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RATE OF FIRE DEVELOPMENT TEST IN FURNITURE

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Rate of Fire Development Test in Furniture

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MEASURING FIRE GROWTH IN FURNITURE
AN EXECUTIVE SUMMARY

By S A Ames, S P Rogers & R J Colwell

1 SUMMARY

A programme of research was carried out for the Home Office to develop a fire growth rate test for upholstered furniture. A range of U.K. upholstery composites was selected and examined using a number of different techniques to assess their fire behaviour information. Ignition, surface fire spread and heat release was obtained using reduced scale specimens, full scale mock seats and "real" production armchairs.

Standard ignitability tests were conducted with additional surface spread of flame and mass loss assessments. A large scale fire calorimeter was used to provide engineering data on the heat, smoke and toxic gases produced, and a standard calorimeter was constructed to permit the evaluation of a new Swedish heat release test specification for furniture.

It was shown that a wide range of ignition resistance and fire growth severity was exhibited by the products selected with very rapid and intense fires being produced by most of the domestic products and slower growing, less intense fires produced by many of the products intended for non-domestic use. The measurement of "rate of heat release" was isolated as the best indicator of fire growth and consequent life hazard.

Although the BS 5852 furniture ignitability test provided a limited indication of the fire behaviour of upholstery materials, it did not provide a reliable indication of fire growth severity even with additional surface flame spread measurements.

It was found that upholstery materials could be successfully assessed using a bench scale instrument, the "cone" calorimeter to provide a good prediction of full scale fire growth behaviour. However assessments using mock chair units in a standard full scale calorimeter developed in Sweden were inconclusive. This was largely due to the limited number of assessments that could be performed within the resources of the contract.

An additional block of work conducted during the project provided data on the fire behaviour of a range of new polyurethane foams called "Combustion Modified High Resilience" (CMHR) foams. This showed that some CMHR foams were only marginally safer in fire than standard foams, whilst some were considerably safer. The evidence provided valuable information for the Home Office during its negotiations with D.T.I. regarding the introduction of new consumer safety regulations designed to limit the flammability of upholstery infill and cover materials.

The changes in manufacturing practice resulting from the new regulations eliminated many of the upholstery foams chosen at the start of the programme, and it was not possible to obtain complete data sets for the latter stages.

It was concluded that the "cone" calorimeter might be used to predict the full scale fire growth behaviour of real furniture from small specimens of fabric/foam combinations. The results obtained using a full scale "furniture calorimeter" provide detailed evidence of fire growth behaviour both from full scale mock armchair specimens and real (production) armchairs. The full scale fire calorimeter test for furniture developed in Sweden (Nordtest No410) was also used to obtain full scale fire behaviour data but the original specification was altered to allow a smaller test specimen to be used and the specified wood crib was replaced by a 25kw gas burner. The lack of time and availability of test materials prevented a full comparison to be made with this apparatus.

Small and large scale calorimetry could be used for regulatory control purposes. It is suggested that a limit could be placed on the peak rate of heat release of whole items of furniture so that "flashover" would not be achieved from the burning of a single item in a typical domestic room. If flashover could be prevented in this way, it is likely that life hazard in the building as a whole could be greatly reduced. A maximum peak rate of heat release of 0.75 MW is proposed as a safe limit. In addition, if a very low level of heat release (below 50kw) could be maintained for the first few minutes after ignition, the safety of persons present in the room of origin might also be improved. A rate of heat release "template" is suggested which could be applied to the heat release curve obtained from a calorimeter test to determine acceptance or rejection.

The data obtained by this exercise have greatly improved understanding of the post-ignition fire performance of furniture. However, before a standard test specification can be written, it will be necessary to obtain a good database from the fire performance of a much wider range of products and materials. This might best be achieved with the co-operation of government bodies and manufacturing industry.

2 INTRODUCTION

The Fire Research Station was commissioned by the Scientific Research and Development Branch of the Home Office to undertake a programme of research to determine a method or methods by which the rate of fire growth in upholstered furniture could be predicted by means of a suitable test. The work was also funded by Construction Industry Directorate of The Department of the Environment. as part of their interest in the conditions that the internal linings of buildings are subjected to during fires. The work was carried out over a three year period and the following report is a summary of the findings of the research programme which have previously been presented in a series of documents produced during the course of the programme.

3 BACKGROUND

The available statistical evidence indicates that fires involving furniture are a major contributor to U.K. fire deaths and injuries and,in consequence, considerable study has been made of the fire behaviour of furniture, particularly upholstered seating, both in the U.K. and abroad. The only B.S. tests available are aimed at determining ignition resistance. These tests were in widespread use before the start of this programme and their use has continued to increase whilst the programme has been conducted. Consumer regulations, government purchase controls and a range of other contract furniture controls have all required fire tests to be conducted using the available ignitability test specifications (BS 5852 parts 1&2). However it is clear that the ignition process is not the only factor responsible for the hazard associated with furniture fires and that the rapidity of fire growth is probably the main contributor to the loss of life and injury reported.

Research directed towards establishing mathematical models of fire has isolated the main parameters which govern the increase in severity of fires and which contribute towards the deterioration in environmental conditions inside buildings which lead to injury and life loss. The occurrence of "flashover" constitutes a severe life risk in a fire inside a building and the main parameter responsible for this phenomenon is the level of heat release of the fire.

In parallel to the developments made in mathematical fire modelling, new tools have been developed for assessing the behaviour of fire in the laboratory. Large and small scale fire calorimeters have been developed for research purposes and their performance is becoming sufficiently well understood to consider them as a routine test tool as well as a research facility. Throughout the progress of the project, work on the establishment of fire calorimeters for standard tests has increased. International standards have been developed and interest has been shown in their use within Europe for regulating building products.

This study was therefore directed towards using the new techniques for examining the post-ignition fire behaviour of upholstered seating in order to make recommendations for suitable fire test methods.

New consumer regulations were introduced during the course of the programme in an attempt to regulate the post ignition flammability of upholstery infills using a modified ignitability test. The efficacy of this method is discussed later.

4 SELECTION OF UPHOLSTERY MATERIALS

The most important materials in upholstered furniture which influence fire behaviour are the covering fabrics and the soft infill materials below them. These materials are required to provide comfort and to be warm to the touch. This requires that the surface is quickly warmed by the heat from the skin of the user, which demands materials of low thermal inertia. Unfortunately, it is this very quality that induces a tendency to easy ignition and fast fire growth, since if the material is easily warmed by the skin it's temperature is also easily raised to its ignition temperature on contact with even the smallest ignition sources.

It was essential therefore that the study was carried out on covering fabrics and infill materials that were in use in the U.K. and a range of materials were selected to represent current usage. The materials were selected to provide a spectrum of performance from the more easily ignitable products present in domestic furniture to the more fire resistant types required by contract furniture specifiers such as the Crown Suppliers. Specimens of both natural and synthetic materials were included in the range and the main groups of fire retardant treated products including covers, fillings and internal fire barrier layers (interliners).

Unfortunately, the specification of upholstery materials is subject to continuous change and by the end of the study many of the materials originally chosen were no longer being manufactured in the U.K. New regulations relating to the flammability of infill materials had prohibited the sale of most of the original foams.

5 IGNITABILITY AND FIRE SPREAD

Foam/fabric combinations were first assessed using the British Standard fire tests for determining the ignitability of furniture (BS 5852 Parts 1 and 2).This test is widely used in the assessment of furniture and called up in the current regulations. It involves subjecting a small specimens, consisting of seat and back cushions only, to a graded series of ignition sources from cigarette and match size to a large (126g) wood crib. