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JOINT FIRE RESEARCH ORGANIZATION

THE GROWTH OF ELECTRICAL FIRE HAZARDS

by

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Summary

The annual rates of electrical fires have been examined for the years 1947-52 and from these an estimate is made of the number of such fires likely to occur in the period up to 1975. It is shown that at the end of this time the rate should be about 22,000 per annum. Various remedial measures are suggested.

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The increasing demand for electricity

During the last fifty years the electrical energy distributed per annum has risen steadily, and in view of this continued upward trend it is perhaps prudent to consider what means might be taken to forecast the fire situation over the next decade or two. Table 1 shows the growth in the demand for electricity with time.

Table 1

The increasing demand for electricity

Year	1905	1915	1925	1935	1945	1955*	1965*	1975*
Electrical energy transmitted (1)	0·5	2	6	17	35	74	120	200
Electrical power generated (2)	-	1·2	4·4	8	12	20	40	60

1. In milliards of units.
2. In millions of kilowatts.
* Estimated (Government White Paper - A Programme of Nuclear Power).

Table 2 shows the growth in the number of consumers and the average amount of electricity consumed over the last few decades (figures were not available prior to 1925).

Table 2

The increasing average consumption of electricity

Year	1925	1935	1945	1955*	1965*	1975*
Consumers (1)	1·86	7·62	10·9	14·0	16·4	17·8
Average electrical energy transmitted (2)	3·2	2·2	3·2	5·3	7·3	11·2
Average electrical power generated (3)	2·4	1·1	1·1	1·4	2·4	3·4

1. In millions.
2. In thousands of units.
3. In kilowatts.
* Estimated.

It will be seen that it is expected that the energy distributed will rise by a factor of approximately three by 1975, while the number of consumers are expected to increase by about a quarter.

Nearly all the electrical energy generated, which is annually equivalent to that of over 3,000 atomic weapons, such as used in the last war, is ultimately degraded to heat in a controlled manner and finally it harmlessly warms the surroundings in which it is used. That this is so is a tribute to the high standard of present electrical circuits and equipment. It is not surprising that sometimes a small amount of this energy is inadvertently misapplied, and when this happens a fire may ensue. The power required to start ignition is quite small, for example a power density in excess of 5 watts/cm^2, applied at the surface, will start a fire in a variety of common combustible materials, though whether this fire is able to spread from the point of origin, will depend upon the nature of the combustible. Statistically speaking, the chance of power being misapplied in this way should depend on the amount of power generated. Statistical information on fires of electrical origin has been collected only since 1947, but it will be seen by reference to Figure 1, that there is undoubtedly a connection between the power generated and the number of fires occurring.

The incidence of fires in electrical wiring and equipment

The electrical fires which occur may be conveniently sub-divided into those occurring in the installation and those occurring in the electrical apparatus connected to it.

Fires due to electrical wire and cable

The number of fires due to electrical wire and cable is shown in Figure 1, where it will be seen that these have a mean rate of about 2,500 per annum, and this appears to be independent of the quantity of electrical energy transmitted. It is interesting to note that if the graph relating to the total number of electrical fires is extrapolated to find the number of fires which would occur when no electrical energy was transmitted, the figure is found to be the same. This would appear to indicate that the number of electrical fires is made up of two parts, one which is independent of the electrical energy transmitted, and represents those fires occurring in wire and cable, and the other which is proportional to the electrical energy transmitted, and this represents the fires occurring in electrical apparatus.

Fires due to electrical wire and cable fall into two categories, fires which are due to heating as a consequence of the current carried by the conductors, and fires which occur as a consequence of electrical leakage between the conductors. The rate of incidence of fires in the first category might be expected to be proportional to the energy transmitted annually, since this is increasing more rapidly than the number of new installations. Fires in the second category would be expected to depend on the number of installations, rather than on the power transmitted, in so far as the electrical conductors would have a potential between them irrespective of whether or not they were carrying a current. As the number of installations is increasing fairly slowly with time, the indication would be that the fires which are occurring are due to leakage rather than the conductors being overloaded.

There is as yet no evidence that the number of fires due to wire and cable will increase markedly with time, though two factors must be borne in mind which may contradict this statement. First, existing circuits are continuously ageing and during the next two decades nearly two-thirds of the installations will be more than thirty years old. Gosland (1) has shown that the chance of an installation being subject to fire increases at a rate of seven per million for each year of its age.

Second, it is common knowledge that the amount of equipment used by consumers increases with time and therefore with the age of the installation, so that it is the relatively old installations which will have to carry a greater proportion of the load in the future. One cannot help wondering, now that most people possess a little electrical knowledge, how many amateur circuit extensions will stand the test of time.

Fires due to electrical apparatus

It is to be expected that the annual number of fires due to electrical apparatus would depend on the quantity of electrical energy transmitted. This is shown to be the case in Figure 1, where it will be seen that the number of fires is roughly proportional to the electrical energy transmitted, one fire occurring for approximately every ten million units sold. If this rate continues over the next twenty years, the number of fires in electrical apparatus would be about trebled. The expected increase of fires of electrical origin, including those due to wire and cable, is shown in Figure 2.

This increase may, however, be accompanied by some decrease in fires where other fuels have formerly been used. For example, a change to electrical heating may result in an electrical fire, but at the same time this will mean that there is potentially one fire less due to coal or gas heating, and the increasing fire incidents associated with electrical fires, cookers and electric wires, may be counterbalanced by a decrease in incidents in coal, gas and oil-fired appliances. Whether for these items the resulting fire situation is better or worse, will of course, depend on the relative merits with regard to fire hazard of the equipments using various fuels. The number of fires resulting from apparatus having functions such that they could use alternative types of fuel is shown in Figure 3. The functions of some equipments (e.g. radio, television etc.) are peculiarly electrical, or alternatively, the fires occur only in the electrical version of others. For such apparatus the increasing fire rate will not be counterbalanced by any decrease in fires in equipments using other forms of fuel; these are shown in Figure 3.

It will be seen therefore that there must be a substantial increase in electrical fires during the next twenty years, and it is necessary to see what remedial steps can be taken now.

Possible future action

Although electrical energy has been distributed now for almost fifty years there seems to be little information on the installations at present in use. Almost all our information is gained after fires have occurred, and this is not the best time to study electrical installations. There is no doubt that an examination of the installations of a cross-section of consumers would add greatly to our knowledge of the possible causes of fires. Among other things it would give information on such questions as the rate of build-up of equipment with time, the nature and extent of circuit installations, the state of the fusing of circuits, and the condition of the installation in relation to its age. Perhaps some of this information already exists on record since it is often the practice to make a routine examination of installations when the tenancy of a building changes.

In examining a fire due to a supposed electrical fault, the chances of detection of the fault are very much greater if the fire has been detected and extinguished in its early stages. At present the only reports received by the Joint Fire Research Organization are from Fire Brigades, and this means that in most of these incidents the fire has developed to an advanced stage. It would be more important if an examination could be made of the small fires which are not usually serious enough to warrant the attention of the Fire Brigade. The pattern of the causes of these fires

should be much the same as that with large fires, since the main difference between small and large fires is in the nature of the stored combustible materials, and in the delay in detection.

Many large department stores must have incidents occurring during the day which are detected in their early stages because of the large number of people present. It might be possible from a study of the reports of these fires to get a clear picture of their causes. Once the causes have been found, it should then be possible to devise suitable remedial measures. If the bulk of electrical fires are associated with apparatus, then it should be possible by co-operation with the manufacturers' associations to bring about an improvement in such equipment. If the fires due to installations are found to be due to leakage or faulty connections in series with the load, then improved fusing of the circuits would not necessarily effect a cure, and some estimate would have to be made of the vulnerable points, and steps would have to be taken in future installations either to locate these in a place where the spreading of fire would be unlikely. Perhaps if this were not possible it might be sufficient to give the combustible parts of the structures of buildings near to such points a fire-retardant treatment. If time should show that the main causes of fire were due to overloading circuits which were incorrectly fused, it might be worth while considering replacing the fuse-box by a sealed cut-out so that the consumer could reset it, but not tamper with the mechanism. The indications are however that fires in circuits are not being caused in this way.

