their use has been classified as so hazardous, that insurance companies will insist on the installation of a method of automatic fire defence before accepting the risk.

With the exception of very hazardous occupancies, it is comparatively rare to find automatic methods in smaller buildings or in larger buildings with less hazardous use. Ramachandran[8.1]

estimated that in 1965 of approximately 55 160* manufacturing establishments employing 11 or more people, about 9400 were sprinklered. A breakdown of the number of sprinklered establishments in different industries is shown below:

NUMBER OF SPRINKLERED ESTABLISHMENTS IN DIFFERENT INDUSTRIES

Industry	Number of establishments employing 11 or more persons	Number of establishments (estimated)	% of sprinklered establishments
Food, Drink, tobacco	5274	840	15.9%
Chemical and allied trade	2451	120	4.8%
Metal manufacturing, engineering and electrical	17885	1250	6.9%
Textiles	5559	2110	37.9%
Clothes, footwear, leather and fur	7195	2090	29.0%
Paper, printing	5215	1720	32.9%
Others	11582	1270	10.9%
Total	55161	9400	17.0%

Fig. 31 Number of sprinklered establishments in different industries.

Source - An enquiry into the frequency of sprinklered premises[8.1]

In a later study, Ramachandran[8.2] was of the opinion that as a result of an overall increase in sprinkler installation between 1965 and 1970, estimated to be from 10% to 15% per annum, there were probably about 15 000 sprinklered manufacturing establishments in 1970. Based on figures published by the Board of Trade for 1966,

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*Annual Abstract of Statistics - Central Statistical Office London, 1965.

he estimated that of the 504 412 retail establishments only about 15000 (3 per cent) were sprinklered; the figure probably having increased to 21000 by 1970. The relatively small percentage of sprinklered premises in the retail section being due to the large number of small shops. Among wholesale distributors, whose number in 1965 according to the Board of Trade was 41049, Ramachandran[8.3] estimated that in 1970 there were about 9000 buildings equipped with sprinkler installations. In addition, he calculated that the average size of new or existing buildings where sprinklers had been installed in 1970 was 49000 sq. ft. (4552m^2). The average size[8.2] of commercial or industrial non sprinklered building where fire occurred in 1967 was approximately 14000 sq. ft. (1300m^2) and for sprinklered buildings 168000 sq. ft. (15608m^2).

During the course of conversations with insurance brokers, tariff company officials, sprinkler and fire surveyors, quantity surveyors, engineers and architects it became apparent that no one was able to say at what size or use of building it was economically viable to install a system of automatic fire defence. The Central Fire Liaison Panel literature[8.4] indicates that on occasions an installation will pay for itself in two to three years, but gives no indication of size of building. Research Services Ltd,[8.5] when investigating the payback period of 50 installations completed in 1969, found that when their method of calculation was used, the payback time varied from less than 2 years to over 20 years*.

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*The 50 companies were in the electrical engineering, textile, chemical, print and paper sectors of industry. Except for extensions to existing buildings, the smallest sprinkler installation was in a building of 23000 sq. ft. (2137m^2) and the average size of building protected was 65000 sq. ft. (6039m^2).

In recent years, changes in taxation, the re-introduction of regional grants and the increases in premium loading have all combined to reduce the size of building and value of contents where the cost of installation is recovered within a comparatively short space of time.

In the following summary of the Case Studies in Appendix C, assessment has been made of the financial return of installing automatic fire defence systems in buildings smaller than those in which such systems have normally been installed in the past.

The first single storey industrial building considered was a factory of 31150 sq. ft. (2894m^2) in floor area used for manufacturing plastic bottles and situated in a development area. However, the insurance premium for the building without any form of automatic fire defence amounted to £34384.00, whereas if a sprinkler installation is installed, the premium is reduced to £2995.00. Because of the high premium loading for an unprotected building, the initial cash flow resulting from the saving in insurance premium, as a result of installing a sprinkler system, is more than the initial capital expenditure as shown in Table 6. In addition, because of the risk involved,the insurance company would not consider providing insurance cover unless sprinklers were installed; for this reason a detailed Case Study was not undertaken.

Two other single storey industrial buildings were examined in detail, both were much smaller than the average size of sprinklered building. One of the buildings has a floor area of 1410m^2, which is slightly larger than the average size of non-sprinklered building where fire occurred in 1967, whilst the other building has a floor area of only 778m^2.

The building of 1410m^2, which forms Case Study No. 1, consists

Plastics - blown polythene 20% development grant No allowance for inflation				Discount rate 5%			Sprinkler Installation			TARIFF MARKET QUOTATION	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Saving in Premium £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	18400	30817	-	-	-	-	-	12417	12417	1.00	12417.00
1		30817	15409	18400	9200	3600	6209	28208	28208	0.952381	26864.76
2		30817	15409				15409	15408	15408	0.907029	13975.50
3		30817	15409				15409	15408	734	0.863838	634.06
4			15409				15409	(-15409)	-	-	-
									Net Present Value		£53891.32

Table 6 Cash flows resulting from the installation of a sprinkler system in a factory manufacturing plastic bottles.

Notes: (a) Cost of installation including storage of water on site - £18400.00

(b) Premium unsprinklered - £34384.00
Premium sprinklered - £ 2995.00
£31389.00
Additional cost due to installation £ 572.00
Saving in Premium £30817.00

of a single storey portal framed factory area, together with a small two storey office block. Situated in a development area, the building will replace existing premises and be used for the production of rubber stamps. The risk is classified by the insurance company as a non-tariff rubber risk. The saving in insurance premium resulting from the installation of a sprinkler system amounts to £1793.00 per annum. The premium is based upon an insured value of building and contents of £268000.00 together with consequential loss cover of £100000.00 for gross profit and £60000.00 for wages as shown in Case Study No. 1 - Appendix C. The capital cost of the sprinkler installation includes provision of a water main and control mechanism sufficiently large to allow for future extensions. The capital and running costs include allowances for a direct link to a centrally manned control and the monitoring of the sprinkler valves. When the figures in the case study are discounted at 5%, the installation shows a net present value of £3261.00 if the cash flows are discounted over 11 years, as shown in Table 7. The installation of an automatic detector system in place of a sprinkler installation apart from failing to give the same degree of protection, results in a negative net present value as shown in Table 8. The discounted cash flows resulting from the savings in premium do not equal the initial capital cost within a discount time of 13 years.

The building in Case Study No. 2 is situated in an Intermediate Development area and is used for the manufacture of overalls. Neither this building nor the building in the first detailed case study would obtain any reduction of insurance premium for their standard of construction. In common with many industrial buildings, use is made of lightweight cladding and both buildings are classed as worse than Standard of Construction V. In Case Study No. 2, quotations were obtained from both tariff and independent companies; the independent

No allowance for inflation 20% development grant Rubber stamp manufacturer				Discount rate 5%		NPV per m^2 = £2.31			Sprinkler installation with direct link	CASE STUDY No 1 TARIFF MARKET QUOTATION	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	6840	1304	-	-	-	-	-	(-5536)	(-5536)	1.00	(-5536.00)
1		1254	652	6840	3420	1220	-2768	5242	5242	0.952381	4992.38
2		1254	627				627	627	627	0.907029	568.71
3		1254	627				627	627	627	0.863838	541.63
4		1254	627				627	627	627	0.822702	515.83
5		1154	627				627	527	527	0.783526	412.92
6		1254	577				577	677	677	0.746215	505.19
7		1254	627				627	627	627	0.710681	445.60
8		1254	627				627	627	627	0.676839	424.38
9		1254	627				627	627	607	0.644607	391.27
10		1154	627				627	527	-	-	-
11			577				577	(-577)	-	-	-

Net Present Value £3261.92

Table 7 Cash flows resulting from the installation of a sprinkler system in a factory manufacturing rubber stamps - Case Study No. 1

Rubber stamp manufacturer No allowance for inflation 20% development grant				Discount rate 5%		NPV per m^2 = £-.84		Automatic detector system		CASE STUDY No 1 TARIFF MARKET QUOTATION	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5% £	NPV at 5% £
0	3908	26	-	-	-	-	-	(-3882)	(-3882)	1.00	(-3882.00)
1		26	13	3908	1954	770	-1941	2737	2737	0.952381	2606.67)
2		26	13				13	13	13	0.907029	11.79
3		26	13				13	13	13	0.863838	11.23
4		26	13				13	13	13	0.822702	10.69
5		26	13				13	13	13	0.783526	10.19
6		26	13				13	13	13	0.746215	9.70
7		26	13				13	13	13	0.710681	9.24
8		26	13				13	13	13	0.676839	8.80
9		26	13				13	13	13	0.644607	8.38
10		26	13				13	13	13	0.613913	7.98
11		26	13				13	13	13	0.584679	7.60
12		26	13				13	13	1	0.556837	.56
13		-	13				13	(-13)	-	-	-

Net Present Value £-1179.17

Table 8 Cash flows resulting from the installation of an automatic detector system in a factory manufacturing rubber stamps - Case Study No. 1

insurance company figures are slightly lower because according to the broker, the insurance company takes account of the good fire record of the firm. As shown in Tables 9 and 10, the cash flows resulting from the installation of a sprinkler system have been discounted at 5%. The installation pays for itself within two years when the tariff company figures are discounted and three years when the Independent company figures are used. It has been assumed that the Department of Trade and Industry would allow a 20% grant because the building is being "adopted". If, however, a grant were not payable then the financial return would be lower and the installation would not pay for itself until the fourth and sixth years according to whether the quotation was from the tariff or the independent company; this would also apply if the building were outside an assisted area.

A decision to install an automatic fire defence system must be based upon the expected length of time during which the building will be used for a specific purpose. In the course of a conversation with one broker it was stated that a number of clients were unwilling to outlay capital, because they expected to move into larger premises within a few years. Very often their expectations of expansion were more ambitious than later proved possible. A period of 11 years has been used for discounting the cash flows resulting from the installation of a sprinkler system in Case Studies 1 and 2. Eleven years is closer to the expected life of the plant within the building* than a length

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*The United States Bureau of Internal Revenue recognises depreciation lives varying from 8 years in the aircraft and electronic industries up to 14 years for the manufacture of rubber, glass and textile products. Source - Depreciation : Guidelines and Rules, publication 456 - U.S. Bureau of Internal Revenue, July 1972.

Overall Manufacturer 20% development grant No allowance for inflation				Discount rate 5%		NPV per m^2 = £2.21			Sprinkler Installation	CASE STUDY No 2 TARIFF MARKET QUOTATION	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash flow £	Discount rate 5% £	NPV at 5% £
0	2800	640	-	-	-	-	-	(-2160)	(-2160)	1.00	(-2160.00)
1		590	320	2800	1400	530	-1080	2200	2200	0.952381	2095.24
2		590	295				295	295	295	0.907029	267.57
3		590	295				295	295	295	0.863838	254.83
4		590	295				295	295	295	0.822702	242.70
5		490	295				295	195	195	0.783526	152.79
6		590	245				245	345	345	0.746215	257.44
7		590	295				295	295	295	0.710681	209.65
8		590	295				295	295	295	0.676839	199.67
9		590	295				295	295	295	0.644609	190.16
10		590	295				295	295	15	0.613913	9.21
11		-	295				295	(-295)	-	-	-
										Net Present Value	£1719.26

Table 9 Cash flows resulting from the installation of a sprinkler system in a factory manufacturing overalls - Case Study No 2 - Tariff Market

Overall Manufacturer 20% development grant No allowance for inflation				Discount rate 5%		NPV per m^2 = £1.19		Sprinkler Installation		CASE STUDY No 2 INDEPENDENT MARKET QUOTATION	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% Corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	2800	466	-	-	-	-	-	(-2334)	(-2334)	1.00	(-2334.00)
1		416	233	2800	1400	530	-1167	2113	2113	0.952381	2012.38
2		416	208				208	208	208	0.907029	188.66
3		416	208				208	208	208	0.863838	179.68
4		416	208				208	208	208	0.822702	171.12
5		316	208				208	108	108	0.783526	84.62
6		416	158				158	258	258	0.746215	192.52
7		416	208				208	208	208	0.710681	147.82
8		416	208				208	208	208	0.676839	140.78
9		416	208				208	208	208	0.644609	134.08
10		416	208				208	208	10	0.613913	6.14
11		-	208				208	(-208)	-	-	-
									Net Present Value		£923.80

Table 10 Cash flows resulting from the installation of a sprinkler system in a factory manufacturing overalls - Case Study No 2 - Independent Market quotation

of time which would approximate to the life of the building. The life of the building may be from 40 to 60 years. Installations which are regularly maintained will have a residual value, provided that when the building is sold account is taken of the installation. The calculation of residual value has, however, been disregarded because of uncertainty over the length of life of both building and installation, but it is a factor which if taken into account would increase the net present value of the installation.

The buildings in Case Studies 1 and 2 could be used for a wide range of industrial purposes. Provided the water supply requirements are similar, the cost of installing a system of automatic fire defence and the subsequent running costs should be identical. The change of use and the value of contents and consequential cover being the only variable factors. The figures relating to Case Study No. 2 have been used as the basis for assessing the economic viability of installing a sprinkler system in the building, assuming it was used for the following purposes:-

(i) Light Engineering.
(ii) Light Engineering associated with plastics.
(iii) Printing.
(iv) Rubber stamp manufacturing.
(v) Radio/TV assembly.
(vi) Hosiery (knitwear) manufacturing.
(vii) Boot and Shoe manufacturing.

The tariff insurance rates per £100 of insured value and consequential loss for the various industries are shown in Fig. 33 and the assumed value of contents, gross profit and wages are shown in Fig. 32.

ASSUMED VALUES RELATING TO MANUFACTURING USES OF CASE STUDY NO. 2

Manufacturing Use	Insured Value of Building £	Insured Value of Contents £	Insured Gross Profit £	Insured Wages £
Light Engineering	59400	54950	36000	60000
Light Engineering and Plastics	59400	54950	36000	60000
Printing	59400	75000	36000	40000
Rubber Stamp Manufacturing	59400	75000	36000	40000
Radio/TV assembly	59400	75000	36000	40000
Hosiery (Knitwear) Manufacturing	59400	75000	36000	40000
Boot and Shoe Manufacturing	59400	75000	36000	40000

Fig. 32 Insured values for the various manufacturing uses of Case Study No 2.

The insured figures for building value and gross profit in Case Study No. 2 have been used for all the manufacturing uses. Case Study No. 2 figures for contents and wages have also been used for Light Engineering and Light Engineering associated with Plastics. The other industrial uses are considered to be more capital intensive and to allow for this the wages have been reduced by £20000.00 and the contents increased by £20000.00. The calculation of the net present value for the various manufacturing uses is shown in Appendix D and summarised in Fig. 34.

TYPE OF RISK	NON-SPRINKLERED BUILDING								SPRINKLERED BUILDING									
	FIRE			CONSEQUENTIAL LOSS					FIRE				CONSEQUENTIAL LOSS					
	RATE	Fire Extinguisher Allowance	Scale of Percentage Adjustment	RATE	Fire Extinguisher Allowance	Consequential Loss Rating Adjustment	Gross Profit	WAGES	RATE	Fire Extinguisher Allowance	Trade Discount	Scale of Percentage Adjustment	RATE	Fire Extinguisher Allowance	Trade Discount	Sprinkler Discount	GROSS PROFIT	WAGES
LIGHT ENGINEERING	.15p	-10%	+50%	. 15p	-10%	+10%	150%	81%	.15p	-42½%	-	-20%	.15p	-42½%	-	-⅓rd	150%	81%
LIGHT ENGINEERING AND PLASTICS	.275p	-10%	+50%	.275p	-10%	+10%	150%	81%	.275p	-42½%	-	-20%	.275p	-42½%	-	-⅓rd	150%	81%
PRINTING	.275p	-10%	+25%	.275p	-10%	+75%	150%	81%	.275p	-37½%	-	-20%	.275p	-37½%	-	-⅓rd	150%	81%
RUBBER STAMP MANUFACTURER	. 25p	-10%	+150%	. 25p	-10%	-	150%	81%	.25p	-50%	-	-20%	.25p	-50%	-	-⅓rd	150%	81%
RADIO/TV ASSEMBLER	. 20p	-10%	+150%	. 20p	-10%	+75%	150%	81%	.20p	-42½%	-	-20%	.20p	-42½%	-	-⅓rd	150%	81%
HOSIERY (KNITWEAR) MANUFACTURER	. 20p	-10%	+500%	. 20p	-10%	+175%	150%	81%	.20p	-45%	-	-20%	.20p	-45%	-	-⅓rd	150%	81%
BOOT AND SHOE MANUFACTURER	.325p	-10%	+400%	.325p	-10%	+50%	150%	81%	.325p	-45%	-33⅓%	-20%	.325p	-45%	-33⅓rd	-⅓rd	150%	81%

Fig 33 Insurance rates for various industrial uses of the building in Case Study No 2 - Appendix C.

Source - Interview with Tariff Company Representative

SUMMARY OF APPENDIX D

Manufacturing Use	Length of time for cash flows to equal installation cost	Net Present Value over 11 years	$\frac{NPV}{m^2}$	Average rate per £100.00 of combined insurance cover
Light Engineering	-	£-527	£-0.68	0.191p%
Light Engineering and Plastics	end of the 6th year	£ 412	£ 0.53	0.335p%
Printing	end of the 4th year	£ 693	£ 0.89	0.375p%
Radio/TV assembly	end of the 2nd year	£1490	£ 1.92	0.417p%
Rubber Stamp Manufacturing	end of the 2nd year	£1746	£ 2.25	0.452p%
Hosiery (Knitwear) Manufacturing	end of the 1st year	£6096	£ 7.84	0.893p%
Boot and Shoe Manufacturing	end of the 1st year	£8160	£10.49	1.114p%

Fig. 34 Summary of Appendix D showing net present value per square metre and the average rate of combined insurance cover.

When the net present value per square metre of floor area $(\frac{NPV}{m^2})$ is plotted against the average rate per £100.00 of combined insurance cover* for the building, contents and consequential loss, as

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*The average combined cost of insurance is calculated by dividing the premium income by the total of the sums insured and expressing the figure as a rate per £100 as follows:

$$\frac{\text{Premium}}{\text{Sum insured}} \times \frac{100}{} = p\%$$

shown in Fig. 35, all the manufacturing uses of the building, with the exception of light engineering, show a positive net present value per square metre when a 20% development grant is allowed. The break-even point (zero NPV) occurs when the combined insurance rate is approximately .26p%. If the building is outside an assisted area, the break-even point (zero NPV) would be approximately .30p% as shown in Fig. 36 and all the manufacturing uses considered except light engineering and light engineering associated with plastics would show a positive net present value per square metre of floor area.

The insurance rates in Fig. 33 are all based upon the building in Case Study No 2, which has a standard of construction worse than Standard V. Higher standards of construction in industrial buildings can generally only be achieved by increasing the cost of construction. This is not true with all forms of construction, particularly multi-storey buildings, where the construction necessary to comply with the requirements of the Building Regulations will enable reductions to be obtained from the basic insurance rate, with little or no extra constructional cost.

The effect of a tariff on an insurance rate, as seen in Chapter 2[8.6], is to penalise the bad features and to allow discounts for the good and this is particularly true in the Shop's Tariff which is now examined in more detail. Case Studies No 3 and 4 (Appendix C) are both retail premises covered by the Shop's Tariff.

The Shop's Tariff is a private and confidential document and the following information relating to the tariff has been obtained as a result of interviews with representatives of tariff insurance companies. The risk involved in the insurance of retail premises varies according to the type of merchandise being sold and the number of assistants

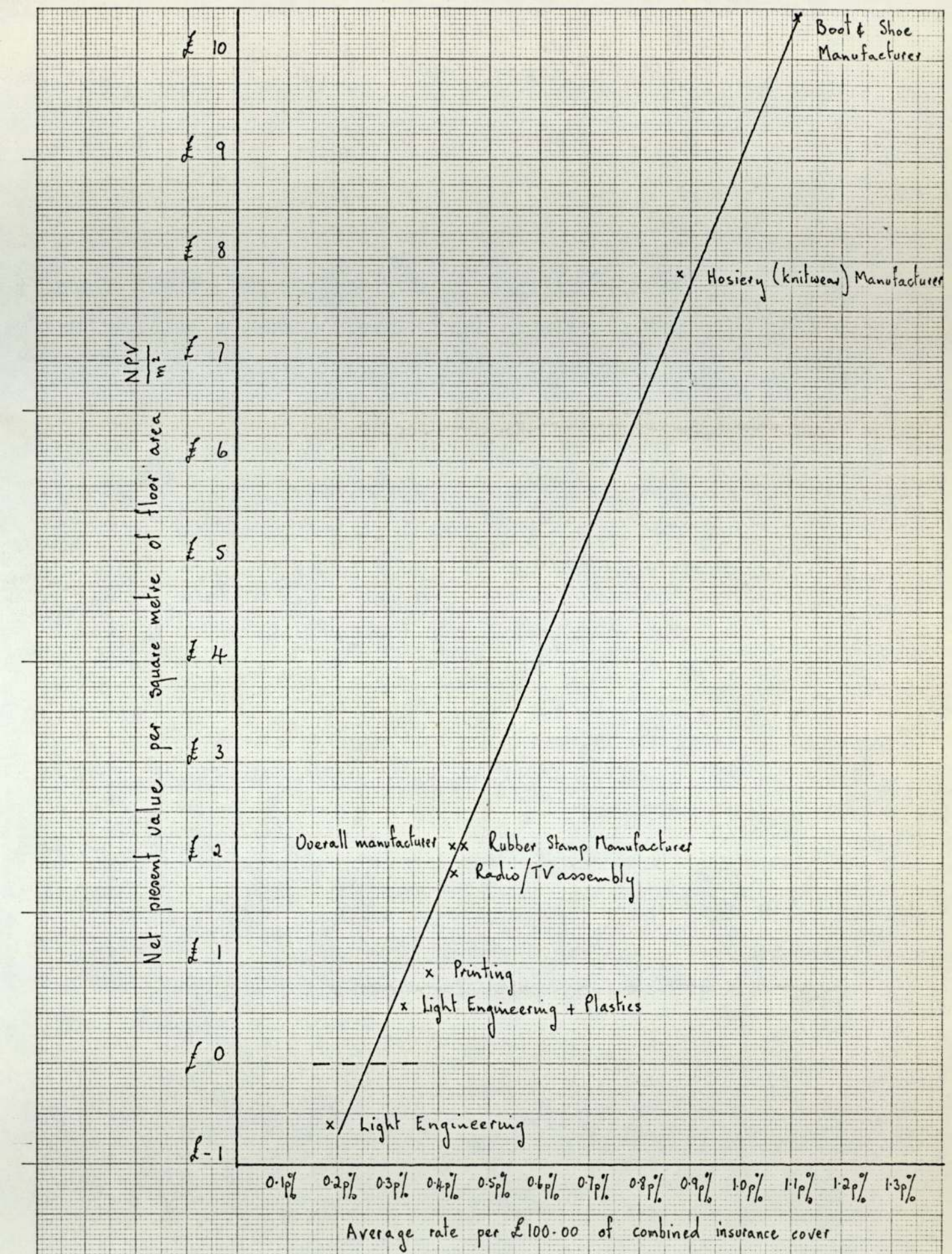

Fig: 35 Relationship between net present value per square metre of floor area and the average rate per £100·00 of combined insurance cover for the various industrial uses of the building which forms Case Study No 2 - in an assisted area.

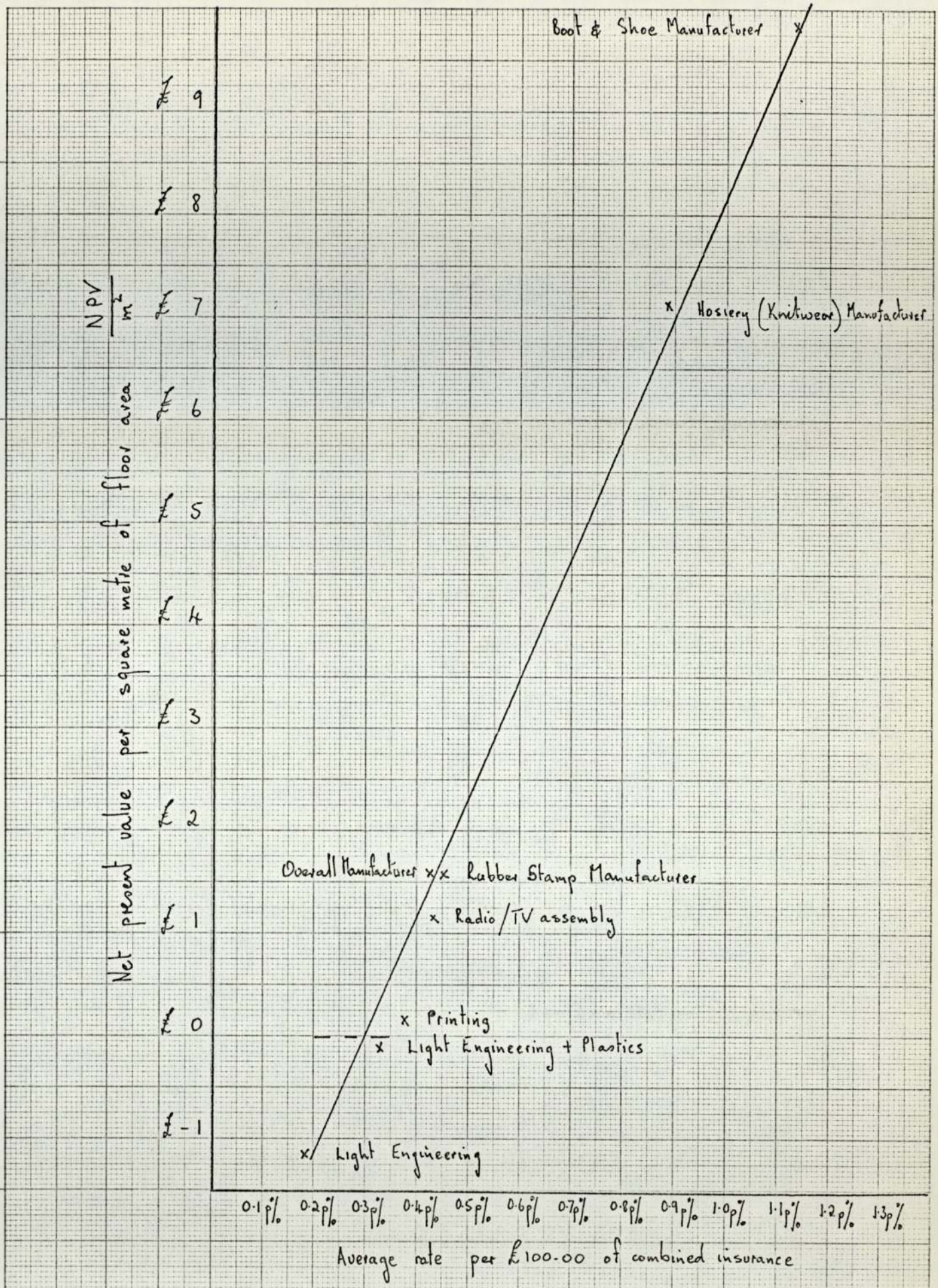

Fig: 36 Relationship between net present value per square metre of floor area and the average rate per £100·00 of combined insurance cover for the various industrial uses of the building which forms base Study No 2 — building outside an assisted area.

employed. The Shop's Tariff reflects these risks, firstly by grouping furniture, drapery and carpet shops together and charging a basic rate of 0.175p%, while rating all other shops at a basic rate of 0.10p%. Secondly by an addition to the basic rate of a percentage based upon the number of assistants employed as shown below:-

ADJUSTMENT TO BASIC RATE FOR NUMBER OF EMPLOYEES

Number of assistants	Addition to the basic rate
below 20 assistants	no addition to the basic rate
20 - 35 assistants	0.05p% added
35 - 50 assistants	0.075p% added
50 - 75 assistants	0.1125p% added
75 - 100 assistants	0.1375p added
100 - 150 assistants	0.175p% added
150 - 200 assistants	0.20p% added
over 200 assistants	0.225p% added

Fig. 37 Adjustment to basic insurance rate for number of employees.

Source - Interview with Tariff Company Representative.

The difference in the basic rate for furniture, carpet and drapery shops compared with other shops is comparatively small. It is however the scale of percentage adjustments applied to unsprinklered buildings which increased the premium as shown below:

SCALE OF PERCENTAGE ADJUSTMENT RELATED TO NUMBER OF EMPLOYEES

Class of Shop	Number of assistants	Scale of Percentage Adjustment
Drapery Shops	up to 20 assistants	+ 30%
	20 - 50 assistants	+ 50%
	50 - 100 assistants	+ 100%
	over 100 assistants	+ 750%
Furniture and carpet shops	regardless of the number of assistants	+ 150%
All other shops	regardless of the number of assistants	+ 15%

Fig. 38 Adjustment of insurance premium resulting from number of employees.

Source - Interview with Tariff Company Representative.

The effect on an insurance premium of the installation of a sprinkler system is to remove the scale of percentage adjustment. In addition the installation permits a discount off the basic rate of between 30% and 45% according to the classification of the water supply*, with a further discount of 20% for the satisfactory performance of sprinkler systems in the past. The overall effect on the premiums of sprinklered and non sprinklered buildings is shown in Fig. 39.

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*A grade III water supply (29th Rules of the FOC para 2210.3) would obtain a 30% reduction whereas a superior water supply (29th Rules of the FOC para 2220)[8.8] would allow a 45% discount.[8.7]

COST OF INSURANCE COVER PER £10000.00 OF INSURED VALUE

Class of Building	Number of Assistants	Non-Sprinklered Building		Sprinklered Building	
		Basic rate and adjustments	Cost per annum of insurance per £10000.00	Basic rate and adjustments	Cost per annum of insurance per £10000.00
Other shops	20 - 35	0.15p% + 15% =0.1725p%	£ 17.25	0.15p%-30%-20% =0.084p%	£8.40
Furniture Shops	20 - 35	0.225p% + 150% =0.5625p%	£ 56.25	0.225p%-30%-20% =0.126p%	£12.60
Other shops	100 - 150	0.275p% + 15% =0.31625p%	£ 31.63	0.275p%-30%-20% =0.154p%	£15.40
Drapery shops	100 - 150	0.35p% + 750% =2.975p%	£297.50	0.35p%-30%-20% =0.196p%	£19.60

Fig. 39 Cost of insurance cover for sprinklered and non sprinklered buildings per £10000.00 of insured value.

Source - Interview with Tariff Company Representative.

The difference between the insurance premiums of non-sprinklered and sprinklered buildings is appreciable and as shown in Fig. 39 gives premium reductions varying from 51% for a shop with 20 to 35 assistants to as high as 94% for a drapery shop with 100 to 150 assistants. These premium savings do not take account of additional discounts for ordinary fire extinguishers, long-term agreements or standards of construction; all of which are deducted from the basic rates of both non-sprinklered and sprinklered buildings. The additional discounts, although reducing the premiums payable, have the effect of reducing the difference in premium between non-sprinklered and sprinklered buildings. In the case of non-sprinklered buildings, they reduce the rate to which the scale of percentage adjustment is added, and for sprinklered buildings reduce the basic rate before the discounts are taken off.

The discounts for compliance with the Rules of the Fire Offices' Committee for Standard III, IV and V Construction[8.9] in the Shop's Tariff are as follows:-

DISCOUNTS FOR COMPLIANCE WITH FOC STANDARDS OF CONSTRUCTION

Standard of Construction	Building	Contents
III	25%	12½%
IV	20%	10 %
V	10%	5 %

Fig. 40 Discounts for compliance with FOC Standards of Construction

Note - In the case of drapery shops, the rate after construction allowances must not fall below .175p%

Source - Interview with Tariff Company Representative

In addition to the above discounts, compliance with the Rules of the Fire Offices' Committee for Standards of Construction also affects the scale of percentage adjustments resulting in considerable reductions as shown in Fig 41.

STANDARDS OF CONSTRUCTION AND THEIR EFFECT ON THE

SCALE OF PERCENTAGE ADJUSTMENT

Class of shop	Standard of Construction	Scale of Percentage Adjustment (S of PA)	
Drapery	III	up to 20 assistants	+ 15%
		20 - 50 assistants	+ 25%
		50 - 100 assistants	+ 50%
		over 100 assistants	+100%
	IV	up to 20 assistants	+ 20%
		20 - 50 assistants	+ 25%
		50 - 100 assistants	+ 50%
		over 100 assistants	+150%
	V	no alteration of rate	-
Furniture and Carpet Shops	III	regardless of the number of assistants	+ 50%
	IV	regardless of the number of assistants	+ 75%
	V	no alteration of rate	-
Other Shops	III	building - no percentage adjustment contents - no alteration of rate	-
	IV	no alteration of rate	-

Fig. 41 Alterations to the Scale of Percentage Adjustments for compliance with FOC Standards of Construction.

Source - Interview with Tariff Company Representative.

Additional discounts would also be given for buildings complying with

Standard I or II Construction, but generally these can be ignored because of the heavy forms of construction necessary to comply with the standards. For shops with single sales floors, it should be possible to achieve Standard III Construction with little or no additional cost. Where escalators, staircases or lifts are necessary to carry the flow of traffic between sales floors, the floor openings must be entirely enclosed by walls of half brick thickness, 100mm concrete or 75mm reinforced concrete. In addition, all openings through the walls must be protected by fireproof doors as detailed in section 3 of Standard III Construction[8.10]. To achieve Standard IV Construction, it is also necessary for openings in floors to be surrounded by incombustible walls but these need only be 50mm thick. All openings in the incombustible walls being protected by doors.[8.11]

The premiums per £10000.00 of value insured shown in Fig. 42 will be subject to considerable adjustment if it is assumed that Standard IV Construction can be achieved and that a 10% discount for ordinary fire extinguishing appliances* and 5% discount for a long term agreement will be obtained. The effect of these discounts upon the premiums in Fig. 39 are shown in Fig. 42. The effect of discounts, particularly the reduction in the Scale of Percentage Adjustment for compliance with Standard IV Construction, is considerable. The greatest reduction occuring in the premiums of drapery, furniture and carpet shops; in particular those where more than 100 assistants are employed.

The majority of departmental stores because they retail a high proportion of clothing as well as carpets and furniture are rated as

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*The 10% discount in this tariff only applies to the sprinklered building.

COST OF INSURANCE COVER PER £10000.00 OF INSURED VALUE

Class of Building	Number of assistants	Non-Sprinklered Building		Sprinklered Building	
		Basic rate and adjustment	Cost per annum of insurance per £10000.00	Basic rate and adjustment	Cost per annum of insurance per £10000.00
Other shops	20 - 35	.15p%-20%+15%-5% =.1311p%	£13.11	.15p%-20%-40%-20%-5% =.060p*%	£ 6.00
Furniture Shops	20 - 35	.225p%-20%+75%-5% =.29925p%	£29.92	.225p%-20%-40%-20%-5% =.08208p%	£ 8.20
Other shops	100 -150	.275p%-20%+15%-5% =.2403p%	£24.03	.275p%-20%-40%-20%-5% =.10032p%	£10.03
Drapery shops	100 - 150	.35p%-20%+150%-5% =.665p%	£66.50	.35p%-20%-40%-20%-5% =.12768p%	£12.77

Fig. 42 Cost of insurance for non-sprinklered and sprinklered buildings per £10000.00 of insured value, assuming Standard IV Construction, 10% discount for ordinary extinguishing appliances, 5% discount for long term agreement and a Grade III water supply for the sprinkler installation.

*The minimum tariff rating is .075p% except that the 20% sprinkler discount can reduce the figure below the minimum tariff rating, the 5% long term agreement would have no effect.

drapery shops. In some instances, the decision taken by the Insurance Company whether a particular risk should be included in the furniture, carpets and drapery category or as 'other shops', will depend upon the number and size of the retail outlets involved and the past fire history of the company.

The building in Case Study No. 3 is one of the smallest that the retail company would normally operate, having a total floor area of 1594m^2, comprising ground floor sales area and first floor stock and staffrooms. The building is smaller than the size of building affected by Building Regulation E5* concerned with the compartmentation of shop premises. The building in Case Study No. 3 relates to a store within a chain of over 1200 retail premises. The retail company's insurance rate per £100.00 of building contents is 0.2125p% + 15% less LTA‡ 5%. The basic insurance rate indicates that the merchandise, although it includes a proportion of drapery as well as carpets and furniture in the larger stores, is largely of a general household nature and is rated by their insurers as "other shops". The insurance rating is standard for the whole chain of stores, no adjustment is made for the number of assistants employed or the size of building.

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*The Building Regulations 1972[8.12] under Regulation E5, Part I Table A - purpose group V dealing with shop premises states that the maxiumum size of compartment shall not exceed 2000m^2 or 7000m^3. The exception being a building which is fitted throughout with an automatic sprinkler system complying with the relevant recommendations of CP402201 : 1952, in which case the maximum limits of compartment size can be doubled.

‡The 5% discount for a long term agreement (LTA) is common insurance practice.

The installation of a sprinkler system in the case study building results in cash flows which produce a negative net present value, even when the installation is assumed to have a life of 40 years. There are a number of reasons why the installation does not result in cash flows that produce a positive net present value. Firstly, the company does not insure for consequential loss; being prepared to carry the consequences of a fire without insurance. Secondly, due to the size of the company, the insurance rate is advantageous and although the company sells a considerable volume of drapery, they are classed as "other shops". In addition, the rate is based on a store employing 50 - 75 persons; whereas between 75 - 100 persons would be employed. Finally, although in a Development Area, retail premises are classed as a service industry and are not therefore eligible for Regional Aid. However, 100% of the capital cost of the installation can be offset against taxation.

When assumed figures for gross profit per annum amounting to £150000.00 and wages of £110000.00 are insured for consequential loss, the installation pays for itself in thirteen years. If the building were insured under the drapery shops' tariff with the same consequential loss figures, the "break even point" would occur at the end of the seventh year. A summary of Case Study No 3 for the different assumptions is shown in Fig 43.

In recent years, there have been a number of developments in retailing which have had their effect on the economics of fire protection. Firstly, there has been an increase in cash and carry warehouses, where large discounts are offered to the public and display and presentation are at a minimum. Secondly, the move towards central area shopping precincts involving the construction of large and complex buildings and thirdly the out of town shopping complex - the ultimate

SUMMARY OF CASE STUDY NO 3

Classification of Insurance	Amounts insured				Length of Time for installation to result in a zero NPV
	Building £	Contents £	Consequential Loss		
			Gross Profit £	Wages £	
"Other Shops"	228690	92000	-	-	-
"Other Shops"	228690	92000	150 000	110000	end of thirteenth year
"Drapery"	228690	92000	150 000	110000	end of the seventh year

Fig. 43 Case Study No. 3 - Length of time for cash flows resulting from the installation of a sprinkler system to produce a zero NPV.

being the "hypermarket".

Case Study No. 4 is a proposed building for a retailing organisation who intend to sell furniture directly to the public from their new premises, which will also be their distribution centre. The building is out of the main shopping area and is of steel portal framed shed construction. The insurance company were undecided whether the building should be rated as retail premises or as a warehouse. Their preference is for a warehouse, although it is the intention to set out the furniture to form a series of room settings. This arrangement of the furniture results in a cost of contents which is low compared with the overall building cost. If the insurance company rate the building as retail premises, then the unsprinklered rate would be 0.4375p% (0.175p% + 150%). When classed as a warehouse the rate increases to £1.125p% (0.25p% - 10% + 400%). The sprinkler installation resulted in premium savings which produced cash flows leading to a zero NPV at the end of the seventeenth year, when the building is rated as retail premises. When rated as a warehouse a

zero NPV occurs at the end of the second year as shown in Fig. 44.

A number of central area developments have been completed in recent years, many of which have no system of automatic fire defence. The Fire and Local Authorities, however, are becoming increasingly concerned at the risks involved as a result of fires in shopping precincts in Wolverhampton[8.13] as well as in the United States[8.14]. The installation of a system of automatic fire defence can be complex, in a building which is divided into a number of separate units, and must be considered at a very early stage in the design. Apart from allowing larger compartment size, the installation of a sprinkler system permits greater freedom in design as outlined in "Fire precautions in town centre redevelopment".[8.15]

The alternative to a sprinkler system in retail premises would be the installation of detector system. A quotation was obtained for the installation of a combined smoke/heat detector system in the building that forms Case Study No. 3. The high annual cost of the direct link resulted in cash flows that were too small to produce a positive NPV as shown in Fig. 45; where the section of the Case Study dealing with the installation of an automatic detector system is summarised.

In Case Study No. 3, the annual rental of the direct link amounts to £160.00 per annum even though the building is less than a mile from the fire station. Unfortunately this fire station does not have a manned control for 24 hours a day and the signal is routed to the County Fire Headquarters, which is 25 miles away, using the VFA system. If the fire station were manned, then the rental would be £32.00 per annum but the return on the initial investment would still not be comparable to that of a sprinkler installation.

SUMMARY OF CASE STUDY NO 4

Classification of Insurance	Amounts Insured				Length of time for cash flows to result in a zero NPV	$\frac{NPV}{m^2}$ based on 18 years life of building
	Building	Contents	Consequential Loss			
			Gross Profit	Wages		
Retail Premises (Furniture)	192500	50000	130000	20000	end of the 17th year	zero
Warehouse	192500	50000	130000	20000	end of the 2nd year	£3.52

Fig. 44 Case Study No. 4 - Length of time for cash flows resulting from the installation of a sprinkler system to produce a zero NPV.

INSTALLATION OF AN AUTOMATIC DETECTOR SYSTEM - SUMMARY OF CASE STUDY NO. 3

Classification of Insurance	Amounts insured				NPV based $\frac{}{m^2}$ on 18 year life of installation
			Consequential Loss		
	Building £	Contents £	Gross Profit £	Wages £	
"Other Shops"	228 690	92 000	-	-	£-1.74
"Other Shops"	228 690	92 000	150 000	110 000	£-1.46
"Drapery"	228 690	92 000	150 000	110 000	£-1.09

Fig. 45 Case Study No. 3 - Negative present values per square metre resulting from the installation of an automatic detector system.

The satisfactory performance of sprinkler systems in retail premises is supported by statistics from numerous sources. The records of one leading manufacturer published in 1957[8.16], show that over 70% of fires in departmental stores were controlled by the operation of only 1 sprinkler head. The Australian Fire Protection Association has published a unique record of all fires that have occurred in sprinklered buildings in Australia and New Zealand between 1886-1968.[8.17] Fig. 46 shows details of the 888 recorded fires in Australian and New Zealand retail premises and warehouses, of which 886 were satisfactorily extinguished by a sprinkler installation. The association's records also show the causes of the 374 fires, which occurred in departmental stores during the same period. The causes of fire together with the performance of the sprinkler installations are listed in Fig. 47.

The insurance premiums of buildings covered by the United Kingdom Shop's tariff will be considerably reduced, both in basic rate and scale of percentage adjustment as shown in Figs. 40 and 41, if the buildings are constructed in accordance with Standards of Construction III and IV. In addition, Standards of Construction III and IV can often be achieved, particularly in multi-storey buildings, with comparatively small increases in constructional costs.

An increase in the standard of construction of industrial buildings will lead to a reduction in the basic rate of insurance, but will not affect the scale of percentage adjustment. Single storey industrial buildings which comply with Standards of Construction III and IV or are designed to resist fire[8.20] will, in general, be more expensive than industrial buildings where the standard of construction is worse than Standard V.

GENERAL OCCUPANCY ANALYSIS

Occupancy Group	No of Fires	Total Unsatisfactory	Total Satisfactory	Satisfactory %	Loss of Life	Number of sprinklers in operation											Greatest number of sprinklers in operation (excluding unsatisfactory	Average number in operation (excluding unsatisfactory)
						1	2	3	4	5	6	7	8	9	10	over 10		
MERCANTILE																		
Chain Stores	42	Nil	42	100	Nil	29	10	1	-	-	-	1	-	1	-	-	9	1.6
Department Stores	374	2	372	99.58	Nil	273	56	18	8	2	4	-	-	1	-	12 (2 uns)	149	2.8
Fancy goods	3	Nil	3	100	Nil	2	-	1	-	-	-	-	-	-	-	-	3	1.7
Hardware retail	35	Nil	35	100	Nil	26	9	-	-	-	-	-	-	-	-	-	2	1.3
Jewellers	1	Nil	1	100	Nil	1	-	-	-	-	-	-	-	-	-	-	1	1.0
Multiple occupancies	250	Nil	250	100	Nil	193	34	12	4	1	-	1	-	1	-	4	23	1.6
Shoe Shops - retail	5	Nil	5	100	Nil	4	1	-	-	-	-	-	-	-	-	-	2	1.2
Shops - general	36	Nil	36	100	Nil	27	7	2	-	-	-	-	-	-	-	-	3	1.3
Sports Goods - retail	4	Nil	4	100	Nil	3	-	1	-	-	-	-	-	-	-	-	3	1.5
Supermarkets	1	Nil	1	100	Nil	-	1	-	-	-	-	-	-	-	-	-	2	2.0
Warehouses -																		
Electrical	11	Nil	11	100	Nil	11	-	-	-	-	-	-	-	-	-	-	1	1.0
Fancy goods	14	Nil	14	100	Nil	10	2	1	-	-	-	-	-	-	-	1	154	12.2
General	35	Nil	35	100	Nil	21	4	5	3	-	-	-	1	-	-	1	12	2.2
Hardware	42	Nil	42	100	Nil	31	4	4	2	1	-	-	-	-	-	-	5	1.5
Music	5	Nil	5	100	Nil	1	3	1	-	-	-	-	-	-	-	-	3	2.0
Softgoods	30	Nil	30	100	Nil	21	5	1	1	-	-	-	-	-	-	2	21	2.5

Fig. 46 Fires in Australian and New Zealand sprinklered retail premises and warehouses occurring between 1886-1968[8.18]

DETAILED OCCUPANCY ANALYSIS

Occupancy	No of fires	Number of sprinkler Heads in operation		Average Number of Heads in Operation	Cause of Fire and number		Part of Building in which Fire Occurred		% of Satisfactory Performances	% of Unsatisfactory Performances	Loss of Life	Hazards peculiar to occupancy
		Heads	Fires		Cause	No	Floor	Fires				
Department Stores	374	1	272	2.8 (excluding unsatisfactory)	Decomposition of Celluloid,	7	Basement	71	99.47	0.53	Nil	Bulk storage of flammables,
		2	57		Electrical/ appliances,	87	Ground	125				Electrical switchboards,
		3	18		Engine exhausts,	1	Mezzanine	2				Escalators,
		4	8		Exposure,	11	First	42				Electrical and gas appliances,
		5	2		Flammable liquids,	19	Second	27				Incinerators,
		6	4		Flues (hot),	1						Kitchen equipment (e.g. deep fryers),
		9	1		Fluorescent lighting,	5	Third	23				Lifts,
		13	1		Friction,	4	Fourth	25				Lighting fixtures,
		14	1		Gas appliances,	11						Refrigerators,
		15	1		Heating equipment,	1	Fifth	33				Rubbish collection and disposal.
		19	1		Hot ashes,	3	Sixth	14				
		24	1		Incendiarism,	13						
		31	1		Incinerators,	50	Seventh	6				
		49	1		Kerosene heaters,	3	Eighth	2				
		84	1		Petroleum gas,	1						
		130	1		Open flames,	1	Ninth	4				
		149	1		Overheating,	9						
		Uns	2		Refrigerators,	9						
					Smoking,	74						
					Spontaneous ignition,	19						
					Welding	14						
					Not recorded	31						

Fig. 47 Causes and control of fires occurring in sprinklered Departmental Stores in Australia and New Zealand between 1886-1968[8.19]

347 fires or 92.9% were extinguished by the operation of 3 sprinkler heads or less.

The financial return from increased constructional standards, in industrial and retail premises, is an area requiring investigation and does not form part of this study.

Merrett Cyriax Associates[8.21], as a result of a survey of fires costing more than £40000.00 occurring between 1966 and 1969, concluded that:-

> "a high proportion of the sampled large fires occurred in "unusual circumstances" falling outside normal procedures"[8.22].

One of the unusual circumstances mentioned was the temporary non-functioning of sprinklers, which were inoperative because of maintenance. Merrett Cyriax argued that because of the close relationship between fire incidence and "unusual circumstances", any effective fire protection must rely on:

> "fire resistance qualities which are in some degree fool-proof. This appears a fundamental advantage of structural fire protection as opposed to sprinklers (requiring a constant water supply), and detectors (requiring unfailing power)"[8.22].

The sample of 56 "large fires" upon which Merrett Cyriax based their findings included 3 buildings where sprinklers had been installed in areas where a fire occurred. In two of the buildings, the sprinklers successfully controlled the fire; whereas in the third building the water supply had been turned off for maintenance and inspection of the sprinkler installation. The estimated cost of the fire was £2.9 million.[8.23]

Considering the comparatively small number of sprinklered buildings in the survey, the conclusions drawn by Merrett Cyriax

do appear to be biased, particularly the reference to:

> "The limitations on sprinklers should be noted however, in that these were found to be no complete substitute for effective structural protection".[8.24]

In 1972,[8.25] 60% of "large fires" were discovered outside normal working hours and analysis of 23 of the largest fires, shows that all the buildings were unsprinklered. The basic object of a sprinkler installation is to prevent a fire from developing, particularly when the building is unoccupied. It is unlikely that conclusions as to the effectiveness of sprinkler installations can be drawn from a survey of fires costing more then £40 000.00 where 94.5% of the buildings are unsprinklered.

Capital expenditure on automatic fire defence, in particular sprinkler installations, should ensure that fire is prevented from developing; whereas capital expenditure on structural protection may confine a fire or prevent a building from collapsing due to the effect of fire, it does nothing to help put the fire out and the subsequent damage may be costly to reinstate. A case study, concerned with the reinstatement of a multi-storey concrete framed building after fire damage, is contained in "Fire and Buildings".[8.26] It is noted that after structural reinstatement had been undertaken a sprinkler installation was installed in the building.

Although the role of structural fire protection and compartmentation cannot be denied. The financial returns from an investment in a sprinkler installation are such that they must be given careful consideration at the design stage by the Quantity Surveyor and others concerned with the economic appraisal of buildings.

Chapter 8

NOTES

8.1 G. Ramachandran, An Enquiry into the Frequency of Sprinklered Premises, (Fire Research Station : Fire Research Note No. 828, May 1970) p.5.

8.2 G. Ramachandran, National Expenditure on Sprinkler Installations (Fire Research Station : Fire Research Note No. 906, December 1971) p. 1.

8.3 Ibid., p. 2.

8.4 Central Fire Liaison Panel, Fire Defence cost or saving? Fact Sheet, 1973 (London : Central Fire Liaison Panel).

8.5 Research Services Ltd, Company Attitudes to Installation of Automatic Fire Prevention/Detection Systems - Unpublished survey for the Central Fire Liaison Panel (London : Research Services Ltd, August, 1970) pp. 1-162.

8.6 Supra, Chapter 2 pp. 23- 25.

8.7 Fire Offices' Committee, Rules for Automatic Sprinkler Installations 29th edition (London : Fire Offices' Committee, December, 1968) p. 23.

8.8 Ibid., p. 23.

8.9 Fire Offices' Committee, Standards of Construction III, IV and V with amendments (London : Fire Offices' Committee 1959).

8.10 Fire Offices' Committee, Standard of Construction III; op, cit, pp. 2-4.

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8.11 Fire Offices' Committee, Standard of Construction IV; op, cit, pp. 2-4.

8.12 Great Britain, The Building Regulations 1972. (London : Her Majesty's Stationery Office : 1972) pp. 42-43.

8.13 "Britain's first large fire in a modern shopping precinct". Fire Prevention. No 93, (December 1971) pp. 36-38.

8.14 E. W. Marchant, ed. Fire and Buildings (Lancaster : Medical and Technical Publishing Co. Ltd., 1972) p. 229.

8.15 Great Britain, Home Office, Scottish Home and Health Department, Fire Prevention Guide - Fire precautions in town centre redevelopment (London : Her Majesty's Stationery Office 1972) pp. 7-9.

8.16 "Fires in Department Stores", The Sprinkler Bulletin No. 190 (House Magazine of Mather and Platt Ltd, Manchester) (31st December, 1957) pp. 1791-1795.

8.17 H. W. Marryatt, Fire - Automatic Sprinkler Performance in Australia and New Zealand 1886-1968, (Melbourne: Australian Fire Protection Association, 1971) pp. 1-540.

8.18 Ibid., p. 105.

8.19 Ibid., pp. 134-135.

8.20 J. C. M. Forrest, "A warehouse to resist fire" Concrete (August, 1969) pp. 315-323.

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8.21 Merrett Cyriax Associates, The Role of Structural Fire Protection (London : Cement and Concrete Association, November, 1969) pp. 1-140.

8.22 Ibid., p. 3.

8.23 Ibid., pp. 139-140.

8.24 Ibid., p. 33.

8.25 "An analysis of the £10000 plus fires in 1972". Fire Prevention No. 101 (January, 1974) pp. 39-46.

8.26 E. W. Marchant, ed, Fire and Buildings, op. cit. pp. 189-204.

Chapter 9

Conclusions

Selection of a System of Automatic Fire Defence - Financial Benefits resulting from the Installation of a Sprinkler System - Additional Benefits.

Current taxation allowances, the level of government grants and increases in insurance premiums for unprotected buildings, can all combine to make the installation of a system of automatic fire defence an economic proposition in addition to protecting a continually increasing number of industrial and commercial buildings.

To obtain a discount from a tariff company insurance premium, as a result of installing a system of automatic fire defence, the system must be FOC approved. Because of this requirement the choice of system, with few isolated exceptions[9.1], will be limited to the installation of automatic detectors or sprinklers.

The installation of FOC approved automatic detectors does not however reduce the insurance premium to the same extent as the installation of sprinklers. In Case Studies 2 and 3 Appendix C, the low rate of discount obtained from the installation of a detector system, together with the high annual rental cost of alarm communication, resulted in cash flows which were much smaller than those obtained from the installation of sprinklers. The installation of automatic detectors is not therefore considered economic in buildings where a high insurance discount can be obtained from installing a sprinkler system; this applies particularly to industrial buildings.

The Holroyd report[9.2], however, recommended the use of detector

systems where life could be endangered as a result of fires in buildings such as hotels, hostels, hospitals and homes for the elderly. The result of a study[9.3] in Canada indicated that 59% of persons asleep at the time of fire could have been saved by an adequate smoke detection system. Sprinkler installations also safeguard life, however, the insurance premiums for hotels, hostels etc., are low and consequently the sprinkler discounts are also low, due to the operation of the Minimum Rates Tariff[9.4]. In buildings such as libraries and museums, where articles of value are housed which would suffer as much damage from water as from fire, automatic detector systems have a distinct advantage over sprinkler installations

The high premium discounts allowed by the Tariff Companies for the installation of sprinkler systems, in the four case studies in Appendix C, resulted in cash flows which produced a positive NPV in each Case Study*. The reduction in premium was between 67% and 89% of the direct fire loss and between 61.5% and 79% of the consequential loss. Although these percentage reductions apply to tariff company premiums, similar reductions would also apply to the independent company premiums, as the independent companies largely follow the tariff rating structure.

At the present time, the future of the tariff structure is in doubt, although to-date no action has been taken on the report of the Monopolies Commission. Both major political parties have, during 1973, expressed dissatisfaction with the present system, one calling for nationalisation and the other for greater competition. It is perhaps ironical that at a time when the FOC

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*In Case Study No. 3 a positive NPV resulted when consequential loss insurance was taken into account.

is collaborating with industry, in the production of more equitable tariffs, it should be under censure. The FOC has recently introduced a tariff for the Plastic's Industry. The object of the tariff is a more equitable distribution of premium income, throughout the Plastic's Industry, which reflects the level of risk. Unless the work of the FOC is undertaken by a "central rate fixing organisation", it is difficult to foresee a continuation of the present rating structure.

The discounted cash flow technique of financial appraisal used in this study enables deferred taxation payments and where applicable government regional aid to be taken into account. The method is based on a theoretical cost of capital which is both net of taxation and of inflation. A figure of 5% in real terms has been used to discount the cash flows. A rate of 5% in real terms is equal to 26%* in money terms, if it is assumed that the level in inflation is 8% per annum and that the rate of Corporation Tax is 50%. When the cash flows resulting from the installation of sprinkler systems in the four case studies in Appendix C are discounted at 5% per annum all have positive net present values. The return from the initial capital outlay is, therefore, in excess of 26% in money terms.

The two industrial buildings which form Case Studies 1 and 2 have considerably less floor area than buildings where sprinkler systems have normally been installed. The floor areas of Case Studies No. 1 and No. 2 are 1410m^2 and 778m^2 respectively, whereas Ramachandran[9.5] estimates the average floor area of new sprinklered buildings completed during 1970 as 4552m^2. The figures from Case Study No. 2, when used as a model to estimate the NPV per square metre of floor area for the installation of a sprinkler system in buildings of various industrial uses, (see Appendix D)

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*26% in money terms less 50% Corporation Tax = 13% in money terms

15% in money terms less 8% inflation = 5% in real terms

resulted in cash flows that produced positive NPV's as follows:-

(i) within a grant aided area - seven out of eight industrial uses,

(ii) outside a grant aided area - six out of eight industrial uses.

The NPV per square metre when plotted against the average combined cost of insurance, resulted in a zero NPV per square metre for industrial uses as shown below:-

AVERAGE COMBINED COST OF INSURANCE

Area	Average combined cost of insurance
(i) Within a grant aided area	0.26p%
(ii) Outside a grant aided area	0.30p%

Fig. 48 Average combined cost of insurance where the NPV per m^2 is equal to zero.

