# Fire Research Note

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## THE RELATIVE FIRE FREQUENCY OF DIFFERENT INDUSTRIES IN GREAT BRITAIN

by

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Summary

Ranking lists have been produced showing the relative likelihood of fire in the production and storage sides of different industries in Gt. Britain in terms of 'an equivalent frequency'. These may be useful in connection with fire protection legislation and insurance, and in revealing those industries in which existing fire precautions would repay further study. They are of interest also in showing the relative effectiveness of precautions in the production and storage sides of some industries.

Introduction

For some purposes, such as fire protection legislation and fire insurance, it is desirable to have some measure of the inherent likelihood of fire in industries. Experience and knowledge of the materials and processes involved have led to the adoption of fire precautions of various kinds in most industries, but despite this there remains some degree of fire hazard which may be more pronounced in one industry than in another and which is reflected both in fire frequency and in fire spread. This study has been made in terms of fire frequency only since there is at present no satisfactory quantitative measure of fire spread available to the Fire Research Station.

The frequencies used in these calculations were obtained from analyses of reports on all fires (other than those confined to chimneys) attended by local authority fire brigades. The many fires extinguished by small means (such as extinguishers), by automatic systems (such as sprinklers) and by works' fire brigades can be regarded as having been adequately dealt with by the fire precautions in the industries concerned. The fire brigade statistics are therefore a measure of the extent to which industries have not themselves succeeded in overcoming their fire problems and these frequencies would tend to reflect the relative incidence of the more serious fires.

As the ultimate objective of fire prevention would be the total elimination of fires in industry it is not possible to define any specific level of fire frequency as being 'acceptable', and the effort has therefore been directed towards deriving a method of comparing one industry with another.

Method of analysis

In comparing the fire situation in industries of widely differing character it is clearly inadequate to consider only the overall frequencies of fire, since these will be affected by a number of characteristic factors related to the size and activity of the industry (e.g. the number and size of the individual units, the number of operatives employed, etc.). Nor will it, in general, be sufficient to regard any of these factors as being of such importance as to outweigh all others since each will contribute, in differing degree, to the overall character of most industries. For comparison between industries to be meaningful, it therefore becomes necessary to devise a quantitative characteristic which can be regarded as descriptive of any of the industries concerned, and to which the fire frequency in the industry can be related.

Multiple regression was rejected as a method for investigating the factors common to all industries which might be related to the number of fires occurring in each industry, for the following reasons:-
(i) the large number of factors to be investigated; (ii) many of the factors, such as numbers employed, number of establishments, purchases of materials, fuels etc., wages and salaries, net output minus wages and salaries, each reflect to a high degree the size of the industry without being able to completely represent the size factor; (iii) unless the effect of the size factor could be almost completely eliminated from

the fire frequencies it would be difficult to say whether any other characteristic of industry such as degree of competitiveness, degree of productivity, level of stocks in relation to size was likely to affect the probability of fire in industry.

The method that has been used in this investigation is basically that of regressing the fire frequencies for each industry upon a set of orthogonal components, the components themselves having been derived from all of the factors using principal component analysis technique.

Introducing the method

The number of fires expected in an industry over a particular period of time is assumed to obey the relationship

$$y_i = \alpha + \Sigma \beta_s x_{is} + u_i + \varepsilon \quad \text{where } \varepsilon \text{ is } N(0, \sigma^2)$$ *

(The $x_{is}$ and $y_i$ can of course be transformed variables of the original variables.)

This is the usual equation for a single regression with the addition of the factor $u_i$ representing the intrinsic fire hazard of industry i. $y_i$ is the number of fires occurring in industry i and is dependent upon the $x_{is}$ components of industry i which are common to all industries, $u_i$ is the factor particular to industry i and $\varepsilon$ the chance variable distributed as $N(0, \sigma^2)$. For example, manpower is required for all industries but some industries are more labour intensive than others; so that the number of people employed is itself a result of both the $x_i$ and $u_i$. The $u_i$ are assumed to reflect the nature of the product, the production process of industry i and the fire protection measures.

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*Greek letters are used to indicate the true parameters, Roman letters being used for their estimates.

The ranking list was drawn up on the basis of $\bar{y}_i + u_i + \varepsilon$ using an estimate of $\sigma^2$ to split the list into three groups, (a) high risk, (b) medium risk, and (c) low risk.

Industries are defined according to the Standard Industrial Classification. The fire frequencies were derived from reports of fires in buildings for the years 1957 to 1961 inclusive, while data concerning the industries was obtained from the Census of Production for 1958[1]. The fire frequencies were further subdivided by production areas and storage areas, since the intrinsic hazard of these areas is probably different. Two ranking lists were therefore drawn up initially, one based on production areas, the other on storage areas. The final ranking list was derived by combining the $\bar{y}_i + u_i + e$ from both lists.

Removal of bias from the dependent variable

The $y_i$ were obtained from all the fire brigade reports in 1957 and from stratified random samples in subsequent years. The sampling fraction (f) was $\frac{1}{4}$ for the years 1958 - 1960 and $\frac{1}{2}$ in 1961.

In order to avoid bias in the total estimates of the $y_i$ the annual estimates were weighted by the inverse of the sum of the sampling variation and the chance variation.

i.e. $$w_g = 1/(\ (1-f_g)s^2 + s^2)$$

$g$ denotes the year and $s^2$ is assumed to apply for all 5 years.

(N.B. $w_{1957} = 1/s^2$.)

and $$\bar{y}_i = \sum_g w_g \cdot y_{ig} \Big/ \sum_g w_g$$

$$= \sum_g [y_{ig}/(2-f_g)] \Big/ \sum_g [1/(2-f_g)]$$

The $y_i$ used was $\sum_g [y_{ig}/(2-f_g)]$. The denominator $\sum_g [1/(2-f_g)]$, being a constant value for all industries, its omission does not affect the industry rankings.

Component analysis

The independent variables, $x_{is}$, which are common to all industries, were derived by carrying out a principal component analysis. This technique has been fully described by Kendall[2].

A matrix of 26 factors for 118 industries was constructed using data from the Census of Production. These factors are given in Table 1.

Any factor where the variation between industries proved to be non-linear was transformed before standardizing to N(0, 1) variates and computing the covariances. The characteristic equation of the 26 x 26 correlation matrix gave 26 roots, of which the six largest accounted for 87.9 per cent of the total variation. The value of the roots were:-

$\lambda_1 = 9.866$, $\lambda_2 = 6.258$, $\lambda_3 = 2.096$, $\lambda_4 = 1.595$, $\lambda_5 = 1.184$, $\lambda_6 = 1.06$, $\lambda_7 = 0.789$, $\lambda_8 = 0.687$, $\lambda_9 = 0.477$, ............$\lambda_{26} = 0.001$.

Six components were obtained by multiplying the vector associated with each of the six largest characteristic roots by the standardized 26 x 118 factor matrix.

i.e. $$\zeta_{ij} = \sum_{k=1}^{26} x_{ik}\, l_{kj}$$

The $l_{kj}$ give the linear transformation for the standardized factor k to component j.

The $\zeta_j$ have an important property, in that they form an orthogonal set. Fluctuations in any one component will not affect the value of any of the other components. A component is, therefore, a useful predictor, since any change in its value will not affect the value of other components, and vice-versa.

A measure of industry size

The fire frequencies were plotted against each of the six components for all 118 industries. They appeared to be highly dependent upon the first component as is shown in Fig. 1, but no relationship appeared to exist with any of the other five components. (Since the components are orthogonal it is not necessary to remove the effect of the first component before graphing fire frequencies against the remaining components).

$\zeta_1$ corresponds to the root $\lambda_1$ which accounted for 38 per cent of the total variation between industries. The vector $l_1$ is given in Table 1. From this Table it can be seen that the component $\zeta_1$ is almost certainly measuring the size of industry: not only is it associated with all of the factors which reflect industry size, but it is the only component of industry affecting the frequency of fire. It is, of course, the purpose of this exercise to eliminate the effect of size from fire frequencies, so that only the intrinsic fire hazard under the circumstances pertaining may be compared between industries.

Description of model

In order to fit the data to the model

$$y_i = \alpha + \beta x_i + \varepsilon \qquad \text{where } \varepsilon \text{ is } N(0,\sigma^2)$$

two transformations were necessary, viz:

$$y_i := \log(y_i)$$

$$x_i := (50 + \zeta_{i_1})^2$$

(Note: the relationship between fires and the component $\zeta_1$ is not linear).

The number of fires which would have occurred in industry i if the size of that industry had been the average industry size can now be predicted.

It has already been mentioned that it was considered likely that the value of $\beta$ would be found to differ for production and storage areas.

It was also possible that $\beta$ would be found to vary between industries, and it was desirable to obtain an estimate of $\sigma_{\epsilon}^2$.

The 118 industries were grouped into 8 fairly homogeneous categories with the object of performing a single regression analysis on each, and then combining these analyses in order to test whether the group regressions varied significantly. The regression for group $t$ being

$$y_{it} = a_t + b_t x_{it} + (u_{it} + e)$$

$u_{it} + e$ was assumed to be distributed as $N(0, s_{u_{it}}^2 + s_e^2)$.

Results

Some results for each group $t$ are given in Table 2, i.e. $n_t$ the number of industries in group $t$, $\bar{x}_t$ the group average industry size, $s_t^2$ the error mean square, $F_{n_t-2}$ the variance ratio, $b_t$ the regression coefficient, and $r_t$ the correlation coefficient.

As the $s_t^2$ were found to differ significantly the sums of squares for each industry group were weighted before embarking upon the combined regression analysis. The weights chosen were

$$w_t = c/s_t^2 \qquad \text{such that } \sum_t w_t = 1.$$

the weighted means being

$$\bar{y}_w = \sum_t w_t \sum_i y_{it} / \sum_t w_t n_t$$

$$\bar{x}_w = \sum_t w_t \sum_i x_{it} / \sum_t w_t n_t$$

and the combined error sum of squares being

$$ESS_{all\ t} = \sum_t w_t (Sy_t^2 - b_t Sxy_t)$$

with 118 - 2(8) degrees of freedom.

The results of the analyses of variance between the eight linear regression relationships is shown in Table 3.

Differences in the $b_t$ were tested by comparing the 'between within group slopes' mean square with the error mean square. This tests the hypothesis that

$$\sum_t b_t w_t Sxy_t = b_c Sxy_c$$

Now

$$Sxy_c = \sum_t w_t Sxy_t$$

Therefore

$$\sum_t b_t w_t Swy_t - b_c \sum_t w_t Sxy = 0$$

if

$$b_t \equiv b_c \qquad \text{for all } t.$$

The relationship between the frequency of fire in production areas and the size of industry does not appear to be the same throughout the eight industry groups. In storage areas, however, the hypothesis that the $b_t$ were sample values of a common $\beta$ was not disproved. Nevertheless, the 'about linear regression of group means' mean square shows that the $a_t$ differ significantly, supporting the view that the industry groups do not share the same risk of fire at equivalent sizes.

The weighted average industry size $\bar{x}_w$ was the basis for both ranking lists, the predicted frequency of fire at size $\bar{x}_w$ for each industry (fire frequency index) being calculated from the regression for the relevant industry group.

i.e.

$$\hat{y}_{it} = y_{it} - b_t(x_{it} - \bar{x}_w)$$

The smallest $s_t^2$ was assumed to be equivalent to $s_e^2$. Industries were then classified according to whether $\hat{y}_{it}$ fell above or below the limits

$$y_{lower} = \bar{y}_w - (1.65)s_e$$

$$y_{upper} = \bar{y}_w + (1.65)s_e$$

1.65 being the value for the t-distribution with 102 degrees of freedom at the 90 per cent confidence level. The 90 per cent confidence level is a convenient significance level to take since, as can be seen from Table 4, this makes for almost equal risk groups. 102 degrees of freedom were chosen by virtue of the degrees of freedom obtained for the residual error in Table 3.

The overall risk for industry was obtained by transforming back to the original units (i.e. $\exp(\hat{y}_{it})$) and summing the resultant fire frequency indices in production and storage areas.

The ranking of industries

The overall ranking list is shown in Table 4. The list is split into 5 groups, (1) high risk, (2) medium-high risk, (3) medium risk, (4) medium-low risk, and (5) low risk.

The high risk category contains those industries with a fire frequency index above that industry with the lowest index having a high risk in production areas; while the low risk category contains those industries with an index below or equal to that industry with the highest index having a low risk in both production and storage areas.

The following table summarizes the scheme:-

| Classification of industry | Risk of marginal industry in | |
|---|---|---|
| | production areas | storage areas |
| High | High | - |
| Medium-high | - | High |
| Medium | - | - |
| Medium-low | Low | - |
| Low | Low | Low |

Some features of lists

The lists produced are subject to some uncertainty arising from chance variation and the order may undergo changes in time, particularly where industries are very close to each other in a list. In addition any pronounced changes in either materials handled or production methods used in an industry could affect its position in the lists. When due allowance has been made for these uncertainties, however, some interesting features can be observed in the lists as shown by the examples given below.

