Fire Research Note No. 803

THE USE OF WATER IN THE EXTINCTION OF FIRES BY BRIGADES

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R. BALDWIN

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FIRE RESEARCH STATION

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SUMMARY

Some American data on the relationship between the rate of application of water and the fire area and between the time taken to control the fire and the fire area are reviewed. Comparison with published British data suggests that in spite of different techniques and conditions, at this level of comparison, the results are very similar. The rate of application of water is about four times as great as in experimental fires, suggesting that the chief problems of fire fighting are operational.

KEY WORDS: Extinguishing, Water, Fire, Size, Time.

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Introduction

Water is the most commonly used agent for the extinction of fires because it is both cheap and generally readily available. However, little data are available on the way in which it is used in relation to the size of the fire, that is the rate of application and time necessary to control fires of a given size. This paper reviews some American data which have been published recently and compares them with other, British, data and with some experimental data.

American data

Illinois Institute of Technology Research Institute have recently[1] published details of a survey of 134 fires attended by the brigades. An attempt was made to obtain a good cross-section of fire operations by choosing various types of occupancy, sizes of city, types of construction and magnitudes of fire. The reports submitted were prepared by two professional fire department chief officers and a fire protection engineer, and included a relatively complete time history of the fire from ignition (where possible to estimate) to control and then to final extinction. Details are also given of the total quantity and rate of application of water and the area destroyed by fire.

Information on the time taken and rate of water application necessary to bring the fire under control are plotted in Figs. 1 and 2 as a function of the area of the fire. These data are quite distinct from the time and water necessary to finally extinguish the fire which will not be discussed here. A statistical analysis shows that the rate of water application W l/s, may be represented by the equation.

$$W = 1.24 \; A^{0.664} \qquad (1)$$

where **A** is the area of the fire in square metres.

The control time **T** (minutes) may be represented by

$$T = 1.66 \; A^{0.559} \qquad (2)$$

There is, as would be expected, considerable scatter about these lines, which are plotted in Figs 1 and 2, a reflection of the difficulties encountered with different situations, and a measure also of the subjective element in fire fighting.

British Data

Thomas[2] has published similar data drawn from the experience of British brigades. This sample of fires was biased heavily in the direction of large fires (i.e. over 200 m^2) and it was felt that it was unwise to extend any conclusions below this range. The corresponding equations deduced from this data were

$$J = 0.33 \sqrt{A} \qquad (3)$$

where J is the number of jets at control time

and

$$T = 3.3 \sqrt{A} \qquad (4)$$

These equations are not the true regression lines, but within the scatter of the data, they are not significantly different from the regression lines.

Discussion

Equations 3 and 4 are plotted in Figs 1 and 2. To obtain the rate of water application it has been necessary to take a representative figure for the rate of discharge of a jet. Here one jet has been assumed to discharge at a rate of 10 l/s although the exact amount is not important in the context of the data on the graph. It can be seen that there is very good agreement between Thomas' data and I.I.T.R.I. data: in fact the index of A in equations 1 and 2 is not significantly different from 0.5 so that the American data could also be represented by a square root law. Thus it would appear that American and British fire fighting techniques and experience lead to very similar results at this level of comparison. It would also appear that Thomas' equation can be extended below 200 m^2 since I.I.T.R.I. data extend to about 20 m^2.

The total amount of water used Q is proportional to the product of W and T so that

$$Q \propto A^{1.2}$$

Thus the amount of water applied per unit area is given by

$$Q/A \propto A^{0.2}$$

and it appears that, as expected, the amount of water per unit area for control increases with the fire area, although the index of A, 0.2, is not significantly different from zero.

These data may also be compared with extinction of experimental fires[1]. These data have been summarised by I.I.T.R.I. and are plotted here in Fig.3. Once again there is considerable scatter, but regression analysis yields

$$W = 0.33\ A^{0.64}$$

Comparing this equation with Equation 1 we see that, perhaps fortuitously, the index of A is approximately the same, but that the coefficient of A is reduced by a factor of between 3 and 4. Thus in real fires the rate of application of water is between 3 and 4 times as great as that in experimental fires. This indicates that the chief problems confronting the fire fighter are operational, i.e. getting the water on to the fire, suggesting that this aspect of fire fighting would repay study.