The insured value of contents and wages which relate to the various industrial uses of the building that forms Appendix D have been assumed and will be subject to variation to suit the particular requirements of individual companies. Provided, however, that the actual figures for contents and wages are not appreciably less than the assumed figures, it would appear that single storey industrial buildings, outside grant aided areas, with floor areas in excess of $778m^2$ will show a positive NPV per square metre*, as

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*It is assumed that a Grade III water supply will be both satisfactory and available.

a result of the installation of a sprinkler system, if the average combined cost of insurance is more than 0.30p%. In a grant aided area an average combined cost of insurance in excess of 0.26p% should result in a positive NPV*.

The installation of sprinklers in buildings with floor areas less than $778m^2$ and industrial uses resulting in high average combined insurance costs will also result in a positive NPV.

Further studies will, however, be necessary to ascertain the size of building and the rate of average combined cost of insurance that results in a positive NPV for industrial uses in buildings of less than $778m^2$ in floor area.

The negative NPV's resulting from the cash flows for industrial uses, where the average combined cost of insurance is less than 0.30p% or 0.26p% depending on whether regional grant aid is available or not, are comparatively small and may not be considered a high cost for the protective benefit which accrue from the installation of a sprinkler system.

In retail premises the number of employees and the standard of construction has a direct effect on the insurance premiums of buildings which are covered by the shops' tariff. It is however the larger shop units, in particular those classed as drapery shops and employing more than a staff of 100, which will show the highest NPV following the installation of a sprinkler system. Case Study No. 3 relates to a retail store within a "large group"; for this reason the Company is able to obtain advantageous insurance rates. These rates would not have been available to a smaller

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*It is assumed that a Grade III water supply will be both satisfactory and available.

organisation. In addition, the Company does not insure for consequential loss cover, which is something that a smaller company could not afford to forego. Although further study will be necessary to assess the size and use of retail premises that will result in a zero NPV, there are financial advantages resulting from the installation of sprinkler systems in the building that form Case Study No. 3 and 4. Case Study No. 3, with a ground floor area of $972m^2$ is very much less in compartment size than retail buildings required to have sprinkler installations to comply with the requirements of the Building Regulations. Case Study No. 4 reflects the increase in premium when the insurance company regard retail premises as warehousing because an alternate method of retail trade is undertaken.

The benefits resulting from the installation of systems of automatic fire defence are considerable and prevent many of the problems that face a company affected by a "large fire". The problems apart from the direct damage to the building, equipment and work in progress may include loss of stocks and records. These losses may not be fully covered due to the operation of "average".[9.6] In addition to the direct losses, the company will suffer from the consequences of fire which may include the cost of re-organisation until new or reinstated buildings are ready for use, loss of orders and loss of key personnel. Although the company may have a consequential loss policy, this policy will also be subject to "average" and as shown in Chapter 2[9.7], may fail to cover the total of the consequential losses.

As industry becomes increasingly capital intensive, the value at risk in industrial buildings will continue to increase. Strother Smith[9.8] points out that:

"twenty years ago, when fire broke out the workpeople could walk out and leave behind them comparatively inexpensive plant and equipment. They had then, and still have, reasonably safe escape routes provided for them by law. Today, when fire breaks out the worker leaves a vast financial investment to burn".

The method of appraisal on which this study is based can be used to evaluate the financial returns resulting from the installation of systems of automatic fire defence and can also be used to compare the NPV of alternate systems. The Quantity Surveyor and others concerned with the financial appraisal of building development, when considering the allocation of cost to the various elements of industrial and the larger retail buildings, should consider not only the investment return resulting from the installation of a system of automatic fire defence but also the benefits of protection.

A system of automatic fire defence will not prevent a fire from occurring, although its installation should prevent the outbreak from developing into a "large fire". Even where a negative NPV occurs, the cost of installation may be considered small in return for the benefits of protection obtained and the knowledge that, with regular maintenance of the sprinkler system, the property and its contents are safeguarded against the effects of a "large fire" throughout 24 hours a day, seven days a week.

NOTES

9.1 Supra; Chapter 3. pp. 54-55

9.2 Great Britain, Home Office and Scottish Home and Health Department, Report of the Departmental Committee on the Fire Service - Sir Ronald Holroyd, Chairman (London, HMSO, May, 1970).

9.3 H. B. Finger, Recent developments in building systems, Phil: Trans: Royal Society London A 272, P 503-531, pp. 21-22.

9.4 Supra; Chapter 2 p. 22.

9.5 G. Ramachandran, National Expenditure on Sprinkler Installations (Fire Research Station, Fire Research Note No. 906, December 1971) pp. 2-3.

9.6 Supra; Chapter 2. p. 27

9.7 Supra; Chapter 2. pp. 34-35.

9.8 N. C. Strother Smith "Preventing fire in the seventies". Journal of the Chartered Insurance Institute. Vol. 69, (1972.)p. 46.

APPENDIX A

The financial return resulting from the installation of a sprinkler system in an industrial building in the United States of America.

The following example of accounting procedure published in the Fire Protection Handbook was prepared as a method guide by Clyde M. Wood for the "Automatic" Sprinkler Corporation of America and although assumed values have been used it is important for two reasons. Firstly because the pay-back method is used to find the break even point and profit earned in twenty years, taking running costs and loss of interest on capital into account, and secondly because it relates to North American practice. Trade literature published by the "Automatic" Sprinkler Corporation of America indicates that considerably reduced insurance premiums will result from the installation of a sprinkler system with pay-back times varying from one to three years. However, the premium income indicates that the sums insured are very large whereas the following details relate to a very much smaller building insured for $175000*. The break even point for this particular installation is 11.58 years with an eventual profit of $26615 after twenty years as shown in Figs. 49 and 50.

If use is made of discounted cash flow techniques instead of the pay back method the break even point will also occur in the 11th year. Both approaches have been made on the assumption that tax is paid on a saving or profit at the same time that it is earned. This

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*Equal to £72916 assuming an exchange rate of $2.4 to £1 with an eventual profit after 20 years of £11089.

APPENDIX A

SPRINKLER SYSTEM INVESTMENT ANALYSIS PREPARED BY CLYDE M. WOOD

FIRE INSURANCE ANALYSIS						
ITEM INSURED	REPLACEMENT AMOUNT	RATES		PREMIUMS		PREMIUM SAVING
		Unsprinklered	Sprinklered	Unsprinklered	Sprinklered	
Business Interruption	$291000	.72	.12	2095	349	1746
Building	175000	.90	.15	1575	263	1312
Contents	275900	1.15	.18	3173	497	2676
TOTALS	741900			6843	1109	5734

A - GROSS ANNUAL PREMIUM SAVING			- $5734
FIXED ANNUAL CHARGES			
State, County Taxes - 3.74% on 50% of $23777			$ 445
Fire insurance on sprinkler system (excluding underground pipe) $17000 @ .15		-	26
Sprinkler leakage insurance $37600 @ .375		-	141
City Water Service Charge		-	100
Maintenance		-	100
Sprinkler inspection service by Installing Co.		-	150
			962
B - Charges except Income Tax	- $962		
3% depreciation on $23777	- 716		
C - Total Expense Deductible from A	- 1678		
D - Net Taxable Income (A - C)	- 4056		
E - Federal (52%) State (1%) = 53% of D		-	2150
F - TOTAL FIXED ANNUAL CHARGES (B + E)		-	$3112
G - NET ANNUAL PREMIUM SAVING (A - F) after taxes EFFECTED BY SPRINKLER SYSTEM			2622
H - TOTAL SPRINKLER SYSTEM COST			$23777

Fig 49 Sprinkler system investment analysis prepared by Clyde M. Wood

Basic data - see Fig 48 for calculations.

APPENDIX A

SPRINKLER INVESTMENT CALCULATION OVER

20 YEARS BY CLYDE M. WOOD

H - Total cost	$23777	Investment end 11th year	$ 1555
G - Net annual saving	2622	G - Net annual saving	2622
Investment begin: 1st year	21155	PROFIT begin: 12th year	1067
5% interest	1058	5% interest	53
		G - Net annual saving	2622
Investment end 1st year	22213	PROFIT begin: 13th year	3742
G - Net annual saving	2622	and so on -	
Investment begin: 2nd year	19591	PROFIT begin: 19th year	22850
5% interest	980	5% interest	1143
Investment end 2nd year	20571	G - Net annual saving	2622
and so on - next column		PROFIT begin: 20th year	26615

Fig. 50 Sprinkler investment calculation over 20 years prepared by Clyde M. Wood.

is certainly not true in the United Kingdom where tax payments may be deferred from eighteen months to two years, depending upon the time of a Company's year end. In the following exercise it has been assumed that a suitable deferred tax interval in the United States, for both Federal and State taxes, would be twelve months. When deferred tax payments are taken into account and the previous figures are discounted at 5% then break even point occurs in the ninth year and the profit after twenty years will amount to $12149 in present day terms as shown in Fig. 51.

CASH FLOWS OF INVESTMENT ANALYSIS PREPARED BY CLYDE M. WOOD

Year	A	B	C	D	E	F	G
	Capital Cost $	Premium Saving $	Federal Tax $	County Tax $	Cash Flow (B-C-D) $	5% discount	Net present value at 5%
0	23777	5217	-	-	(-18560)	1.00	(-18560.00)
1		5217	2150	445	2622	0.952381	2497.14
2		5217	2150	445	2622	0.907029	2378.23
3		5217	2150	445	2622	0.863838	2264.98
4		5217	2150	445	2622	0.822702	2157.12
5		5217	2150	445	2622	0.783526	2054.40
6		5217	2150	445	2622	0.746215	1956.58
7		5217	2150	445	2622	0.710681	1863.41
8		5217	2150	445	2622	0.676839	1774.67
9		5217	2150	445	2622	0.644609	1690.16
10		5217	2150	445	2622	0.613913	1609.68
11		5217	2150	445	2622	0.584679	1533.03
12		5217	2150	445	2622	0.556837	1460.03
13		5217	2150	445	2622	0.530321	1390.50
14		5217	2150	445	2622	0.505068	1324.29
15		5217	2150	445	2622	0.481017	1261.23
16		5217	2150	445	2622	0.458112	1201.17
17		5217	2150	445	2622	0.436297	1143.97
18		5217	2150	445	2622	0.415521	1089.50
19		5217	2150	445	151	0.395734	59.76
20		-	2150	445	-	-	-

Net Present Value $12149.85

Fig. 51 Cash Flows relating to the investment analysis prepared by Clyde M. Wood.

APPENDIX A

At first sight it might appear that the payback method of calculation will give a greater return but in order to make a true comparison the returns must be expressed in the same terms. The discounted cash flow technique enables future sums to be expressed as present values. In order to convert the sum of $26615 which will be obtained in 20 years to its present worth, it must be discounted by 0.395734 which means that it is worth $10532 today, as compared with the figure of $12149 obtained by taking deferred tax payments into account and using the discounted cash flow technique.

APPENDIX B

Regional Aid within the European Economic Community.

Under Article 154 of the Treaty of Accession, the principles which govern regional assistance in the European Economic Community have also applied to Britain since the 1st July, 1973. However, at the end of June 1973, it was announced by the United Kingdom Government that as a result of negotiations with EEC members in Brussels, the regional development incentives applicable at present would in the immediate future remain unaltered.

Regional policy within the EEC at present lacks coherence*, with aid being administered through four seperate institutions** and in general going to those areas which are extremely backward such as Southern Italy. At present the community is divided into central and peripheral areas and there is no limit to the regional aid from national government to the peripheral areas of the Community such as South-west France, West Berlin and parts of Southern Italy. The rest of the Community constitutes the "central" areas where regional aid may also be available but it is limited to 20% of the after-tax cost of incentive over and above the aid which is available to the country as a whole.

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*"Peripheral Prospects - Developments in British Regional Policy". Barclays Review (August, 1972) pp. 53-56.

**The European Coal and Steel Community, Guidance Section of the European Agricultural Fund, the European Social Fund and the European Investment Bank.

APPENDIX B

It was proposed to review the 20% ceiling at the end of 1973. Unfortunately, the size of the Regional Fund has become the subject of bitter argument between members of the EEC and neither the "ceiling" or the size of the fund had been decided at the end of January, 1974.

Regional aid in the United Kingdom will be affected by the "ceiling" and by the eventual size of the fund. In addition, the designation of central and peripheral areas is likely to be crucial in determining future incentives for regional development. It is likely, therefore, that the present (January, 1974) level of regional aid in the United Kingdom will be subject to changes in the future.

APPENDIX C

CASE STUDIES

CONTENTS

APPENDIX C

CASE STUDY NO 1

1.0 The Company

1.1 The company has existing premises in the centre of a city in the North West and manufactures rubber stamps. The building, which forms this case study, is in course of construction (1973) and is situated on the outskirts of the city within a development area. The building will replace the existing city centre works and provide employment for approximately 60 people.

The contents, which are largely metal dies are insured for £150000. This was the figure that had been agreed with the insurance brokers. Although the insurance value is far higher than the sale value of the dies, in the event of fire it is unlikely that the dies could be replaced in a reasonable time without paying considerably more than their market value.

The fire record of the company is good and the company's business is classed by the insurance companies as a non tariff rubber risk. The existing premises are co-insured by two tariff companies.

2.0 The Building

2.1 Details

Single storey building - $1160m^2$

Two storey building - $250m^2$

2.2 Description

The single storey building is of steel portal construction with asbestos sheeted roof. The external walls are of brickwork to a height of 1.4 metres, with glazing and decorative sheet cladding above. Overall height to eaves 3 metres.

The two storey office block across the front of the single storey building is of load bearing brick construction with precast concrete floor and roof supported by cased steelwork.

3.0 Basic insurance rate

3.1 The rate for the building and contents is 0.25p%.

4.0 Adjustment of the basic rate

4.1 The percentage adjustment on the basic rate is +150%. The adjustment was reduced from +200% on the 1st January, 1973.

4.2 There is a reduction of 10% for ordinary fire extinguishing appliances.

4.3 The consequential loss basic rate is reduced by 10% for the provision of ordinary fire extinguishing appliances.

4.3.1 Wages are insured for 100% of cost for the first 6 weeks and 25% for the remainder of the first year. Rate - 50% of the basic rate.

4.3.2 Gross profit is insured at a rate of 125% of the basic rate.

5.0 Adjustment of the basic rate for sprinkler installation

5.1 The tariff company quotation for a sprinklered building included the following reductions:-

5.1.1 50% off the basic rate, made up of 40% for an installation with a grade III water supply and 10% for ordinary hand appliances.

5.1.2 5% reduction for a direct link to a centrally manned control.

5.1.3 20% off the basic rate, which is the Scale of Percentage Adjustment allowance.

5.1.4 Consequential loss basic rate is reduced by 50%, made up of 40%+10% as 5.1.1 with a further Scale of Percentage Adjustment allowance of $\frac{1}{3}$rd.

6.0 Sums insured

		£
6.1	Building - replacement value	108000.00
	fees say 10%	10800.00
6.2	Contents	150000.00
		£268800.00

6.3 Consequential loss - agreed with the broker that cover would be on a dual basis as follows:-

		£
6.3.1 Gross profit per annum	-	100000.00
6.3.2 Wages - 100% for 6 weeks and then 25% for 12 months	-	60000.00

7.0 Cost of insurance per annum -- Unsprinklered Building

		£
7.1 Building and contents		
0.25p%-10%+150%=0.5625p%x£268800.00	-	1512.00
7.2 Consequential loss - because of anticipated length of recovery time, the cover is for 24 months.		
7.2.1 Gross profit (24 months)		
125% of 0.25p%-10%=0.28125p%x£200000	-	562.50
7.2.2. Wages (24 months)		
50% of 0.25p%-10%=0.1125p%x£120000	-	135.00
		£2209.50

8.0 Cost of sprinkler installation

		£
8.1 Capital cost - budget price from Mather and Platt. The figure includes 125mm control valves and equipment to allow for future extention and is based on 180 sprinkler heads.	-	5000.00
	carried forward	£5000.00

brought forward £5000.00

8.2 Connection to water company main - provisional figure from water company for connection to 125mm water main between £250-£450. The higher figure has been used. - 450.00

8.3 Direct link to centrally manned control - Estimate from EPS for a direct link together with monitoring of sprinkler valves. - 700.00

8.4 Loss of floor area due to sprinkler control valves, storage of water, pumps etc. - not applicable

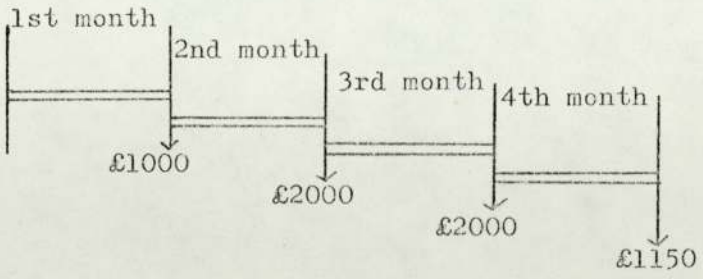
8.5 Loss of interest resulting from progress payments until the installation is commissioned.

(i) capital cost £6150.00,

(ii) estimated duration of installation - 4 months,

(iii) interest rate say .833% per month.

Financing pattern



carried forward £6150.00

brought forward £6150.00

£1000.00 outstanding for 3 months

$= 1000 \times \frac{.833}{100} \times 3$ - 24.99

£2000.00 outstanding for 2 months

$= 2000 \times \frac{.833}{100} \times 2$ - 33.32

£2000.00 outstanding for 1 month

$= 2000 \times \frac{.833}{100}$ - 16.66

8.6 Architects, surveyors and consultants fees for additional work - advice, design and valuation.

10% of £6150.00 - 615.00

8.7 Loss of production - not applicable in a new building. -

8.8 Cost of executive time in making decision as to whether an installation should be installed or not. not calculated

£6839.97

9.0 Annual costs resulting from the installation of a sprinkler system

£

9.1 Rates (Commercial rate 1973 - 39p in the £1)
The increase in ratable value would be based upon the cost of the installation as follows:
5% of the capital cost x rate payable.

$= \frac{5}{100} \times 6150 \times \frac{39}{100}$ - 119.93

carried forward £119.93

brought forward £119.93

9.2 Water rate (Water rate 1973 - 2.5p in the £1)

Rate is based on increase in net annual value of £307.5.