Miscellaneous wood and cork manufacture, furniture and upholstery, wooden containers and baskets appear high on both lists, while contractors' plant and quarrying machinery, industrial engines, engineers' small tools and gauges are at the low end; the position of these industries would be expected from the nature of the materials they handle. On the other hand some industries, such as tobacco, and spirit distilling and compounding, although handling flammable materials, are low on both lists; in the two quoted this is probably due to the stringent requirements of the excise laws. Other obviously dangerous industries, such as explosives and fireworks, are fairly well down the lists; in these the dangers are well understood and stringent and effective precautions are applied.

In some industries, of which linoleum, leather cloth, etc., is an example, the fire hazard of the production side has not been overcome, although there appears to be a smaller danger in the storage of the products. Again there are industries in which this situation is reversed; the pottery industry for example, which is thirty-sixth in order of fires in production areas, is third on the list for storage areas, presumably because of the nature of the packing materials used.

Acknowledgment

The Board of Trade assisted in the industrial classification of the fire reports and Mr. J. M. Firth with the computations.

References

1. The report on the census of production for 1958. Board of Trade. London, 1960-1961. H.M. Stationery Office.

2. KENDALL, M. G. A course in multivariate analysis. London, 1957. Statistical Monographs and Courses No. 2. London 1957. Charles Griffin & Co., Ltd.

Table 1

Factors of industry and the vector 1

| | Factors of industry | Vector 1 | |
|---|---|---|---|
| 1 | Number of establishments: employing 25 or more | + 0.913 | 1 |
| 2 | employing less than 25 | + 0.658 | 2 |
| 3 | Purchases of materials, fuels, etc. | + 0.857 | 3 |
| 4 | Products on hand for sale: Change during year | - 0.188 | 4 |
| 5 | at end of year | + 0.271 | 5 |
| 6 | Stocks of material and fuel: change during year | - 0.071 | 6 |
| 7 | at end of year | + 0.448 | 7 |
| 8 | Payments for transport | + 0.832 | 8 |
| 9 | Net output minus wages and salaries: 25 or more employed | + 0.963 | 9 |
| 10 | less than 25 employed | + 0.428 | 10 |
| 11 | Wages and salaries: operatives | + 1.000 | 11 |
| 12 | other employees | + 0.972 | 12 |
| 13 | Average number employed: (25 or more): operatives | + 0.969 | 13 |
| 14 | other employees | + 0.971 | 14 |
| 15 | (less than 25): operatives | + 0.478 | 15 |
| 16 | other employees | + 0.762 | 16 |
| 17 | New building work: (25 or more employed) | + 0.822 | 17 |
| 18 | (less than 25 employed) | + 0.616 | 18 |
| 19 | Plant and machinery (acquisitions minus disposals): (25 or more employed) | + 0.775 | 19 |
| 20 | (less than 25 employed) | + 0.574 | 20 |
| 21 | Vehicles (acquisitions minus disposals) | + 0.962 | 21 |
| 22 | Net output per person employed | + 0.071 | 22 |
| 23 | Wages and salaries per head (25 or more employed): operatives | + 0.357 | 23 |
| 24 | other employees | - 0.058 | 24 |
| 25 | Average number of persons employed (less than 25 employed): males | + 0.613 | 25 |
| 26 | females | + 0.477 | 26 |

Table 2

Some results from the industry groups regression analyses

| | Statistic | Food, drink & tobacco | Chemicals & allied industries | Metal, shipbuilding & vehicles | Engineering & electrical goods | Textiles and paper | Leather, fur, clothing | Timber furniture | Miscellaneous industries |
|---|---|---|---|---|---|---|---|---|---|
| | $n_t$ | 14 | 15 | 18 | 20 | 18 | 12 | 6 | 15 |
| | $\bar{x}_t$ | 2947 | 2052 | 3120 | 3021 | 2482 | 2069.5 | 2595 | 2374 |
| production areas | $s_t^2$ | 0.0516 | 0.0912 | 0.0275 | 0.1546 | 0.0721 | 0.0868 | 0.0285 | 0.1298 |
| | $F_{n_t-2}$ | 50.76 | 4.66 | 109.76 | 11.45 | 17.09 | 8.07 | 29.19 | 11.59 |
| | $b_t(10^3)$ | 0.553 | 0.242 | 0.288 | 0.264 | 0.203 | 0.295 | 0.432 | 0.371 |
| | $r_t$ | 0.91 | 0.51 | 0.93 | 0.62 | 0.72 | 0.67 | 0.94 | 0.69 |
| storage areas | $s_t^2$ | 0.1207 | 0.0507 | 0.0469 | 0.2387 | 0.1352 | 0.0658 | 0.0923 | 0.1099 |
| | $F_{n_{t-2}}$ | 17.12 | 4.96 | 38.87 | 3.57 | 9.49 | 32.89 | 4.23 | 12.57 |
| | $b_t(10^3)$ | 0.448 | 0.186 | 0.224 | 0.183 | 0.207 | 0.164 | 0.296 | 0.356 |
| | $r_t$ | 0.77 | 0.53 | 0.84 | 0.41 | 0.6 | 0.5 | 0.72 | 0.7 |

Table 3

Analysis of variation between industry group regressions

| Source of variation | Degrees of freedom | Sum of squares | Confidence level of variance ratio | |
|---|---|---|---|---|
| | | | Production areas | Storage areas |
| Overall linear regression | 1 | $b_o Sxy_o$ | 0.1 per cent | 0.1½ |
| Difference between average within group slope and between group slope | 1 | $\frac{Sx_c^2 Sx_m^2 (b_c - b_m)^2}{Sx_o^2}$ | - | 5 per cent |
| About linear regression of group means | 6 | $Sy_m^2 - b_m Sxy_m$ | 0.1 per cent | 0.1 per cent |
| Between within group slopes | 7 | $\sum_t b_t Sxy_t - b_c Sxy_c$ | 1.0 per cent | - |
| Error (or residual) | 102 | $\sum_t w_t (Sy_t^2 - b_t Sxy_t)$ | | |
| Total | 117 | $Sy_o^2$ | | |

$Sy_t^2 = \sum_i (y_{it} - \bar{y}_t)^2$ $\quad Sy_c^2 = \sum_t w_t Sy_t^2$ $\quad Sy_m^2 = \sum_t w_t n_t (\bar{y}_t - \bar{y}_w)^2$ $\quad Sy_o^2 = Sy_c^2 + Sy_m^2$

$Sx_t^2 = \sum_i (x_{it} - \bar{x}_t)^2$ $\quad Sx_c^2 = \sum_t w_t Sx_t^2$ $\quad Sx_m^2 = \sum_t w_t n_t (\bar{x}_t - \bar{x}_w)^2$ $\quad Sx_o^2 = Sx_c^2 + Sx_m^2$

$Sxy_t = \sum (x_{it} - \bar{x}_t)(y_{it} - \bar{y}_t)$ $\quad Sxy_c = \sum_t w_t Sxy_t$ $\quad Sxy_m = \sum_t w_t n_t (\bar{x}_t - \bar{x}_w)(\bar{y}_t - \bar{y}_w)$ $\quad Sxy_o = Sxy_c + Sxy_m$

$b_c = \frac{Sxy_c}{Sx_c^2}$ $\quad b_m = \frac{Sxy_m}{Sx_m^2}$ $\quad b_c = \frac{Sxy_o}{Sx_o^2}$

$\bar{x}_w = 2739.3$

Table 4

| Standard Industrial Classification | Fire Frequency Index | Description of Industry | Index in Production Areas | Index in Storage Areas |
|---|---|---|---|---|
| | | HIGH RISK GROUP | | |
| 479 | 455 | Miscellaneous wood or cork manufacturers | 393 | 62 |
| 475 | 335 | Wooden containers and baskets | 257 | 78 |
| 472 | 319 | Furniture and upholstery | 257 | 62 |
| 492 | 275 | Linoleum, leathercloth, etc. | 263 | 12 |
| 499 | 250 | Miscellaneous manufacturing industries | 209 | 41 |
| 601 | 246 | Gas | 214 | 32 |
| 473 | 241 | Bedding, etc. | 170 | 71 |
| 423 | 232 | Textile finishing | 204 | 28 |
| 414 | 218 | Woollen and worsted | 191 | 27 |
| 471 | 208 | Timber | 170 | 38 |
| 415 | 203 | Jute | 158 | 45 |
| 429 | 188 | Other textile industries | 155 | 33 |
| 496 | 186 | Plastics moulding and fabricating | 151 | 35 |
| 313 | 176 | Iron castings, etc. | 162 | 14 |
| 602 | 174 | Electricity | 141 | 33 |
| 395 | 173 | Cans and metal boxes | 145 | 28 |
| 276 | 171 | Synthetic resins and plastics materials | 158 | 13 |
| 274 | 171 | Paint and printing ink | 145 | 26 |
| 462 | 166 | Pottery | 98 | 68 |
| 365 | 163 | Domestic electric appliances | 141 | 22 |
| 481 | 161 | Paper and board | 129 | 32 |
| 474 | 160 | Shop and office fitting | 145 | 15 |
| | | MEDIUM-HIGH RISK GROUP | | |
| 431 | 150 | Leather (tanning and dressing) and fellmongery | 132 | 18 |
| 449/1, 3, 4 | 150 | Corsets, umbrellas and walking sticks and other dress industries not elsewhere specified | 129 | 21 |
| 432 | 147 | Leather goods | 126 | 21 |
| 271/3 | 145 | Other chemicals | 132 | 13 |
| 391 | 145 | Tools and implements | 129 | 16 |
| 494 | 145 | Toys, games and sports equipment | 107 | 38 |
| 321 & 322 | 140 | Light and base metals | 123 | 17 |
| 311 | 135 | Iron and steel (general) | 126 | 9 |
| 422/2 | 135 | Canvas goods and sacks | 81 | 54 |
| 419 | 131 | Carpets | 107 | 24 |
| 385 | 125 | Railway carriages and wagons and trams | 115 | 10 |
| 216 | 125 | Sugar | 102 | 23 |
| 275 | 120 | Vegetable and animal oils and fats | 115 | 5 |
| 450 | 119 | Footwear | 87 | 32 |
| 433 | 117 | Fur | 100 | 17 |
| 335 | 114 | Textiles machinery and accessories | 105 | 9 |
| 399 | 114 | Metal industries not elsewhere specified | 93 | 21 |
| 416 | 110 | Rope, twine and net | 81 | 29 |
| 461 | 109 | Bricks, fireclay and refractory goods | 79 | 30 |
| 369 | 107 | Other electrical goods | 89 | 18 |
| 493 | 106 | Brushes and brooms | 71 | 35 |

Table 4 (cont'd)

| Standard Industrial Classification | Fire Frequency Index | Desciption of Industry | Index in Production Areas | Index in Storage Areas |
|---|---|---|---|---|
| | | MEDIUM RISK GROUP | | |
| 411 | 105 | Production of man-made fibres | 93 | 12 |
| 394 | 105 | Wire and wire manufacturers | 89 | 16 |
| 393 | 104 | Bolts, nuts, screws, rivets, etc. | 93 | 11 |
| 389 | 102 | Perambulators, hand-trucks, etc. | 85 | 17 |
| 392 | 101 | Cutlery | 89 | 12 |
| 489 | 100 | Other printing, publishing, book-binding, engraving, etc. | 74 | 26 |
| 396 | 99 | Jewellery, plate and refining of precious metals | 87 | 12 |
| 463 | 98 | Glass | 72 | 26 |
| 271/1 | 95 | Dyestuffs | 87 | 8 |
| 312 | 95 | Steel tubes | 78 | 17 |
| 446 | 94 | Hats, caps and millinery | 78 | 16 |
| 445 | 93 | Dresses, lingerie, infants wear, etc. | 79 | 14 |
| 370 | 93 | Shipbuilding and marine engineering | 68 | 25 |
| 277/2 | 80 | Gelatine, adhesives, etc. | 48 | 32 |
| 275/2 | 79 | Soap, detergents, candles and glycerine | 60 | 19 |
| 277/1 | 78 | Polishes | 69 | 9 |
| 483 | 77 | Manufacturers of paper and board not elsewhere specified | 47 | 30 |
| 482 | 76 | Cardboard boxes, cartons and fibre-board packing cases | 55 | 21 |
| 383 | 70 | Aircraft manufacturing and repairing | 66 | 4 |
| 364 | 70 | Radio and other electronic apparatus | 56 | 14 |
| 263 | 69 | Lubricating oils and greases | 55 | 14 |
| 422/1 | 68 | Household textiles and handkerchiefs | 51 | 17 |
| 211 | 67 | Grain milling | 54 | 13 |
| 262 | 64 | Mineral oil refining | 51 | 13 |
| 421 | 64 | Narrow fabrics | 43 | 21 |
| | | MEDIUM-LOW RISK GROUP | | |
| 469/1 | 63 | Abrasives | 33 | 30 |
| 441 | 62 | Weatherproof outerwear | 56 | 6 |
| 214 | 60 | Bacon curing, meat and fish products | 50 | 10 |
| 342 | 58 | Ordnance and small arms | 54 | 4 |
| 384 | 58 | Locomotives and railway truck equipment | 52 | 6 |
| 469/2 | 58 | Building materials not elsewhere specified | 47 | 11 |
| 417 | 57 | Hosiery and other knitted goods | 49 | 8 |
| 382 | 57 | Motor cycle, three-wheel vehicles and pedal cycle manufacturing | 46 | 11 |
| 381 | 55 | Motor vehicle manufacturing | 47 | 8 |
| 271/2 | 55 | Fertilizers and chemicals for pest control | 40 | 15 |
| 273 | 55 | Explosives and fireworks | 40 | 15 |

Table 4 (cont'd)

| Standard Industrial Classification | Fire Frequency Index | Description of Industry | Index in Production Areas | Index in Storage Areas |
|---|---|---|---|---|
| | | MEDIUM-LOW RISK GROUP (cont'd) | | |
| 351 | 53 | Scientific, surgical and photographic instruments, etc. | 38 | 15 |
| 272/2 | 52 | Toilet preparations | 36 | 16 |
| 486 | 51 | Printing, publishing of newspapers and periodicals | 44 | 7 |
| 362 | 49 | Insulated wires and cables | 32 | 17 |
| 212 | 47 | Bread and flour confectionery | 38 | 9 |
| 442 | 45 | Men's and boy's tailored outerwear | 40 | 5 |
| 429/1 | 45 | Asbestos | 36 | 9 |
| 443 | 43 | Women's and girls' tailored outerwear | 35 | 8 |
| 272/1 | 43 | Pharmaceutical preparations | 35 | 8 |
| 349 | 43 | Other mechanical engineering not elsewhere specified | 35 | 8 |
| 352 | 42 | Watches and clocks | 20 | 22 |
| | | LOW RISK GROUP | | |
| 213 | 41 | Biscuits | 35 | 6 |
| 218 | 41 | Fruit and vegetable products | 30 | 11 |
| 495 | 41 | Miscellaneous stationers' goods | 31 | 10 |
| 231 | 40 | Brewing and malting | 24 | 16 |
| 229/1 | 39 | Margarine | 19 | 20 |
| 215 | 39 | Milk products | 28 | 11 |
| 331 | 38 | Agricultural machinery (except tractors) | 37 | 1 |
| 339 | 36 | Other machinery | 27 | 9 |
| 219 | 34 | Animal and poultry foods | 23 | 11 |
| 449/2 | 33 | Gloves | 26 | 7 |
| 464 | 33 | Cement | 26 | 7 |
| 239/2 & 3 | 32 | Wines, cider, perry and soft drinks | 21 | 11 |
| 444 | 32 | Overalls and men's shirts, underwear, etc. | 19 | 13 |
| 418 | 31 | Lace | 29 | 2 |
| 338 | 31 | Office machinery | 25 | 6 |
| 603 | 29 | Water supply | 23 | 6 |
| 332 | 26 | Metal-working machine tools | 26 | - |
| 239/1 | 26 | Spirit distilling and compounding | 23 | 3 |
| 217 | 26 | Cocoa, chocolate and sugar confectionery | 19 | 7 |
| 261 | 20 | Coke ovens and manufactured fuel | 13 | 7 |
| 337 | 18 | Mechanical handling equipment | 13 | 5 |
| 240 | 17 | Tobacco | 16 | 1 |
| 361 | 16 | Electrical machinery | 14 | 2 |
| 333 | 15 | Engineers' small tools and gauges | 15 | - |
| 334 | 15 | Industrial engines | 11 | 4 |
| 336 | 12 | Contractors' plant and quarrying machinery | 11 | 1 |
| 363 | 11 | Telegraph and telephone apparatus | 5 | 6 |
| 341 | 10 | Industrial plant and steelwork | 8 | 2 |

Definitions: Production areas - factory sections; workshop, welding shop; drying or heat treatment sections; paint shop, paint store.