Conclusions

1. American data on fire department operations suggest that the rate of water application W, and the time T, necessary to control a fire are given as a function of the fire area by the equations:

$$W = 1.24\ A^{0.664}$$

$$T = 1.66\ A^{0.559}$$

for areas in excess of 20 m^2, although both may also be represented by a square root law.

2. Comparison with similar British data suggests that in spite of different techniques and conditions, at this level of comparison, the results are very similar.

3. The rate of application of water is about four times as great as in experimental fires, suggesting that the chief problems of fire fighting are operational.

REFERENCES

1. LABES, W.G. Fire department operation analysis, final report. Illinois Institute of Technology Research Institute. Contract No. N0022867 C0701, OCD Work unit 2522F, January, 1968.

2. THOMAS, P. H. Use of water in the extinction of large fires. Inst. Fire Eng. Quarterly, 19 (35), 130-2, 1959.

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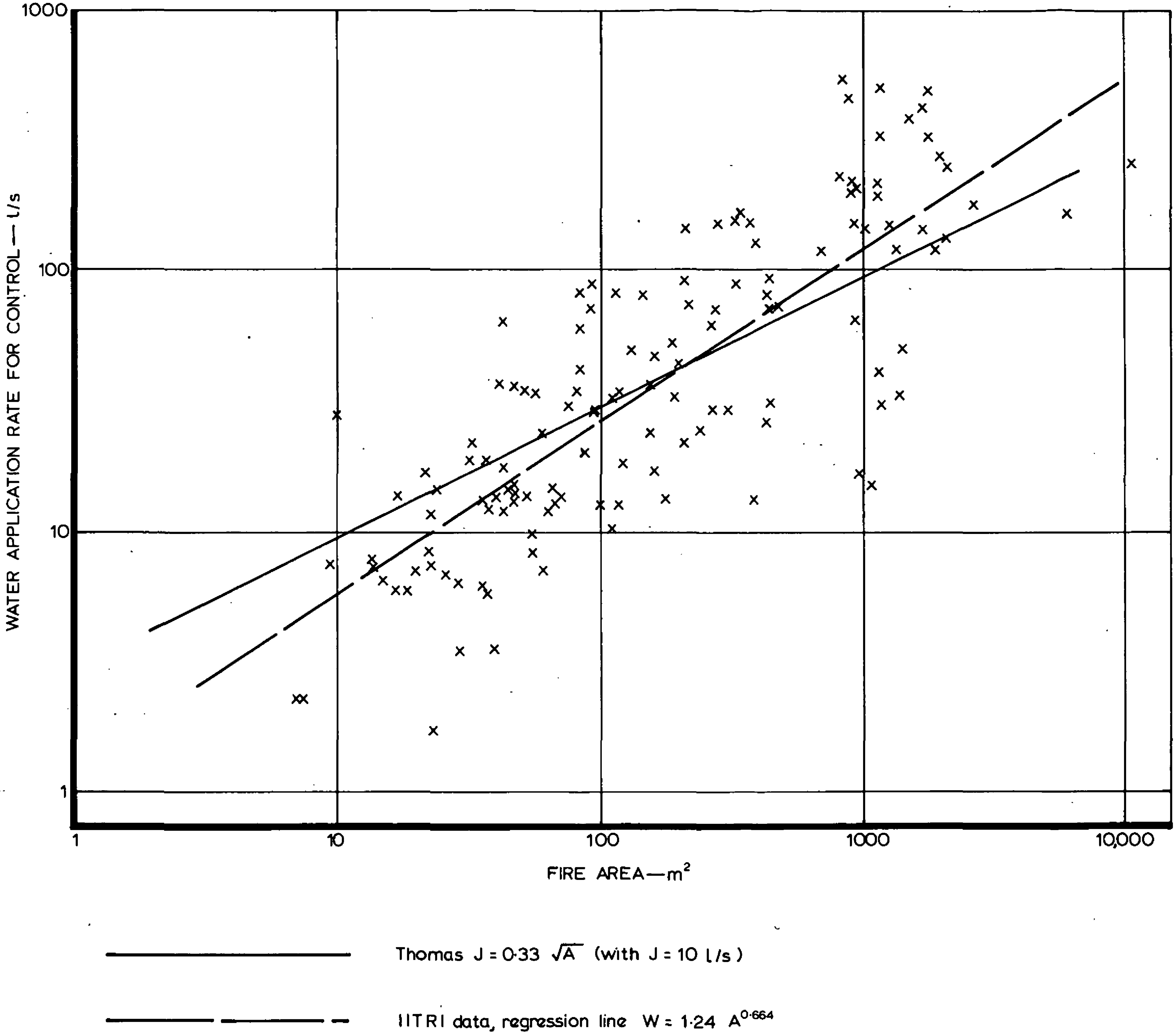