$= \frac{2.5}{100} \times £307.5$ - 7.69

9.3 Cost of water supply.

		£	
9.3.1	annual connection charge	- 3.47	
9.3.2	annual charge for number of sprinkler heads 2 x 87p	- 1.74	5.21

9.4 Direct link and monitoring of valves.

Annual charge including cost of shared GPO line. - 235.00

9.5 Sprinkler leakage.

9.5.1	Building 1d%+150% = $2\frac{1}{2}$d%x£118800 -	12.38
	Additional for office = $2\frac{1}{2}$d%x£20000 -	2.08
9.5.2	Contents $2\frac{1}{2}$p%+150%=6.25p%x£150000.00 -	93.75
	Contents (2 storey block) =6.25p%x£20000.00 -	12.50
		£488.54

£

10.0 Other charges resulting from the installation of a sprinkler system

10.1 Servicing of the installation - charge based on two visits per annum by a Sprinkler Engineer at £25.00 per visit. - 50.00

For the first twelve months, servicing visits are not charged. -

10.2 Maintenance. Cost of repairs and replacement assumed to occur during the 5th year. Cost £100.00.

11.0 Cost of insurance per annum - sprinklered building

£

11.1 Building and contents - £268800.00

Additional capital cost of installation - £ 6150.00

0.25p%-50%-5%-20%=0.095p%x£274950.00 - 261.20

11.2 Consequential loss

11.2.1 Gross profit (12 months)

150% of 0.25p%-50%-5%-⅓rd =

0.1187505p% x £100000.00 - 118.75

11.2.2 Wages (12 months)

75% of 0.25p%-50%-5%-⅓rd =

0.05938p% x £60000.00 - 35.62

£415.57

12.0 Annual saving in insurance premiums - sprinklered building

		£
12.1	Cost of insurance per annum - unsprinklered building	2209.00
12.2	Cost of insurance per annum - sprinklered building	416.00
		1793.00
12.3	Less annual costs resulting from installation	489.00
	1st year	£1304.00

12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00. In the 5th year, the annual saving will be reduced by £100.00 due to maintenance.

The cash flows resulting from the annual premium savings, together with taxations and grants have been discounted in Table 7 - Chapter 8 p.144.

13.0 Installation of an automatic detector system £

13.1 Effect on the insurance premium

Insurance premium for the building unprotected as section 7.0.	-	2210.00
Insurance premium when the building is protected by a Class A installation (reduction of 12½%).	-	1934.00
saving in insurance premium p.a.		£ 276.00

13.2 Capital cost of installation £

13.2.1 Budget price from AFA-Minerva for a smoke/heat system.	-	3500.00
13.2.2 Connection to Fire Brigade - quote from AFA-Minerva.	-	50.00
13.2.3 Loss of interest resulting from progress payments until the installation is completed. Say 1 month x £1000 = 1000 x $\frac{.833}{100}$ say		8.00
13.2.4 Architects, Surveyors and consultants fees for additional work - advice, design and valuation.	10% of £3500.00	350.00
13.2.5 Loss of production - not applicable		-
carried forward		£3908.00

13.0 Installation of an automatic detector system (Cont)

brought forward £3908.00

13.2.6 Cost of executive time in making decision as to whether an installation should be installed or not. - not calculated

£3908.00

13.3 Annual costs resulting from the installation of an automatic detector system £

13.3.1 Rates (commercial rate 1973 - 39p in the £1). The increase in ratable value would be based upon the cost of the installation as follows:-

5% of the capital cost x rate payable.

$= \frac{5}{100} \times 3500 \times \frac{39}{100}$ - 68.25

13.3.2 Maintenance - quotation from AFA/Minerva 100.00

13.3.3 Direct link - rental maintenace 32.00

- G.P.O. rental (2 miles of line) 50.00

£250.25

13.3.4 Annual saving in insurance premium

Saving in insurance premium per annum as 13.1 276.00

Less

Annual costs resulting from installation 250.00

£ 26.00

The cash flows resulting from the annual premium savings, together with taxation allowances and grants have been discounted in Table 8 - Chapter 8 p. 145.

APPENDIX C

CASE STUDY NO 2

1.0 The Company

1.1 The company manufactures overalls, employing 70 persons in a building which is situated in an Intermediate Development Area.

The company comes within Standard Industrial Classification Order XV (444) and would qualify for assistance under the Industry Act, 1972.

2.0 The Building

2.1 Details

Floor area - $778m^2$

Height of ridge - original building 5.6 metres,

- extension 4.7 metres.

2.2 Description

Single storey steel portal construction with brickwork externally to a height of 2.7 metres and asbestos cement to gables above brickwork. Asbestos cement sheeted roof with flame retardent roof lights and fireproof lining to the underside of the roof area.

Office area of approximately $80m^2$ included within the total building area of $778m^2$.

The original building was constructed in 1965 and extended in 1969.

3.0 Basic insurance rate - Tariff rated risk		Build up of basic rate %
3.1 The rate for the building is 10p%	-	10p
3.2 The standard of construction is worse than Standard V and the building is subject to a 5p% increase of the basic rate.		5p
3.3 The heating is by free standing oil fired hot air blowers which will increase the basic rate by $2\frac{1}{2}$p%.	-	$2\frac{1}{2}$p
3.4 Removal of waste is satisfactory and there would be no increase to the basic rate	-	-
3.5 The materials used in the manufacturing process are nylon, cotton and polyester, which do not increase the basic rate; nor would there be an increase in the rate for the number of employees until the number exceeded 100.	-	-
	Basic rate	$17\frac{1}{2}$p%

4.0 Adjustment of the basic rate

4.1 Provision of fire extinguishers reduces the basic rate by 10%.

4.2 The scale of percentage adjustment for the clothing industry tariff is +300%.

4.0 Adjustment of the basic rate (continued)

4.3 The consequential loss rating adjustment is +25%, with a reduction of 10% for ordinary hand extinguishing appliances.

4.3.1 Wages are insured for 100% of cost for the first 8 weeks and 25% for the remainder of the first year. Rate 81% of the basic rate.

4.3.2 Gross profits are insured at a rate of 150% of the basic rate.

5.0 Adjustment of the basic rate resulting from the installation of a sprinkler system

5.1 The tariff company quotation allowed the following reductions for a sprinklered building:-

5.1.1 35% off the basic rate, made up of 25% for an installation with a grade III water supply and 10% for ordinary hand appliances.

5.1.2 20% off the basic rate which is the Scale of Percentage Adjustment allowance.

5.1.3 Consequential loss is reduced by 35%, made up of 25% + 10% as 5.1.1 with a further Scale of Percentage Adjustment allowance of $\frac{1}{3}$rd.

			£
6.0	Sums insured		
6.1	Building - replacement value	-	54000.00
	fees say 10%	-	5400.00
6.2	Contents	-	54950.00
			£114350.00

			£
6.3	Consequential loss (dual basis)		
6.3.1	Gross profit	-	36000.00
6.3.2	Wages	-	60000.00

			£
7.0	Cost of insurance per annum - Unsprinklered Building		
7.1	Building and contents		
	0.175p%-10%+300%=0.63p%x£114350.00	-	720.40
7.2	Consequential loss (12 months)		
7.2.1	Gross profit		
	150% of 0.175p%-10%+25% =		
	0.2953125p%x£36000.00	-	106.31
7.2.2	Wages		
	81% of 0.175p%-10%+25% =		
	0.15947p%x£60000.00	-	95.68
			£922.39

8.0 Cost of sprinkler installation £

8.1 Capital cost - budget price from Norris Warming & Co. Ltd. The figure is based on a 4" (101mm) supply from the water main and upon 120 sprinkler heads. - 2400.00

8.2 Connection to water company main - budget price from water authority for a 4" (101mm) connection, non-return value and all reinstatement. The main is fed from two directions and the pressure is sufficient to give a grade III supply. - 120.00

8.3 Direct link to centrally manned control - not calculated

8.4 Loss of floor area due to sprinkler control valves, storage of water, pumps etc. - not applicable

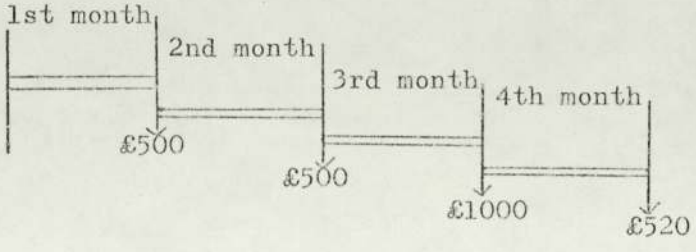
8.5 Loss of interest resulting from progress payments until the installation is commissioned.

(i) capital cost £2520.00,

(ii) estimated duration of installation - 4 months,

(iii) interest rate say .833% per month

Financing pattern



carried forward £2520.00

8.0 Cost of sprinkler installation (continued) £

brought forward £2520.00

£500.00 outstanding for 3 months $-500 \times \frac{.833 \times 3}{100}$)
£500.00 " for 2 months $-500 \times \frac{.833 \times 2}{100}$) 29.00
£1000.00 " for 1 month $-1000 \times \frac{.833}{100}$)

8.6 Architects, surveyors and consultants fees for additional work - advice design and valuation.

10% of £2520.00 say 251.00

8.7 Loss of production not calculated

8.8 Cost of executive time in making decision to install. not calculated

£2800.00

9.0 Annual costs resulting from the installation of a sprinkler system £

9.1 Rates (Commercial rate payable, 42.5p in the £1)

The Valuation Officer said that the increase cost of the installation as follows:-

5% of capital x rate payable in 1973

$= \frac{5}{100} \times 2520 \times \frac{42.5}{100}$ - 53.55

9.2 Water rate (Rate payable 6.5p in the £1)

The water rate is based on 30% of the increase in the net annual value. NAV = £126

Rate - 30% of £126 $\times \frac{6.5p}{100}$ - 2.46

carried forward £56.01

9.0 Annual costs resulting from the installation of a sprinkler system (continued)	£
brought forward	56.01
9.3 Cost of water supply - The water board does not charge for the supply of water to a sprinkler installation.	-
9.4 Direct link and monitoring of valves	not included
9.5 Sprinkler leakage	
9.5.1 Building 1d%+150%=2½d%x£59400.00 =	6.19
9.5.2 Contents 2½d%+150%=.0625p%x£54950.00 =	34.34
	£96.54

10.0 Other charges resulting from the installation of a sprinkler system	£
10.1 Servicing of the installation-charge based on two visits per annum by a Sprinkler Engineer at £25.00 per visit - For the first twelve months, servicing visits are not charged.	50.00
10.2 Maintenance. Cost of repairs and replacement assumed to occur during the 5th year - Cost £100.00.	

11.0 Cost of insurance per annum - Sprinklered Building £

Tariff Company quotation

		£	£
11.1	Building and contents	114350.00	
	Cost of sprinkler installation	2520.00	
	0.175p%-35%-20%=0.091p%x	£116870.00	106.35
11.2	Consequential loss		
11.2.1	Gross profit		
	150% of 0.175p%-35%-⅓rd=0.114p% x	£36000.00	41.04
11.2.2	Wages		
	81% of 0.175p%-35%-⅓rd=0.062p% x	£60000.00	37.20
			£184.59

12.0 Annual saving in insurance premiums £

12.1	Cost of insurance per annum - unsprinklered building	922.00
12.2	Cost of insurance per annum - sprinklered building	185.00
		737.00
12.3	Less annual costs resulting from installation	97.00
	1st year -	£640.00

12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th year the saving will be reduced by £100 due to maintenance. The cash flows resulting from the annual premium saving, together with taxation and grants have been discounted in Table 9 Chapter 8 p. 147.

ALTERNATIVE A

Insurance cover based on a quotation from an Independent Company. (Name of company not disclosed by Broker)

A.3.0 Basic insurance rate - $12\frac{1}{2}$p%.

A.4.0 Adustment of the basic rate

A.4.1 Provision of fire extinguishers reduces the basic rate by 10%.

A.4.2 The scale of adjustment applied by the company is + 400%.

A.4.3 The consequential loss rating adjustment is + 25%

A.4.3.1 Wages are insured for 100% of cost for the first 8 weeks and 25% for the rest of the first year. Rate - 81% of the basic rate.

A.4.3.2 Twelve months gross profit is insured at a rate of 150% of the basic rate.

A.7.0 Cost of insurance per annum - Unsprinklered building	£
A.7.1 Building and contents	
0.125p%-10%+400%=0.5625%x£114350.00	643.22
A.7.2 Consequential loss (12 months)	
A.7.2.1 Gross profit	
150% of 0.125p%-10%+25% = 0.21094p% x £36000.00	75.94
carried forward	719.16

A.7.0 Cost of insurance per annum - Unsprinklered building (cont) £

brought forward	719.16
A.7.2.2. Wages	
81% of 0.125p%-10%+25%=0.114%x£60000.00	68.40
	787.56
Less 5% LTA	39.38
	£748.18

A.11.0 Cost of insurance cover per annum - Sprinklered building £

Assumed as for tariff quotation -	185.00

A.12.0 Annual saving in insurance premiums £

A.12.1 Cost of insurance per annum - unsprinklered building	748.00
A.12.2 Cost of insurance per annum - sprinklered building	185.00
	563.00
A.12.3 Less annual costs resulting from installation	97.00
1st year premium saving	£466.00

A.12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th year the saving will be reduced by £100 due to maintenance.

The cash flows resulting from the annual premium savings, together with taxation allowances and grants have been discounted in Table 10 - Chapter 8 p. 148

APPENDIX C

CASE STUDY NO 3

1.0 The Company

1.1 The company is an international organisation with over 1200 retail premises in the United Kingdom. The merchandise consists of a wide range of general household articles together with clothing and foodstuffs. The proposed building is in East Lancashire and will be one of the smallest units in the chain of stores, giving employment to 130 people. A high proportion of the staff will be in part time employment (Saturdays only).

It is company policy to insure the building and its contents but not to extend the insurance to cover the consequences resulting from a fire.

Although the company has experienced a number of costly fires in recent years, it is not company policy to install sprinkler systems in their new buildings. The exception being when the Local Authority insist on installation because of the size of the premises.

2.0 The Building

2.1 Details

Ground floor area - $972m^2$

First floor area - $622m^2$

2.2 Description

The building is steel framed with fireproof casing and precast floor and roof units. The ground floor is entirely sales area and the staff and stockrooms are on the first floor.

3.0 Basic insurance rate

3.1 The rate for the building and contents is 0.2125p%. The insurer does not adjust the rate for the number of staff employed.

NOTE:- This quotation is below the tariff rating but is based upon the insurance of the whole chain of stores and would not apply to the insurance of a single store.

4.0 Adjustment of the basic rate

4.1 The percentage adjustment on the basic rate is + 15%.

4.2 There is a reduction of 5% for long-term agreement.

5.0 Adjustment of the basic rate resulting from the installation of a sprinkler system

5.1 Under the Shop's tariff the basic rate for buildings with sprinkler installations conforming with the 29th Rules is 10p% - 20%.

5.2 There is a reduction of 5% for a long-term agreement.

6.0 Sums insured

			£
6.1	Building - replacement value		207900.00
	- fees 10%		20790.00
6.2	Contents - fixtures -	£42000.00	
	- stock -	£50000.00	92000.00
6.3	Consequential loss		not applicabl
			£320690.00

7.0 Cost of insurance per annum - Unsprinklered building £

7.1 Building and contents

0.2125p%+15%-5% = 0.232156p%x£320690.00 - 744.50

8.0 Cost of sprinkler installation £

8.1 Capital cost - based on a budget price from Norris Warming & Co Ltd - installation of 215 sprinkler heads. - 4300.00

8.2 Connection to water main - connection to 6" (150mm) pipe estimated by the Water Company to be between £300 - £400 (Grade III supply) say 350.00

8.3 Direct link to centrally manned control - not calculated

8.4 Loss of floor area due to sprinkler control values, storage of water, pumps etc. not applicable

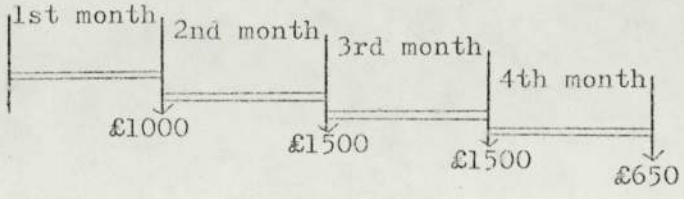
8.5 Loss of interest resulting from progress payments until the installation is commissioned.

(i) capital cost £4650.00

(ii) estimated duration of installation - 4 months

(iii) interest rate say .833% per month

Financing pattern



carried forward £4650.00

8.0 Cost of sprinkler installation (cont) £

brought forward 4650.00

8.5 Financing Pattern (continued)

£

£1000.00 outstanding for 3 months - $1000 \times \frac{.833}{100} \times 3 = 24.99$

£1500.00 outstanding for 2 months - $1500 \times \frac{.833}{100} \times 2 = 24.99$

£1500.00 outstanding for 1 month - $1500 \times \frac{.833}{100} = 12.50$ 62.48

8.6 Architects surveyors and consultants fees for additional work -- advice, design and valuation

10% of £4650.00 - 465.00

8.7 Loss of sales etc - not applicable because the building is new - not applicab

8.8 Cost of executives time in making decision to install. not calculat

£5177.48

9.0 Annual costs resulting from the installation of a sprinkler system £

9.1 Rates (Commercial rate payable, 1973 - 40p in the £1). The Valuation Officer was not prepared to estimate the increase in ratable value but indicated that the contractor method might well be used. Cost based on contractor method.

$= \frac{5}{100} \times 4300 \times \frac{40}{100}$ - 86.00

carried forward £86.00

9.0 Annual costs resulting from the installation of a sprinkler system (cont) £

brought forward 86.00

9.2 Water rate

The Water Board charge is based on 50% of the Net Annual Value but the minimum charge is based on a NAV of £3000.00. The NAV for this building is well in excess of £3000.00. no charge

9.3 Cost of Water Supply

The Water Board charges are as follows:-

(a) connection - £5.00 per annum

(b) number of sprinkler heads -

£1 per 100 or part - £3.00 per annum 8.00

9.4 Direct link and monitoring of valves not included

9.5 SprinklerLeakage Policy

9.5.1 Building 1d%+150%+100% = 5d%x£228690.00 47.64

9.5.2 Contents $2\frac{1}{2}$p%+150%+100%=12.5p%x£92000.00 115.00

£256.64

10.0 Other charges resulting from the installation of a sprinkler system £

10.1 Servicing of the installation - charge based on two visits per annum by a Sprinkler Engineer at £25.00 per visit. 50.00

For the first twelve months, servicing visits are not charged.

10.0 Other charges resulting from the installation of a sprinkler system (cont)

10.2 Maintenance. Cost of repairs and replacements assumed to occur during the 5th year.

Cost £100.00

11.0 Cost of insurance per annum - Sprinklered Building £

11.1 Building and contents (grade III water supply)

0.10p%-20%-5% = 0.076p%x£320690.00 - 243.72

12.0 Annual saving in insurance premiums £

12.1	Cost of insurance per annum - unsprinklered building	744.00
12.2	Cost of insurance per annum - sprinklered building	243.00
		501.00
12.3	Less annual costs resulting from installation	256.00
	1st year premium saving	£245.00

12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th/10th/15th/20th years etc the saving will be reduced by £100.00 due to maintenance.

The cash flows resulting from the annual premium savings together with taxation allowances have been discounted in Table 11 - page 222.

Retail Premises No allowance for inflation Service Industry - No Government Grant				Discount rate 5%		NPV per m^2 = £-0.63		Sprinkler Installation	CASE STUDY No 3 Building and contents classed as "Other Shops"	
	A	B	C	D	E	F	G	H	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax payable on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Discount rate 5%	NPV at 5%
0	5177	245	-	-	-	-	-	(-4932)	1.00	(-4932.00)
1		195	123	5177	2589	NA	-2466	2661	0.952381	2534.29
2 to 39		195	98				98	97	16.867893) x 0.952381)	1558.27
Adjustment for maintenance										
5		£100 maintenance is reduced to £52 after adjustment of deferred taxation						(-52)	0.783526	(-40.74)
10								(-52)	0.613913	(-31.92)
15								(-52)	0.481017	(-25.01)
20								(-52)	0.376889	(-19.60)
25								(-52)	0.295303	(-15.37)
30								(-52)	0.231377	(-12.03)
35								(-52)	0.181290	(- 9.43)
Adjustment for deferred taxation										
40			98				98	(-98)	0.142046	(-13.74)
								Net Present Value		£1007.33

Table 11 Cash flows resulting from the installation of a sprinkler system in retail premises classed as "other shops". No insurance for consequential loss.

AMENDMENT A

A3.0 Effect on Premium Saving if consequential loss is taken into account

Rate for consequential loss - similar to the rate for building and contents ie:- 0.2125p%.

There is no rating adjustment for consequential loss but the rate will be subject to a discount of 5%. LTA Assumed Sums for Gross Profit and Wages.

(a) Gross profit - £150000.00

(b) Wages - £110000.00

A7.0 Cost of insurance per annum - Unsprinklered Building	£
A7.1 Building and contents as 7.1	744.50
A7.2 Gross profit (110% of basic rate has been used because of the large number of premises involved) 110% of 0.2125p%-5% = 0.222p%x£150000.00	333.00
A7.3 Wages 81% of 0.2125p%-5% = 0.163p%x£110000.00	179.30
	£1256.80

A11.0 Cost of insurance per annum - Sprinklered Building	£
A11.1 Building and contents as 11.1	243.72
A11.2 Gross profit 110% of 0.10p%-20%-5% = 0.084p%x£150000.00	126.00
carried forward	£369.72

A11.0 Cost of insurance per annum - Sprinklered Building(Cont) £

brought forward 369.72

A11.3 Wages

81% of 0.10p%-20%-5% = 0.062p%x£110000.00 68.20

£437.92

A12.0 Annual saving in insurance premium - taking consequential loss into account £

A12.1 Cost of insurance per annum - unsprinklered building 1257.00

A12.2 Cost of insurance per annum - sprinklered building 438.00

819.00

A12.3 Less annual costs resulting from installation 256.00

1st year premium saving £563.00

A12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th and 10th years the saving will be reduced by £100.00 due to maintenance.

The cash flows resulting from the annual premium savings together with taxation allowances have been discounted in Table 12 page. 225

Retail Premises No allowance for inflation Service Industry - No Government Grant				Discount rate 5%		NPV per m^2 = £0.02		Sprinkler Installation AMENDMENT A		CASE STUDY No 3 Building contents and consequential loss classed as "other shops"	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	5177	563	-	-	-	-	-	(-4614)	(-4614)	1.00	(-4614.00)
1		513	282	5177	2589	NA	-2307	2820	2820	0.952381	2685.71
2		513	257				257	256	256	0.907029	232.20
3		513	257				257	256	256	0.863838	221.14
4		513	257				257	256	256	0.822702	210.61
5		413	257				257	156	156	0.783526	122.23
6		513	207				207	306	306	0.746215	228.34
7		513	257				257	256	256	0.710681	181.93
8		513	257				257	256	256	0.676839	173.27
9		513	257				257	256	256	0.644609	165.02
10		413	257				257	156	156	0.613913	95.77
11		513	207				207	306	306	0.584679	178.91
12		513	257				257	256	256	0.556837	142.55
13		513	257				257	256	12	0.530321	6.36
14		-	257				257	-257	-	-	-
									Net Present Value		£30.03

Table 12 Cash flows resulting from the installation of a sprinkler system in retail premises classes as "other shops".

AMENDMENT B

B3.0 Effect on Premium Savings if the building is classed as Drapery and does not form part of a chain of stores.

Standard of Construction Class III

Insurance Rate - building and contents

(i)	Basic rate	-	0.175p%
(ii)	75 - 100 assistants	-	0.1375p%
(iii)	Standard of Construction	-	less 25% building
		-	less 12½% contents
(iv)	Scale of percentage adjustment- Class III standard of construction	-	+50%
(v)	Long term agreement	-	less 5%
(vi)	Hand appliances	-	less 10%

Insurance rate - consequential loss

(i)	Basic rate	-	0.175p%
(ii)	75 - 100 assistants	-	0.1375p%
(iii)	Percentage applied to gross profit	-	150%
(iv)	Percentage applied to wages	-	81%
(v)	Hand appliances	-	less 10%
(vi)	Long term agreement	-	less 5%

AMENDMENT B

B7.0 Cost of insurance per annum - Unsprinklered Building £

Building

0.3125p%-10%-25%+50%-5% = 0.30p%x£22869.00 686.07

Contents

0.3125p%-10%-12½%+50%-5% = 0.350p%x£92000.00 322.00

Consequential loss

Gross profit

150% of 0.3125p%-10%-5% = 0.40p%x£150000.00 600.00

Wages

81% of 0.3125p%-10%-5% = 0.216p%x£110000.00 237.60

£1845.67

B5.0 Insurance rate - sprinklered building

(i) Basic rate - 0.175p%

(ii) 75 - 100 assistants - 0.1375p%

(iii) Standard of construction - less 25% off building
- less 12% off contents

(iv) Grade(III) water supply - less (30% + 10%)

(v) Sprinkler discount - less 20%

(vi) Long term agreement - less 5%

B5.0 Insurance rate - consequential loss - sprinklered building

(i) Basic rate - 0.175p%

(ii) 75 - 100 assistants - 0.1375p%

(iii) Percentage applied to gross profit - 150%

(iv) Percentage applied to wages - 81%

(v) Water Supply and hand appliances - less 40%

(vi) Sprinkler discount - ⅓rd

(vii) Long term agreement - 5%

AMENDMENT B

		£
B11.0	Cost of insurance per annum - Sprinklered Building	
	Building	
	0.3125p%-25%-40%-20%-5% = 0.1069p%x£22869.00	244.47
	Contents	
	0.3125p%-12½%-40%-20%-5% = 0.1247p%x£92000.00	114.72
	Consequential loss	
	Gross profit	
	150% of 0.3125p%-40%-⅓rd%-5% = 0.178p%x£150000.00	267.00
	Wages	
	81% of 0.3125p%-40%-⅓rd%-5% = 0.096p%x£110000.00	105.60
		£731.79

		£
B12.0	Annual saving in insurance premium - assuming building is classed as Drapery - Standard of Construction Class III	
B12.1	Cost of insurance per annum - unsprinklered building	1845.00
B12.2	Cost of insurance per annum - sprinklered building	731.00
		1114.00
B12.3	Less annual costs resulting from installation as 9.0	256.00
	1st year premium saving	£ 858.00

B12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th year, the saving will be reduced by £100.00 due to maintenance.

AMENDMENT B

The cash flows resulting from the annual premium saving together with taxation allowances have been discounted in Table 13 page 230

Retail Premises No allowance for inflation Service Industry - No Government Grant				Discount rate 5%		NPV per m^2 = £0.09		Sprinkler Installation AMENDMENT B		CASE STUDY No 3 Building, contents and consequential loss classed as "Drapery Shops".	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	5177	858	-	-	-	-	-	(-4319)	(-4319)	1.00	(-4319.00)
1		808	429	5177	2589	NA	-2160	2968	2968	0.952381	2826.67
2		808	404				404	404	404	0.907029	366.44
3		808	404				404	404	404	0.863838	348.99
4		808	404				404	404	404	0.822702	332.37
5		708	404				404	304	304	0.783526	238.19
6		808	354				354	454	454	0.746215	338.78
7		808	404				404	404	20	0.710681	14.21
8			404				404	(-404)	-	-	-
									Net Present Value		£146.65

Table 13 Cash flows resulting from the installation of a sprinkler system in retail premises classed as a "Drapery Shop".

13.0 Installation of an automatic detector system £

13.1 Effect on insurance premium

13.1.1 ALTERNATIVE 1 - BUILDING AND CONTENTS CLASSED AS "OTHER SHOPS"

Insurance premium for the building unprotected as section 7.0	-	744.50
Insurance premium after the installation of a Class A Detector system (reduction of 12½%)	-	651.50
Gross premium saving		£ 93.00

13.1.2 ALTERNATIVE 2 - BUILDING, CONTENTS AND CONSEQUENTIAL LOSS CLASSED AS "OTHER SHOPS"

		£
Insurance premium for the building unprotected as section A.7.0	-	1256.00
Insurance premium after the installation of a Class A Detector system (reduction of 12½%)	-	1099.00
Gross premium saving		£ 157.00

13.1.3 ALTERNATIVE 3 - BUILDING, CONTENTS AND CONSEQUENTIAL LOSS CLASSED AS "DRAPERY"

		£
Insurance premium for the building uprotected as section B.7.0	-	1845.00
Insurance premium after the installation of a Class A Detector system (reduction of 12½%)	-	1615.00
Gross premium saving		£ 230.00

13.2 Capital cost of installation		£
13.2.1 Budget price from AFA-Minerva for a smoke/ heat detection system	-	2500.00
13.2.2 V.F.A. signalling connection charge	-	35.00
13.2.3 Loss of interest resulting from progress payments until the installation is completed. say 1 month x £1000 = £1000 x $\frac{.833}{100}$ say		8.00
13.2.4 Architects, Surveyors and consultants fees for additional work - advice design and valuation. 10% on £2500.00		250.00
13.2.5 Loss of production	-	not applicable
13.2.6 Cost of executives time in making decision as to whether an installation should be installed		not calculated
		£2793.00

13.3 Annual costs resulting from the installation of an automatic detector system		£
13.3.1 Rates (commercial rate 1973 - 40p in the £1) The increase in ratable value would be based upon the cost of installation as follows:- 5% of the capital cost x rate payable $= \frac{5}{100} \times 2500 \times \frac{40}{100}$	-	50.00
13.3.2 Maintenance - servicing of system, quotation from AFA/Minerva	-	78.00
13.3.3 Rental and maintenance of V.F.A. signalling		160.00
		£288.99

13.4 Annual saving in insurance premium £

13.4.1 ALTERNATIVE 1 - gross premium saving as

13.1.1 - 93.00

LESS

Annual costs resulting from installation - 288.00

£-195.00

The cash flows from alternative 1 have been discounted in Table 14 - p. 234

13.4.2 ALTERNATIVE 2 - gross premium saving as £

13.1.2 - 157.00

LESS

Annual costs resulting from installation - 288.00

£-131.00

The cash flows from alternative 2 have been discounted in Table 15 - p. 235

13.4.3 ALTERNATIVE 3 - gross premium saving as £

13.1.3 - 230.00

LESS

Annual costs resulting from installation - 288.00

£- 58.00

The cash flows from alternative 3 have been discounted in Table 16 - p. 236

Retail Premises No allowance for inflation Service Industry - No Government Grant				Discount rate 5%			Automatic detector installation ALTERNATIVE I			CASE STUDY No 3 Building and Contents classed as "other shops"	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual cost of installation £	Taxation allowance against annual cost £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant £	Corporation tax allowed (C+E) £	Cash flow (G-B-A) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	2793	195	-	-	-	-	-	(-2988)	(-2988)	1.00	(-2988.00)
1		195	98	2793	1396	NA	1494	1299	1299	0.952381	1237.14
2		195	98				98	(- 99)	)	)	)
3		195	98				98	(- 99)	)	)	)
4		195	98				98	(- 99)	)	)	)
5		195	98				98	(- 99)	)	)	)
6		195	98				98	(- 99)	)	)	)
7		195	98				98	(- 99)	)	x11.2741	)
8		195	98				98	(- 99)	(- 99)	x 0.952381	(-1062.99)
9		195	98				98	(- 99)	)	)	)
10		195	98				98	(- 99)	)	)	)
11		195	98				98	(- 99)	)	)	)
12		195	98				98	(- 99)	)	)	)
13		195	98				98	(- 99)	)	)	)
14		195	98				98	(- 99)	)	)	)
15		195	98				98	(- 99)	)	)	)
16		195	98				98	(- 99)	)	)	)
17		195	98				98	(- 99)	)	)	)
18		195	98				98	(- 99)	)	)	)
19		-	98				98	98	98	0.395734	38.78
									Net Present Value		£-2773.00

Table 14 Cash flows resulting from the installation of an automatic detector system in retail premises classed as "other shops". No insurance for consequential loss.

Retail Premises No allowance for inflation Service Industry - No government grant				Discount rate 5%			Automatic detector installation ALTERNATIVE 2			CASE STUDY No 3 Building, Contents and Consequential loss as "other shops"	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual cost of installation £	Taxation allowance against annual cost £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant £	Corporation tax allowed (C+E) £	Cash flow (G-B-A) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	2793	131	-	-	-	-	-	(-2924)	(-2924)	1.00	(-2924.00)
1		131	66	2793	1396	NA	1462	1331	1331	0.952381	1267.62
2		131	66				66	(- 65))	)		)
3		131	66				66	(- 65))	)		)
4		131	66				66	(- 65))	)		)
5		131	66				66	(- 65))	)		)
6		131	66				66	(- 65))	)		)
7		131	66				66	(- 65))	)		)
8		131	66				66	(- 65))	(- 65))	x11.2741	)
9		131	66				66	(- 65))	)	x 0.952381	(- 697.92)
10		131	66				66	(- 65))	)		)
11		131	66				66	(- 65))	)		)
12		131	66				66	(- 65))	)		)
13		131	66				66	(- 65))	)		)
14		131	66				66	(- 65))	)		)
15		131	66				66	(- 65))	)		)
16		131	66				66	(- 65))	)		)
17		131	66				66	(- 65))	)		)
18		131	66				66	(- 65))	)		)
19			66				66	66	66	0.395734	26.12
									Net Present Value		£-2328.18

Table 15 Cash flows resulting from the installation of an automatic detector system in retail premises classed as "other shops".

Retail Premises No allowance for inflation Service Industry - No government grant				Discount rate 5%			Automatic detector installation ALTERNATIVE 3			CASE STUDY No 3 Building, Contents and consequential loss classed as "Drapery Shops".	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual cost of installation £	Taxation allowance against annual cost £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant £	Corporation tax allowed (C+E) £	Cash flow (G-B-A) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	2793	58	-	-	-	-	-	(-2735)	(-2735)	1.00	(-2735.00)
1		58	29	2793	1396	NA	1425	1367	1367	0.952381	1301.90
2		58	29				29	(- 29))	)		)
3		58	29				29	(- 29))	)		)
4		58	29				29	(- 29))	)		)
5		58	29				29	(- 29))	)		)
6		58	29				29	(- 29))	)		)
7		58	29				29	(- 29))	)		)
8		58	29				29	(- 29))	(- 29))	x11.2741	(-311.38)
9		58	29				29	(- 29))	)	x 0.952381	)
10		58	29				29	(- 29))	)		)
11		58	29				29	(- 29))	)		)
12		58	29				29	(- 29))	)		)
13		58	29				29	(- 29))	)		)
14		58	29				29	(- 29))	)		)
15		58	29				29	(- 29))	)		)
16		58	29				29	(- 29))	)		)
17		58	29				29	(- 29))	)		)
18		58	29				29	(- 29))	)		)
19		-	29				29	29	29	0.395734	11.48
									Net Present Value		£-1733.00

Table 16 Cash flows from the installation of an automatic detector system in retail premises classed as a "Drapery Shop".

APPENDIX C

CASE STUDY NO 4

1.0 The Company

1.1 An old established firm of furniture retailers who propose to sell directly to the public from a purpose built warehouse. The Insurance Company would in all probability regard the use of the building as a warehouse rather than retail premises. The rating authority would certainly regard the building as a warehouse.

Whether regarded as a warehouse or as retail premises, the building use is classed as a "service industry" and would not qualify for a Government Grant.

The number of people employed in the building would be 12.

2.0 The Building

2.1 Details

Floor area - $3400m^2$

Height to eaves - 4 metres

2.2 Description

Single storey steel portal construction with brickwork externally to eaves level and gables. Asbestos cement sheeted roof with flame retardent roof lights and fireproof lining to the underside of the roof area.

2.3 Standard V Construction

3.0 Basic insurance rate - Classed as a Warehouse

3.1 The basic rate for the building is 0.25p%.

4.0 Adjustment of the basic rate

4.1 Provision of fire extinguishers reduces the basic rate by 10%.

4.2 The scale of percentage adjustment for a furniture warehouse is + 400%.

4.3 The consequential loss rating adjustment is + 50%.

4.3.1 Wages are insured for 100% of cost for the first 4 weeks and 20% for the remainder of the first year. Rate - 76% of the basic rate.

4.3.2 Gross profit is insured at a rate of 150% of the basic rate.

5.0 Adjustment of the basic rate resulting from the Installation of a sprinkler system

5.1 The tariff company quotation allowed the following reductions for a sprinklered building:-

5.1.1 40% off the basic rate, made up of 30% for an installation with grade III water supply and 10% for ordinary hand appliances.

5.1.2 20% off the basic rate which is the Scale of Percentage Adjustment allowance.

5.1.3 Consequential loss is reduced by 40%, made up of 30% + 10% as 5.1.1 with a further Scale of Percentage Adjustment allowance of $\frac{1}{3}$rd.

			£
6.0	Sums insured		
6.1	Building	- replacement value	175000.00
		- fees 10%	17500.00
6.2	Contents	-	50000.00
	(Value of the contents is low because although the building is classed as a warehouse, the function is to sell directly to the public and the furniture is laid out for viewing)		£242500.00

			£
6.3	Consequential loss		
6.3.1	Gross profit	-	130000.00
	(Based on the clients estimation of a gross profit of £2500.00 per week)		
			£
6.3.2	Wages	-	20000.00

		£
7.0	Cost of insurance per annum - Unsprinklered building	
7.1	Building and contents	
	0.25p%-10%+400% = £1.125p%x£242500.00	2728.13
7.2	Consequential loss (12 months)	
7.2.1	Gross profit	
	150% of 0.25p%-10%+50% = 0.50625p% x £130000.00	658.13
7.2.2	Wages	
	76% of 0.25p%-10%+50% = 0.257p% x £20000.00	51.40
		£3437.66

8.0 Cost of sprinkler installation £

8.1 Capital cost - based on a budget price from AFA-Minerva. 400 sprinkler heads - 8100.00

8.2 Connection to water company main - budget price from Water Board based on a 6" connection to far side of roadway (12" main) and all necessary reinstatement. - 350.00

8.3 Direct link to centrally manned control - not calculated

8.4 Loss of floor area due to sprinkler control valves, storage of water, pumps etc. - not applicable

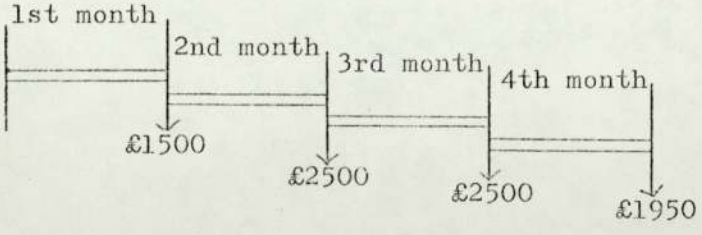
8.5 Loss of interest resulting from progress payments until the installation is commissioned.

(i) capital cost - £8450.00

(ii) estimated duration of installation - 4 months

(iii) interest rate say .833% per month

Financing Pattern



£1500 outstanding for 3 months - $1500 \times \frac{.833}{100} \times 3$

£2500 outstanding for 2 months - $2500 \times \frac{.833}{100} \times 2$ say 100.00

£2500 outstanding for 1 month - $2500 \times \frac{.833}{100}$

carried forward £8550.00

8.0 Cost of sprinkler installation (cont)		£
	brought forward	8550.00
8.6 Architects, surveyors and consultants fees for additional work - advice design and valuation.	10% of £8450.00	845.00
8.7 Loss of production - new building		not applicable
8.8 Cost of executive time in making decision to install		not calculated
		£9395.00

9.0 Annual costs resulting from the installation of a sprinkler system		£
9.1 Rates, 1973 (Commercial rate payable 42.1p in the £1) Valuation officer said that increase in valuation would be based on 5% of the capital cost as follows:-		
$= \frac{5}{100} \times 8450 \times \frac{42.1}{100}$	-	177.87
9.2 Water rate (Rate payable 4.48p in the £1). Water rate is based on the increase in the net annual value		
$= £422 \times \frac{4.48}{100}$	-	18.90
	carried forward	£196.77

9.0 Annual costs resulting from the installation of a sprinkler system (cont)	£
brought forward	196.77
9.3 Cost of water supply - The charges for the supply of water per annum are:-	
(a) connection to the main - £ 3.47	
(b) every 100 sprinkler heads or part 4 x 87p - 3.48	6.95
9.4 Direct link and monitoring of valves	not included
9.5 Sprinkler leakage	
9.5.1 Building 1d% + 150% (not considered necessary because of the nature of the building, negligible damage by water)	-
9.5.2 Contents $2\frac{1}{2}$p%+150%=0.0625p%x£ 50000.00	31.25
	£234.97

10.0 Other charges resulting from the installation of a sprinkler system	£
10.1 Servicing of the installation - charge based on two visits per annum by a Sprinkler Engineer at £25.00 per visit. For the first twelve months, servicing visits are not charged.	50.00
10.2 Maintenance, Cost of repairs and replacement assumed to occur during the 5th year. Cost £100.00	

11.0 Cost of insurance per annum - Sprinklered Building £

Tariff Company Quotation

		£	£
11.1	Building and contents	242500.00	
	Cost of sprinkler installation	8100.00	
	0.25p%-40%-20% = 0.12p%x£250600.00		300.72
11.2	Consequential loss		
11.2.1	Gross profit		
	150% of 0.25p%-40%-⅓rd = 0.15p% x £130000.00		195.00
11.2.2	Wages		
	76% of 0.25p%-40%-⅓rd = 0.076p% x £20000.00		15.20
			£510.92

12.0 Annual saving in insurance premiums £

12.1	Cost of insurance per annum - unsprinklered building	3437.00
12.2	Cost of insurance per annum - sprinklered building	511.00
		2926.00
12.3	Less annual costs resulting from installation	235.00
	1st year premium saving	£2691.00

12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th, 10th and 15th years the saving will be reduced by £100.00 due to maintenance.

The cash flows resulting from the annual premium savings together with taxation allowances have been discounted in Table 17 page 245.

Retail Premises classed as a Warehouse No allowance for inflation				Discount rate 5%		$\frac{NPV}{m^2}$ = £3.52		Sprinkler Installation		CASE STUDY No 4 Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash Flow £	Discount rate 5%	NPV at 5%
0	9395	2691	-	-	-	-	-	(-6704)	(-6704)	1.00	(-6704.00
1		2641	1346	9395	4697	NA	-3351	5992	5992	0.952381	5706.67
2		2641	1321				1321	1320	1320	0.907029	1197.28
3		2641	1321				1321	1320	1320	0.863838	1140.27
4		2641	1321				1321	1320	1320	0.822702	1085.97
5		2541	1321				1321	1220	1220	0.783526	955.90
6		2641	1271				1271	1370	1370	0.746215	1022.31
7		2641	1321				1321	1320	1320	0.710681	938.10
8		2641	1321				1321	1320	1320	0.676839	893.43
9		2641	1321				1321	1320	1320	0.644609	850.88
10		2541	1321				1321	1320	1220	0.613913	748.97
11		2641	1271				1271	1370	1370	0.584679	801.01
12		2641	1321				1321	1320	1320	0.556837	735.02
13		2641	1321				1321	1320	1320	0.530321	700.02
14		2641	1321				1321	1320	1320	0.505068	666.69
15		2541	1321				1321	1220	1220	0.481017	586.84
16		2641	1271				1271	1370	1370	0.458112	627.61
17		2641	1321				1321	1320	62	0.436297	27.05
18			1321				1321	(-1321)	-	-	-
									Net Present Value		£11980.02

Table 17 Cash flows resulting from the installation of a sprinkler system in retail premises classed by the Insurance Company as a warehouse.

ALTERNATIVE A

A3.0 Basic insurance rate - Classed as retail premises

A3.1 The basic rate for the building is 0.175p%

A4.0 Adjustment of the basic rate

A4.1 There is no reduction for the provision of hand extinguishers in this tariff.

A4.2 The Scale of Percentage Adjustment is + 150%.

A4.3 There is no consequential loss rating adjustment.

A5.0 Adjustment of the basic rate resulting from the installation of a sprinkler system

A5.1 The tariff company quotation allowed the following reductions for a sprinklered building:-

A5.1.1 40% off the basic rate for a grade III water supply together with 10% for ordinary hand appliances.

A5.1.2 20% off the basic rate which is the Scale of Percentage Adjustment allowance.

A5.1.3 Consequential loss is reduced by 40% as A5.1.1, with a further Scale of Percentage Adjustment allowance of $\frac{1}{3}$rd.

ALTERNATIVE A

A7.0 Cost of insurance per annum - Unsprinklered building £

A7.1 Building and contents

0.175p%+150% = 0.4375p%x£242500.00 1060.94

A7.2 Consequential loss (12 months)

A7.2.1 Gross profit

150% of 0.175p% = 0.2625p%x£130000.00 341.25

A7.2.2 Wages

76% of 0.175p% = 0.133p%x£20000.00 26.60

£1428.79

A11.0 Cost of insurance per annum - Sprinklered building £

		£	
A11.1	Building and contents	242500.00	
	Cost of sprinkler installation	8100.00	
	0.175p%-40%-20% = 0.084p% x	250600.00	210.50

A11.2 Consequential loss

A11.2.1 Gross profit

150% of 0.175p%-40%-$\frac{1}{3}$rd =

0.105p%x£130000.00 136.50

A11.2.2 Wages

76% of 0.175p%-40%-$\frac{1}{3}$rd =

0.053p%x£20000.00 10.60

£357.60

ALTERNATIVE A

A12.0 Annual saving in insurance premium £

A12.1 Cost of insurance per annum - unsprinklered building 1428.00

A12.2 Cost of insurance per annum - sprinklered building 357.00

1071.00

A12.3 Less annual costs resulting from installation 235.00

1st year premium saving £ 836.00

A12.4 After the 1st year, the cost of servicing will reduce the annual saving by £50.00 per annum. In the 5th year the saving will be reduced by £100.00 due to maintenance.

The cash flows resulting from the annual premium savings together with taxation allowances have been discounted in Table 18 page 249.

Retail Premises No allowance for inflation ALTERNATIVE A				Discount rate 5%		$\frac{NPV}{m^2}$ = £0.02		Sprinkler Installation		CASE STUDY No 4 Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government Grant £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	9395	836	-	-	-	-	-	(-8559)	(-8559)	1.00	(-8559.00)
1		786	418	9395	4697	NA	-4279	5065	5065	0.952381	4823.81
2		786	393				393	393	393	0.907029	356.46
3		786	393				393	393	393	0.863838	339.49
4		786	393				393	393	393	0.822702	323.32
5		686	393				393	293	293	0.783526	229.57
6		786	343				343	443	443	0.746215	330.57
7		786	393				393	393	393	0.710681	279.30
8		786	393				393	393	393	0.676839	265.30
9		786	393				393	393	393	0.644609	253.33
10		686	393				393	293	293	0.613913	179.88
11		786	343				343	443	443	0.584679	259.01
12		786	393				393	393	393	0.556837	218.84
13		786	393				393	393	393	0.530321	208.42
14		786	393				393	393	393	0.505068	198.49
15		686	393				393	293	293	0.481017	140.94
16		786	343				343	443	443	0.458112	202.94
17		786	393				393	393	19	0.436297	8.29
18		-	393				393	(-393)	-		
									Net Present Value		£58.96

Table 18 Cash flows resulting from the installation of a sprinkler system in retail premises.

APPENDIX D

Case Study No 2 used for alternative industrial processes.

The figures from Case Study No 2 - Appendix C have been used as a "model" for calculating the cash flows resulting from the installation of a sprinkler system, if the building were used for the following purposes:-

(I) Light Engineering.

(II) Light Engineering associated with plastics.

(III) Printing.

(IV) Rubber stamp manufacturing.

(V) Radio/TV assembly.

(VI) Hosiery (Knitwear) manufacturing.

(VII) Boot and Shoe manufacturing.

APPENDIX D

LIGHT ENGINEERING

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.15p%-10%+50% = 0.2025p%x£114350.00	231.56
(ii) Consequential Loss	
(a) Gross Profit	
150% of 0.15p%-10%+10% = 0.22275p%x£36000.00	80.19
(b) Wages	
81% of 0.15p%-10%+10% = 0.120285p%x£60000.00	72.17
	£383.92

B Premium - Sprinklered building	£
(i) Building Contents	
0.15p%-42½%-20% = 0.069p%x£114350.00	78.90
(ii) Consequential loss	
(a) Gross Profit	
150% of 0.15p%-42½%-⅓rd = 0.0862p%x£36000.00	31.03
(b) Wages	
81% of 0.15p%-42½%-⅓rd = 0.046575p%x£60000.00	27.95
	£137.88

C Annual saving in insurance premiums	£
Cost of insurance per annum - unsprinklered building	384.00
Cost of insurance per annum - sprinklered building	138.00
	246.00
Less annual costs resulting from installation	97.00
	£149.00

APPENDIX D

LIGHT ENGINEERING (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss £

$$\left.\begin{array}{lllll} 0.2025 & \times & 1.1435 & = & 0.232 \\ 0.22275 & \times & 0.36 & = & 0.080 \\ 0.120285 & \times & 0.60 & = & 0.072 \end{array}\right) = \frac{0.384}{2.1035} = 0.191\text{p}\%$$

The cash flows resulting from the annual premium saving have been discounted in Table 19. p. 253

Light Engineering 20% development grant No allowance for inflation			Discount rate 5%		$\frac{NPV}{m^2}$ = £-0.68		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash Flow (B+F-A-G) £	Adjusted Cash flow £	Discount rate 5%	NPV at 5%
0	2800	149	-	-	-	-	-	(-2651)	(-2651)	1.00	(-2651.00)
1		99	75	2800	1400	530	-1325	1954	1954	0.952381	1860.95
2		99	50				50	49	49	0.907029	44.44
3		99	50				50	49	49	0.863838	42.33
4		99	50				50	49	2	0.822702	1.65
5		-	50				50	(-50)	-	-	-
6		99	-				-	99	99	0.746215	73.88
7		99	50				50	49	49	0.710681	34.82
8		99	50				50	49	49	0.676839	33.16
9		99	50				50	49	49	0.644609	31.58
10		99	50				50	49	2	0.613913	1.23
11			50				50	(-50)	-	-	-
									Net Present Value		£-527.04

Table 19 Cash flows resulting from the installation of a sprinkler system in the building, which forms Case Study No 2 - Appendix C, when used for light engineering.

APPENDIX D

LIGHT ENGINEERING AND PLASTICS

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.275p%-10%+50% = 0.37125%x£114350.00	424.52
(ii) Consequential loss	
(a) Gross Profit	
150% of 0.275p%-10%+10% = 0.4084p%x£36000.00	147.02
(b) Wages	
81% of 0.275p%-10%+10% = 0.221p%x£60000.00	132.60
	£704.14

B Premium - Sprinklered Building	£
(i) Building and Contents	
0.275p%-42½%-20% = 0.1265p%x£114350.00	144.65
(ii) Consequential loss	
(a) Gross Profit	
150% of 0.275p%-42½%-⅓rd = 0.15813p%x£36000.00	56.93
(b) Wages	
81% of 0.275p%-42½%-⅓rd = 0.085p%x£60000.00	51.24
	£252.82

C Annual saving in insurance premium	£
Cost of insurance per annum - unsprinklered building	704.00
Cost of insurance per annum - sprinklered building	253.00
	451.00
Less annual costs resulting from installation	97.00
	£354.00

LIGHT ENGINEERING AND PLASTICS (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss

$$\left.\begin{array}{lcll} 0.37125 & \times & 1.1435 = 0.425 &) \\ & & &) \\ 0.4084 & \times & 0.36 = 0.147 &) \\ & & &) \\ 0.221 & \times & 0.60 = 0.1326 &) \end{array}\right\} = \frac{0.7046}{2.1035} = 0.335\text{p}\%$$

The cash flows resulting from the annual premium savings have been discounted in Table 20. p. 256.

Light Engineering and Plastics No allowance for inflation 20% development allowance				Discount rate 5%		$\frac{NPV}{m^2}$ = £0.53		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash flow £	Discount rate 5%	NPV at 5%
0	2800	354	-	-	-	-	-	(-2446)	(-2446)	1.00	(-2446.00)
1		304	177	2800	1400	530	-1223	2057	2057	0.952381	1959.05
2		304	152				152	152	152	0.907029	137.87
3		304	152				152	152	152	0.863838	131.30
4		304	152				152	152	152	0.822702	125.05
5		204	152				152	52	52	0.783526	40.74
6		304	102				102	202	202	0.746215	150.73
7		304	152				152	152	152	0.710681	108.02
8		304	152				152	152	152	0.676839	102.88
9		304	152				152	152	152	0.644609	97.98
10		304	152				152	152	7	0.613913	4.30
11		-	152				152	(-152)	-	-	-
									Net Present Value		£411.92

Table 20 Cash flows resulting from the installation of a sprinkler system in the building, which forms Case Study No 2 - Appendix C, when used for light engineering associated with plastics.

APPENDIX D

PRINTERS

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.275p%-10%+25% = 0.309p%x£134400.00	415.30
(ii) Consequential loss	
(a) Gross profit	
150% of 0.275p%-10%+75% = 0.65p%x£36000.00	234.00
(b) Wages	
81% of 0.275p%-10%+75% = 0.351p%x£40000.00	140.40
	£789.70

B Premium - Sprinklered building	£
(i) Building and Contents	
0.275p%-37½%-20% = 0.1375p%x£134400	184.80
(ii) Consequential loss	
(a) Gross profit	
150% of 0.275p%-37½%-⅓rd = 0.1719p%x£36000.00	61.88
(b) Wages	
81% of 0.275p%-37½%-⅓rd = 0.093%x£40000.00	37.20
	£283.88

C Annual saving in insurance premiums	£
Cost of insurance per annum - unsprinklered building	790.00
Cost of insurance per annum - sprinklered building	284.00
	506.00
Less annual costs resulting from installation	97.00
	£409.00

APPENDIX D

PRINTERS (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss

$$\left.\begin{array}{lllll} 0.309 & \times & 1.344 & = & 0.415 \\ 0.65 & \times & 0.36 & = & 0.234 \\ 0.351 & \times & 0.40 & = & 0.140 \end{array}\right) = \frac{0.789}{2.104} = 0.375\text{p\%}$$

The cash flows resulting from the annual premium savings have been discounted in Table 21. p. 259.

Printers 20% development grant No allowance for inflation				Discount rate 5%		$\frac{NPV}{m^2}$ = £0.89		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash Flow £	Discount rate 5%	NPV at 5%
0	2800	409	-	-	-	-	-	(-2391)	(-2391)	1.00	(-2391.00)
1		359	205	2800	1400	530	-1195	2120	2120	0.952381	2019.05
2		359	180				180	179	179	0.907029	162.36
3		359	180				180	179	179	0.863838	154.63
4		359	180				180	179	179	0.822702	147.26
5		259	180				180	79	79	0.783526	61.90
6		359	130				130	229	229	0.746215	170.88
7		359	180				180	179	179	0.710681	127.21
8		359	180				180	179	179	0.676839	121.15
9		359	180				180	179	179	0.644609	115.38
10		359	180				180	179	8	0.613913	4.91
11		-	180				180	(-180)	-	-	-
									Net Present Value		£693.73

Table 21 Cash flows resulting from the installation of a sprinkler system in the building, which forms Cast Study No 2 - Appendix C, when used as a printing works.

APPENDIX D

RADIO/TV ASSEMBLY

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.20p%-10%+150% = 0.45p%x£134400.00	604.80
(ii) Consequential loss	
(a) Gross profit	
150% of 0.20p%-10%+75% = 0.4725p%x£36000.00	170.10
(b) Wages	
81% of 0.20p%-10%+75% = 0.255p%x£40000.00	102.00
	876.90

B Premium - Sprinklered building	£
(i) Building and Contents	
0.20p%-42½%-20% = 0.092p%x£134400.00	123.65
(ii) Consequential loss	
(a) Gross profit	
150% of 0.20p%-42½%-⅓rd = 0.11505p%x£36000.00	41.42
(b) Wages	
81% of 0.20p%-42½%-⅓rd = 0.062p%x£40000.00	24.80
	£189.87

C Annual saving in insurance premium	£
Cost of insurance per annum - unsprinklered building	877.00
Cost of insurance per annum - sprinklered building	190.00
	687.00
Less annual costs resulting from installation	97.00
	£590.00

APPENDIX D

RADIO/TV ASSEMBLY (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss

$$\left.\begin{array}{lllll} 0.45 & \times & 1.344 & = & 0.605 \\ 0.4725 & \times & 0.36 & = & 0.170 \\ 0.255 & \times & 0.40 & = & 0.102 \end{array}\right\} = \frac{0.877}{2.104} = 0.417p\%$$

The cash flows resulting from the annual premium savings have been discounted in Table 22. p. 262

Radio/TV Assembly 20% development grant No allowance for inflation			Discount rate 5%		NPV= £1.92 / m^2		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash flow £	Discount rate 5%	NPV at 5%
0	2800	590	-	-	-	-	-	(-2210)	(-2210)	1.00	(-2210.00)
1		540	295	2800	1400	530	-1105	2175	2175	0.952381	2071.43
2		540	270				270	270	270	0.907029	244.90
3		540	270				270	270	270	0.863838	233.24
4		540	270				270	270	270	0.822702	222.13
5		440	270				270	170	170	0.783526	133.20
6		540	220				220	320	320	0.746215	238.79
7		540	270				270	270	270	0.710681	191.88
8		540	270				270	270	270	0.676839	182.75
9		540	270				270	270	270	0.644609	174.04
10		540	270				270	270	13	0.613913	7.98
11		-	270				270	(-270)	-	-	-
									Net Present Value		£1490.34

Table 22 Cash flows resulting from the installation of a sprinkler system in the building, which forms Case Study No 2 - Appendix C, when used for radio or TV assembly.