Storage areas - store, stockroom; loading bay, packaging department, showroom.

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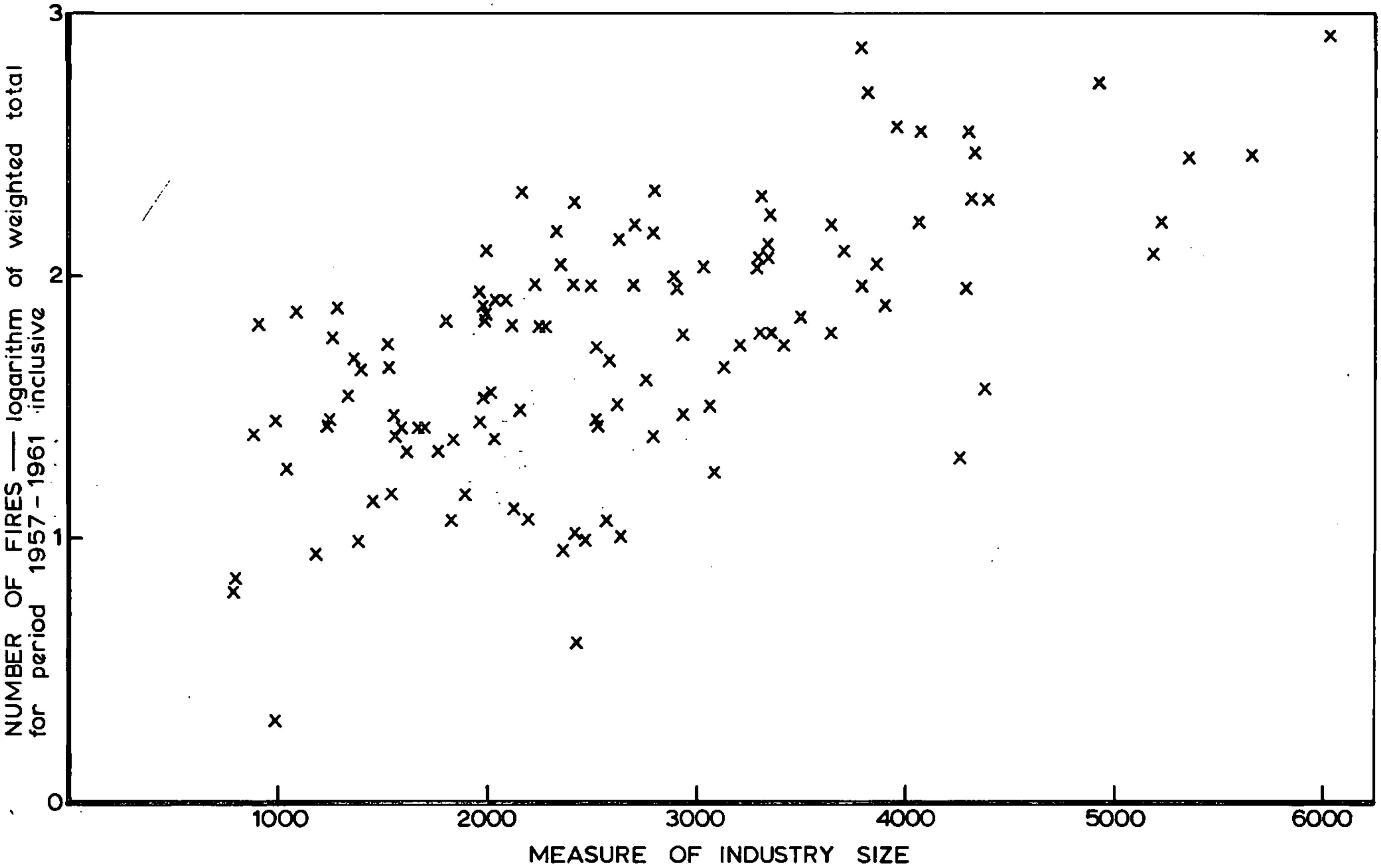


FIG. 1. FREQUENCY OF FIRES ORIGINATING IN PRODUCTION AREAS IN 118 INDUSTRIES IN GREAT BRITAIN IN RELATION TO A MEASURE OF INDUSTRY SIZE