One thing is certain, any attempt to bring about a reduction in electrical fires will be time-consuming, both from the point of view of the examination of the causes, and of suggesting suitable economic remedial measures. In the meantime, the electrical load is increasing yearly and the sooner a start is made on the problem the better.

Acknowledgments

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Reference

(1) GOSLAND, L. Ageing of electrical installations as indicated by the incidence of fires. (To be published in the Proceedings of the Institution of Electrical Engineers).

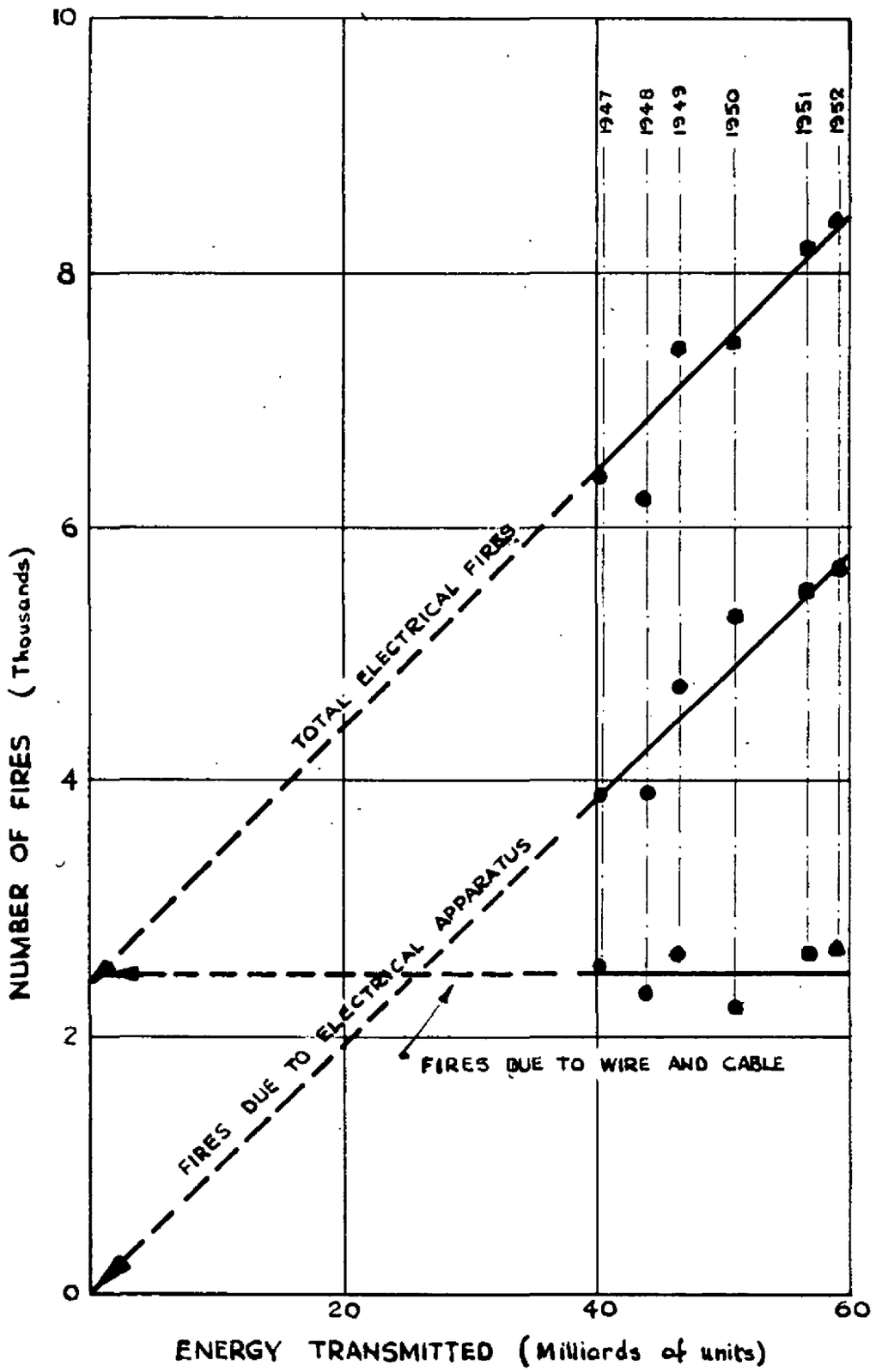


FIG. 1 NUMBER OF ELECTRICAL FIRES ANNUALLY IN TERMS OF ELECTRICAL ENERGY TRANSMITTED