APPENDIX D

RUBBER STAMP MANUFACTURER

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.25p%-10%+150% = 0.5625p%x£134400.00	756.00
(ii) Consequential loss	
(a) Gross profit	
150% of 0.25p%-10% = 0.3375p%x£36000.00	121.50
(b) Wages	
81% of 0.25p%-10% = 0.182p%x£40000.00	72.80
	£950.30

B Premium - Sprinklered Building	£
(i) Building and Contents	
0.25p%-50%-20% = 0.10p%x£134400.00	134.40
(ii) Consequential loss	
(a) Gross profit	
150% of 0.25p%-50%-$\frac{1}{3}$rd = 0.12499p%x£36000.00	45.00
(b) Wages	
81% of 0.25p%-50%-$\frac{1}{3}$rd = 0.0675p%x£40000.00	27.00
	£206.40

C Annual saving in insurance premium	£
Cost of insurance per annum - unsprinklered building	950.00
Cost of insurance per annum - sprinklered building	206.00
	744.00
Less annual costs resulting from installation	97.00
	£647.00

APPENDIX D

RUBBER STAMP MANUFACTURER (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss

$$\left.\begin{array}{llll} 0.5625 \times 1.344 = 0.756 \\ 0.3375 \times 0.36 = 0.1215 \\ 0.182 \times 0.40 = 0.0728 \end{array}\right) = \frac{0.9503}{2.104} = 0.452p\%$$

The cash flows resulting from the annual premium savings have been discounted in Table 23. p. 265.

Rubber Stamp Manufacturer 20% development grant No allowance for inflation				Discount rate 5%		$\frac{NPV}{m^2}$ = £2.25		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash Flow (B+F-A-G) £	Adjusted Cash flow £	Discount rate 5%	NPV at 5%
0	2800	647	-	-	-	-	-	(-2153)	(-2153)	1.00	(-2153.00)
1		597	324	2800	1400	530	-1076	2203	2203	0.952381	2098.09
2		597	299				299	298	298	0.907029	270.29
3		597	299				299	298	298	0.863838	257.42
4		597	299				299	298	298	0.822702	245.16
5		497	299				299	198	198	0.783526	155.14
6		597	249				249	348	348	0.746215	259.68
7		597	299				299	298	298	0.710681	211.78
8		597	299				299	298	298	0.676839	201.70
9		597	299				299	298	298	0.644609	192.09
10		597	299				299	298	14	0.613913	8.59
11		-	299				299	(-299)	-	-	-
									Net Present Value		£1746.94

Table 23 Cash flows resulting from the installation of a sprinkler system in the building, which forms Case Study No 2 - Appendix C, when used for the manufacture of rubber stamps.

APPENDIX D

HOSIERY (KNITWEAR) MANUFACTURER

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.20p%-10%+500% = 1.08p%x£134400.00	1451.52
(ii) Consequential loss	
(a) Gross profit	
150% of 0.20p%-10%+175% = 0.7425p%x£36000.00	267.30
(b) Wages	
81% of 0.20p%-10%+175% = 0.401p%x£40000.00	160.40
	£1877.22

B Premium - Sprinklered building	£
(i) Building and Contents	
0.20p%-45%-20% = 0.088p%x£134400.00	118.27
(ii) Consequential loss	
(a) Gross profit	
150% of 0.20p%-45%-$\frac{1}{3}$rd = 0.1099p%£36000.00	39.56
(b) Wages	
81% of 0.20p%-45%-$\frac{1}{3}$rd = 0.059p%x£40000	23.60
	£181.43

C Annual saving in insurance premium	
Cost of insurance per annum - unsprinklered building	1877.00
Cost of insurance per annum - sprinklered building	181.00
	1696.00
Less annual costs resulting from installation	97.00
	£1599.00

APPENDIX D

HOSIERY (KNITWEAR) MANUFACTURER (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss

1.08	x	1.344	=	1.4515	)			
					)			
0.7425	x	0.36	=	0.2673	)	=	1.8792	= 0.893p%
					)			
0.401	x	0.40	=	0.1604	)		2.104	

The cash flows resulting from the annual premium savings have been discounted in Table 24. p. 268.

Hosiery (Knitwear) Manufacturer 20% development grant No allowance for inflation				Discount rate 5%		$\frac{NPV}{m^2}$ = £7.84		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted Cash flow £	Discount rate 5%	NPV at 5%
0	2800	1599	-	-	-	-	-	(-1201)	(-1201)	1.00	(-1201.00)
1		1549	799	2800	1400	530	-601	2680	2680	0.952381	2552.38
2		1549	775				775	774	774	0.907029	702.04
3		1549	775				775	774	774	0.863838	668.61
4		1549	775				775	774	774	0.822702	636.77
5		1449	775				775	674	674	0.783526	528.10
6		1549	725				725	824	824	0.746215	614.88
7		1549	775				775	774	774	0.710681	550.07
8		1549	775				775	774	774	0.676839	523.87
9		1549	775				775	774	774	0.644609	498.93
10		1549	775				775	774	36	0.613913	22.10
11		-	775				775	(-775)	-	-	-
									Net Present Value		£6096.75

Table 24 Cash flows resulting from the installation of a sprinkler system in the building, which forms Case Study No 2 - Appendix C, when used for the manufacture of hosiery.

APPENDIX D

BOOT AND SHOE MANUFACTURER

A Premium - Unsprinklered building	£
(i) Building and Contents	
0.325p%-10%+400% = 1.4625p%x£134400.00	1965.60
(ii) Consequential loss	
(a) Gross profit	
150% of 0.325p%-10%+50% = 0.65813p%x£36000.00	236.93
(b) Wages	
81% of 0.325p%-10%+50% = 0.355p%x£40000.00	142.00
	£2344.53

B Premium - Sprinklered building	£
(i) Building and Contents	
0.325p%-45%-33⅓%-20% = 0.0953p%x£134400.00	128.08
(ii) Consequential loss	
(a) Gross profit	
150% of 0.325p%-45%-33⅓%-⅓rd = 0.1192p% x £36000.00	42.91
(b) Wages	
81% of 0.325p%-45%-33⅓%-⅓rd = 0.0644p% x £40000.00	25.76
	£196.75

C Annual saving in insurance premium	£
Cost of insurance per annum - unsprinklered building	2344.00
Cost of insurance per annum - sprinklered building	197.00
	2147.00
Less annual costs resulting from installation	97.00
	£2050.00

APPENDIX D

BOOT AND SHOE MANUFACTURER (Cont)

D Average cost of insurance per £100 of building, contents and consequential loss

$$\left.\begin{array}{rcrcl} 1.4625 & x & 1.344 & = & 1.9656 \\ 0.65813 & x & 0.36 & = & 0.2369 \\ 0.355 & x & 0.40 & = & 0.142 \end{array}\right) = \frac{2.3445}{2.104} = 1.114p\%$$

The cash flows resulting from the annual premium savings have been discounted in Table 25. p. 271.

Boot and Shoe Manufacturer No allowance for inflation 20% development grant				Discount rate 5%		$\frac{NPV}{m^2}$ = £10.49		Sprinkler Installation		Appendix D Tariff Market Quotation	
	A	B	C	D	E	F	G	H	I	J	K
Year	Capital Expenditure £	Annual Premium Saving £	50% corporation tax on premium saving £	Initial allowance against capital expenditure £	Tax allowance (Dx50%) £	Government grant 20% £	Corporation tax payable (C-E) £	Cash flow (B+F-A-G) £	Adjusted cash flow £	Discount rate 5%	NPV at 5%
0	2800	2050	-	-	-	-	-	(-750)	(-750)	1.00	(-750.00)
1		2000	1025	2800	1400	530	-375	2905	2905	0.952381	2766.67
2		2000	1000				1000	1000	1000	0.907029	907.03
3		2000	1000				1000	1000	1000	0.863838	863.84
4		2000	1000				1000	1000	1000	0.822702	822.70
5		1900	1000				1000	900	900	0.783526	705.17
6		2000	950				950	1050	1050	0.746215	783.53
7		2000	1000				1000	1000	1000	0.710681	710.68
8		2000	1000				1000	1000	1000	0.676839	676.84
9		2000	1000				1000	1000	1000	0.644609	644.61
10		2000	1000				1000	1000	48	0.613913	29.47
11		-	1000				1000	(-1000)	-	-	-
									Net Present Value		£8160.54

Table 25 Cash flows resulting from the installation of a sprinkler system in the building, which forms Case Study No 2 - Appendix C, when used for the manufacture of boots and shoes.

B I B L I O G R A P H Y

BIBLIOGRAPHY

"An analysis of the £10000 plus fires in 1972". Fire Prevention, No 101, January, 1974.

Architects' Journal Information Library, "A. J. Insurance Handbook, 1972". The Architects' Journal, 11th October, 1972 and 22nd November, 1972.

Baldwin, R. and North, M. A. The Number of Sprinkler Heads Opening in Fires. Fire Research Station, Fire Research Note No. 886.

Baldwin, R. and Thomas, P. H. Passive and Active Fire Protection - The Optimum Combination. Fire Research Station, Fire Research Note No. 963.

Bassett, J. C. and Wheeler, Cement. Bean and Lockwood's Rating Valuation Practice, 6th ed. London, Stevens and Sons Ltd, 1969.

"Britain's first large fire in a modern shopping precinct". Fire Prevention, No. 93, December, 1971.

British Insurance Association. Insurance Facts and Figures, 1971 London, British Insurance Association.

Benn, K. J. "Sprinkler discounts : the hit or miss of fire protection". Policy Holder Insurance Journal, 24th December, 1971.

British Standards Insitution. No 3116 : 1970, Automatic Fire Alarm Systems in Building Part 1 : Heat Sensitive (point) Detectors. London, British Standards Institution.

British Standards Institution. No 3116 : 1970, Automatic Fire Alarm Systems in Building, Part 2 : Heat Sensitive (line) Detectors. London, British Standards Institution.

Burtner, C. E. Risk Management : The Economics of Fire Protection Engineering. MP 67-10. Boston, National Fire Protection Association.

Burtner, C. E. "The Economics of a fire protection program". Fire Technology, February, 1966.

Carter, R. L. Economics and Insurance. Stockport, P H Press Ltd, 1972

Central Fire Liaison Panel. Fire Defence cost or saving? Fact Sheet, 1973. London, Central Fire Liaison Panel.

Clarkson, G. P. E. and Elliot, B. J. "Managing Capital Funds". National Westminster Bank Quarterly Review, August, 1970.

Department of Trade and Industry. Incentives for Industry in the assisted areas. London, Department of Trade and Industry.

Department of Trade and Industry. Regional Development Grants (Industry Act, 1972) RDG/BEN, London, Department of Trade and Industry.

"De L'Utilisation Des Installations D'Extincteurs Automatiques A Eau". Face Au Risque. No 91, 15 Mars - 15 Avril, 1973.

Doublett, A. R. "Current Trends in the Fire Department". Journal of the Chartered Insurance Institute, Vol : 64, 1967.

Doublett, A. R. "Fire Economics and Insurance". Fire Supplement, IFE/CFOA Conference Papers, 1967.

Doublett, A. R. "Fire Insurance Problems and Risk Improvement". Journal of the Chartered Insurance Institute, Vol : 67, 1970.

Farrington, J. T. "The Economics of Fire Protection". Journal of the Chartered Insurance Institute, Vol : 64, 1967.

Finger, H. B. "Recent developments in building systems". Phil. Trans Royal Society, London, A272, P 503-531.

"Fire detector systems - the range of choice". Fire Prevention, No 91, July, 1971.

"Fires in Department Stores". The Sprinkler Bulletin No 190, House magazine of Mather and Platt, Ltd, Manchester. 31st December 1957.

Fire Protection Association. Fire Prevention Design Guide, A handbook for architects. London, Fire Protection Association, 1969.

Fire Offices' Committee. List of Approved Automatic Fire Alarm Systems. London, Fire Offices' Committee, July, 1973.

Fire Offices' Committee. Automatic Sprinkler Installations - List of Approved Sprinklers. London, Fire Offices' Committee, March, 1973.

Fire Offices' Committee. Rules for Automatic Fire Alarm Installation, 11th edition with amendment. London, Fire Offices' Committee, July, 1973.

Fire Offices' Committee. Rules for Automatic Sprinkler Installation - 29th Edition with amendments. London, Fire Offices' Committee, 1968.

Fire Offices' Committee. Standards of Construction I to V with amendments. London, Fire Offices' Committee, 1959.

Fire Offices' Committee. Scale of Allowances for ordinary fire extinguishing appliances. London, Fire Offices' Committee, June, 1970.

Fire Services Act, 1947. 10 and 11 Geo. 6, Ch. 41. London, HMSO.

Forrest, J. C. M. "A warehouse to resist fire". Concrete, August, 1969.

Fry, J. F. and Eveleigh, C. The Behaviour of Automatic Fire Detection Systems. Fire Research Station, Fire Research Note No 810.

Gibson, H. and Jackson, E. The Valuation of Plant and Machinery for Rating. London, The Estates Gazette Ltd, 1972.

Hogg, W. M. "Investigating and reporting on the business - interruption risk in industry and commerce". Journal of the Chartered Insurance Institute, Vol : 69, 1972.

Home Office, Scottish Home and Health Department. Fire Prevention Guide - Fire precautions in town centre redevelopment. London, HMSO, 1972.

Home Office, Scottish Home and Health Department. Report of the Departmental Committee on the Fire Service - (Sir Ronald Holroyd, chairman). London, HMSO, 1970.

Horrigan, W. Risk, Risk Management and Insurance. Sussex, Withdean Publications, 1969.

Howes, T. C. "Problems of full value in relation to average". Journal of the Chartered Insurance Institute, Vol : 66, 1969.

Industrial and Regional Development - (Government White Paper Cmnd 4942). London, HMSO, March, 1972.

Jessop, C. M. and Chambers, E. D. Auto Diallers in the United Kingdom. Fire Research Station, Fire Research Note No 888.

Lawson, D. I. A Laser Beam Fire Detection System. Fire Research Station, Fire Research Note No 824.

Leworthy, L. R. "Automatic Sprinkler Installations". Architects' Journal Information Library, 3rd September, 1969.

Leworthy, L. R. "Fire alarm communication and control". Architects' Journal Information Library, 22nd July, 1970.

Liverpool Polytechnic. Valuation for Rating, Conference Papers, June, 1972.

Marchant, E. W. (ed). Fire and Buildings. Lancaster, Medical and Technical Publishing Co. Ltd, 1972.

Marryatt, H. W. Fire - Automatic Sprinkler Performance in Australia and New Zealand, 1886-1968. Melbourne, Australian Fire Protection Association, 1971.

Maskell, D. V. Cost of Fire Protection - Towards a Definition. Fire Research Station, Fire Research Note No 898.

Mather and Platt Ltd. Fire Protection Handbook. Manchester, Mather and Platt Ltd, 1969.

Merrett, Cyriax Associates. The Role of Structural Fire Protection. London, Cement and Concrete Association, 1969.

Merrett, A. J. and Sykes, A. Capital Budgeting and Company Finance. London, Longmans, 1966.

Merrett, A. J. and Sykes, A. The Finance and Analysis of Capital Projects. London, Longmans, 1963.

Monopolies Commission. Fire Insurance - Report on the supply of Fire Insurance. London, HMSO, 1972.

National Economic Development Council. Investment Appraisal. London, HMSO, 1971.

National Fire Protection Association. National Fire Code 13A - Care and Maintenance of Sprinkler Systems, Boston, National Fire Protection Association, 1973.

Neave, J. A. S. "Reinsurance Today - A general survey". Journal of the Chartered Insurance Institute, Vol : 63, 1966.

Nwankwo, G. O. "Taxation, Inflation and Company Finance", The Bankers' Magazine, London, November, 1972.

Osborne, W. "The Economics of Fire", Fire Supplement, IFE/CFOA Conference Papers, 1967.

O'Sullivan, E. F., Gosh, B. K. and Sumner, R. L. Experiments on smoke detection, part 3 : fires in expanded polystrene, polyurethane and compressed cork, Fire Research Station, Fire Research Note No. 845.

O'Sullivan, E. F., Gosh, B. K. and Turner, J. Experiments on the use of a laser beam for fire detection, Fire Research Station, Fire Research Note No. 823.

"Peripheral Prospects - Developments in British Regional Policy", Barclays Review, August, 1972.

Purt, G. A. "The Evaluation of the Fire Risk as a Basis for Planning Automatic Fire Protection Systems", Fire Technology, November, 1972.

Ramachandran, G. An Enquiry into the frequency of Sprinklered Premises, Fire Research Station, Fire Research Note No 828.

Ramachandran, G. Fire Losses in Different Countries, Fire Research Station, Fire Research Note No. 844.

Ramachandran, G. Fire Loss Indexes, Fire Research Station, Fire Research Note No. 839.

Ramachandran, G. National Expenditure on Sprinkler Installations, Fire Research Station, Fire Research Note No. 906.

Ramachandran, G. The Economics of Sprinkler Protection 1. The User of the Building, Private Communication.

Ramachandran, G. Eveleigh, C. and Hudson, E. Large Fires During 1971, Fire Research Station, Fire Research Note No. 956.

Ramachandran, G. and Kirsop, P. A Brief Analysis of Large Fires During 1965 and 1968, Fire Research Station, Fire Research Note No 792.

Ramachandran, G. Kirsop, P. and Eveleigh, C. Large Fires During 1969, Fire Research Station, Fire Research Note No. 829.

Ramachandran, G., Kirsop, P. and Eveleigh, C. Large Fires During 1970. Fire Research Station, Fire Research Note No. 891.

Reform of Corporation Tax - (Government White Paper Cmnd 4955) London, HMSO, April 1972.

Research Services Ltd. Company Attitudes to the Installation of Automatic Fire Prevention/Detection Systems - Unpublished survey prepared for the Central Fire Liaison Panel, London, Research Services Ltd, 1970.

Royal Insurance Group. International Insurance Directory, Western Europe, Liverpool, Royal Insurance Group, 1972.

Schofield, N. D. "The Need for Active Fire Defence", The Quantity Surveyor, Vol : 29 No 5, March/April, 1973.

Silcock, A. "Protecting buildings against fire - Background to costs", Architects' Journal Information Library, 13th January, 1967.

"Sprinkler Leakage Insurance", Estates Gazette, Vol : 191, 8th August, 1964.

Stone, P. A. Building Design Evaluation, Costs in Use, London, E & FN Spon 1967.

Stone, P. A. "The Economics of Building Design", Journal of the Royal Statistical Society, Series A General, 123-3, 1960.

Stone, P. A. The Economics of Factory Building - Factory Study No. 12 London, HMSO, 1969.

Strother Smith, N. C. "A global survey of fire and its prevention", Journal of the Chartered Insurance Institute, Vol : 65, 1968.

Strother Smith, N. C. "Preventing fire in the seventies", Journal of the Chartered Insurance Institute, Vol : 69, 1972.

Tarrant, R. K. "A Guide to the Economics of Fire Protection", Fire Protection Review, Vol : 23, 1960.

The Building Regulations 1972. No 317, London, HMSO.

The Plant and Machinery (Rating) Order 1960, No 122, London HMSO.

Tryon, G. H. ed. Fire Protection Handbook 13th Edition, Boston, National Fire Protection Association, 1969.

Water Act, 1945, 8 and 9 Geo 6, Ch 42, London, HMSO.

Water Bill, London, HMSO, 1973.

Yarnwood, A. J. "The Economics of Fire Protection", Policy Holder Insurance Journal, 22nd July, 1966.

Yarnwood, A. J. "Claims Under Sprinkler Leakage Policies", Journal of the Chartered Insurance Institute, Vol : 62, 1965.

Young, R. A. Fire Tests with Sprinklers on High Piled Stock, Fire Research Station, Fire Research Note No. 814.