FIG. 1. CORRELATION OF WATER APPLICATION RATE AND FIRE AREA

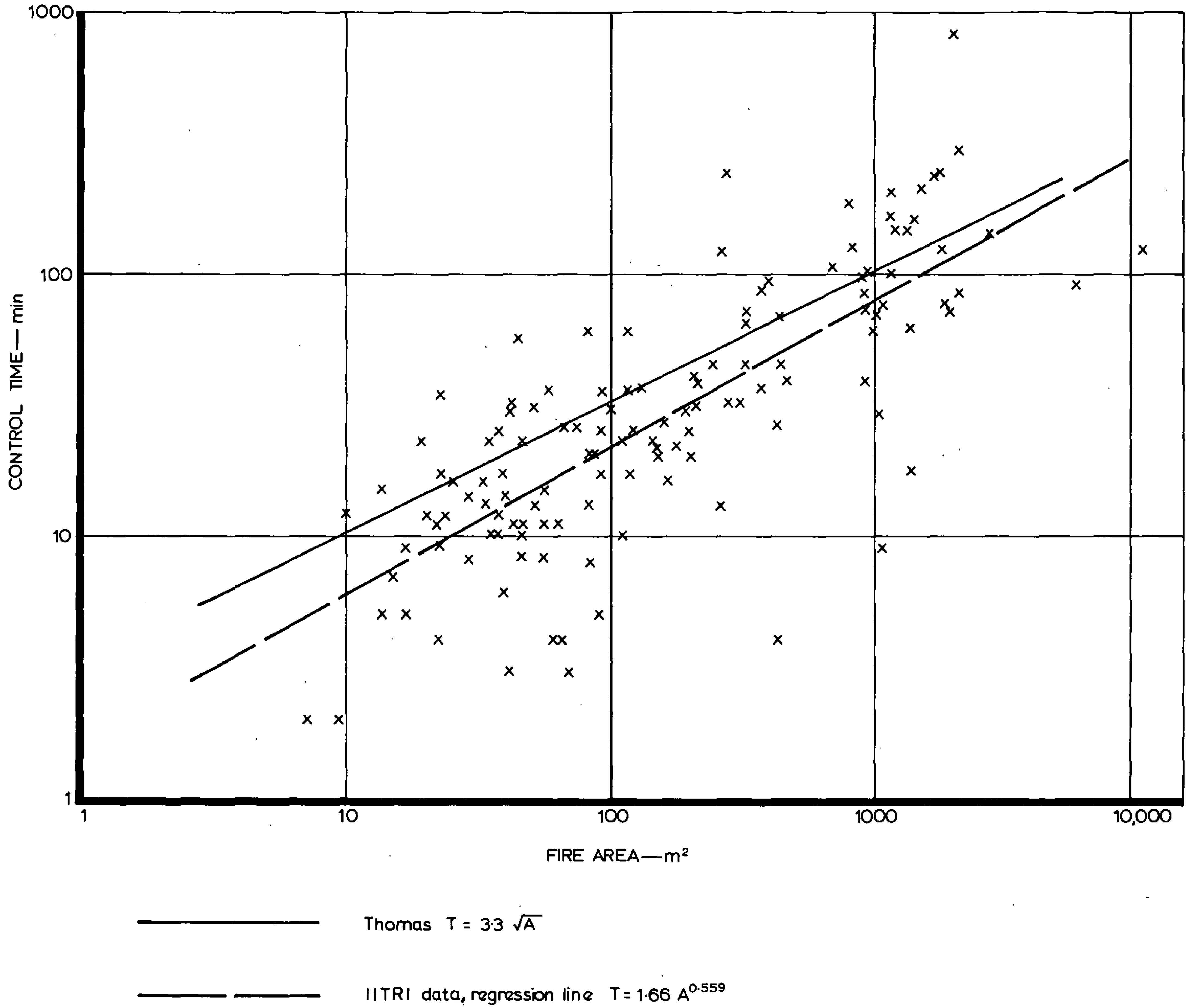

FIG. 2. CORRELATION OF CONTROL TIME AND FIRE AREA

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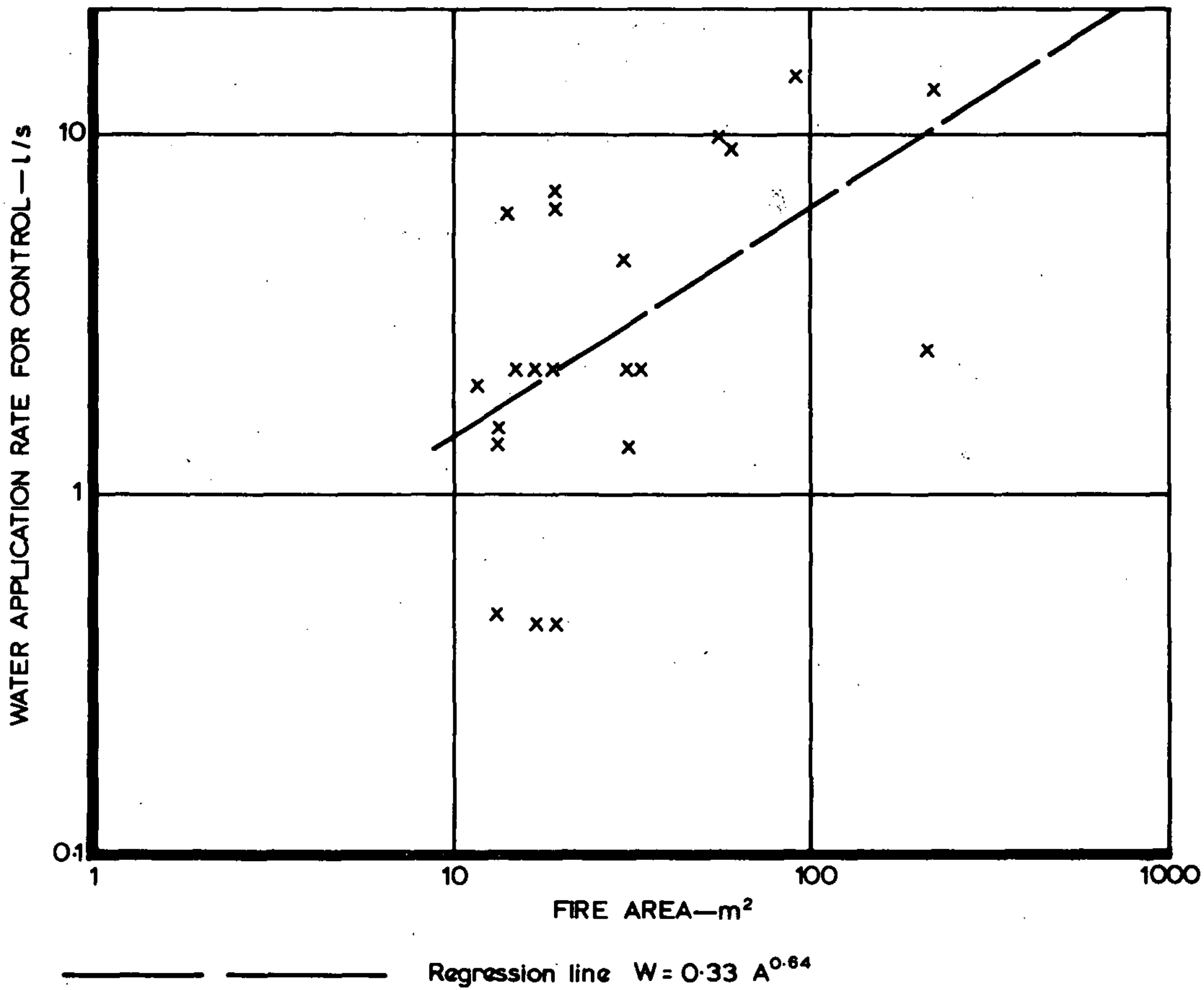

FIG. 3. CORRELATION OF WATER APPLICATION RATE WITH FIRE AREA— EXPERIMENTAL FIRES (IITRI DATA)