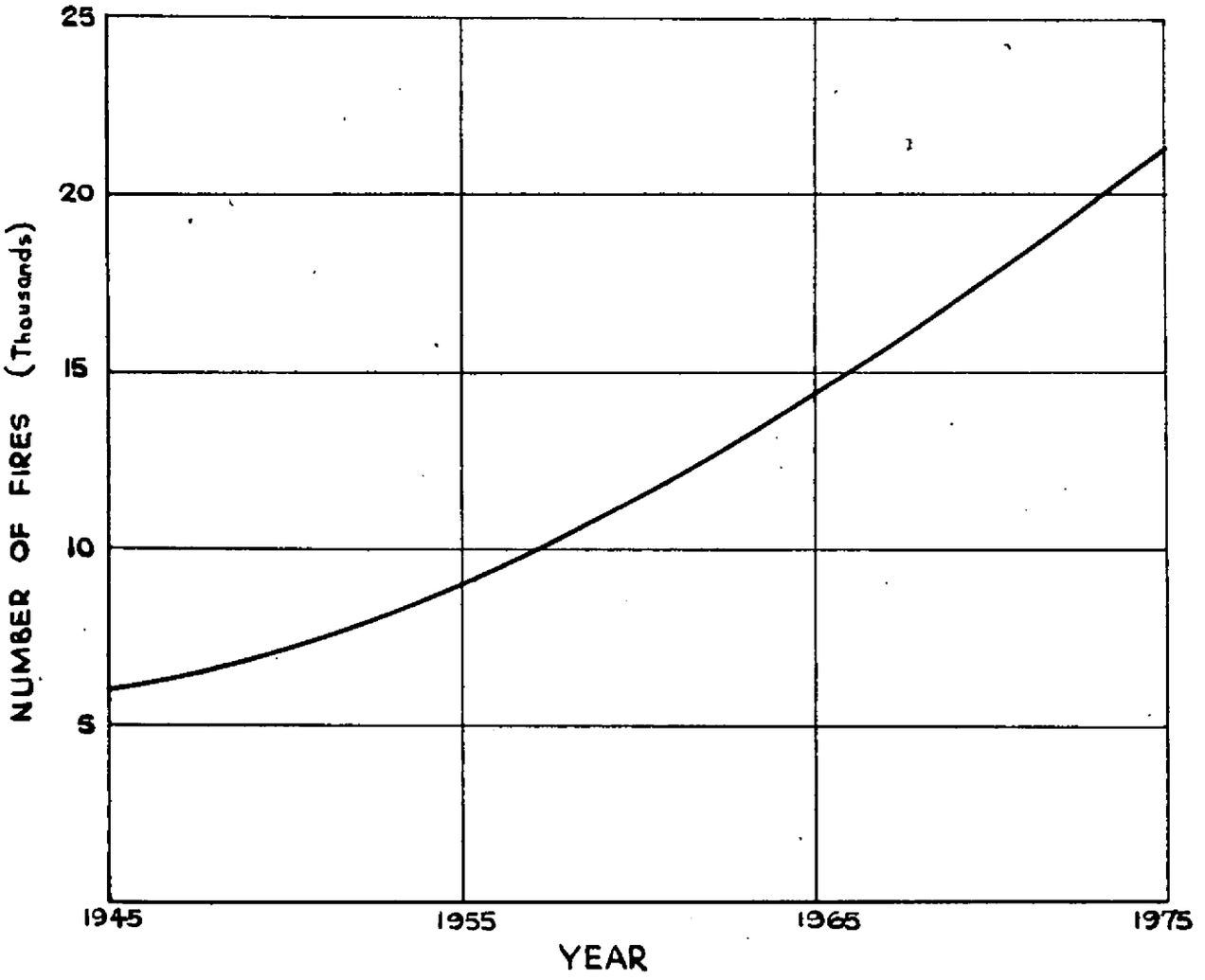
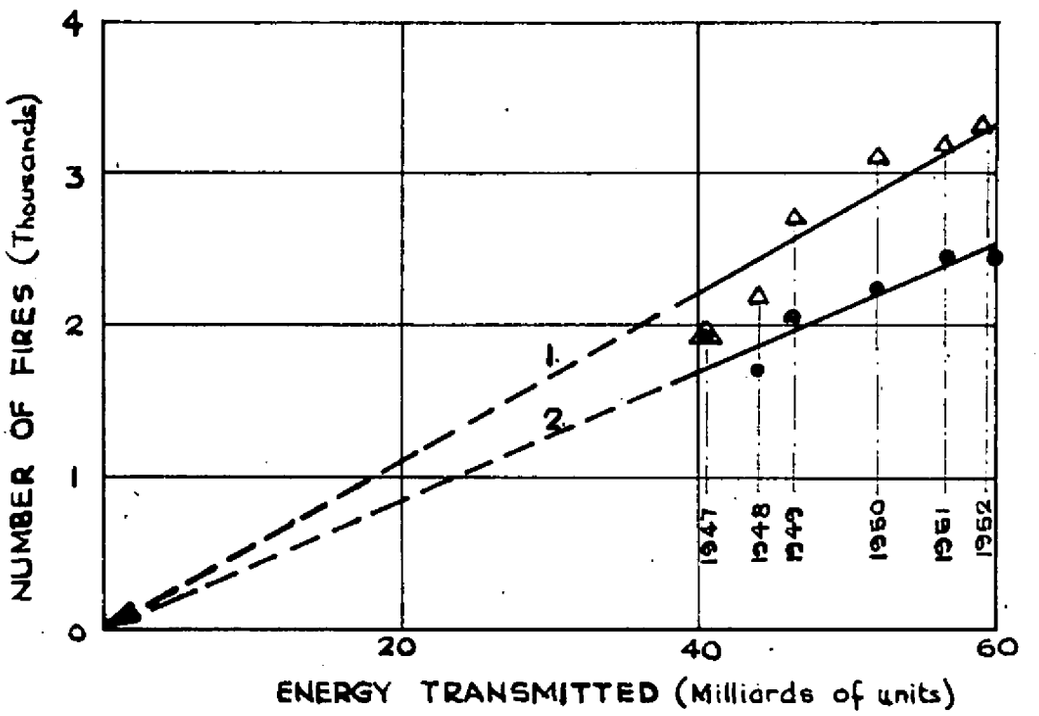


FIG. 2 ESTIMATED NUMBER OF ELECTRICAL FIRES ANNUALLY IN GT. BRITAIN FOR THE PERIOD UP TO 1975



1. APPARATUS PECULIAR TO ELECTRICITY
2. APPARATUS NOT PECULIAR TO ELECTRICITY

FIG. 3 EFFECT OF TYPE OF ELECTRICAL APPARATUS ON ANNUAL NUMBER OF FIRES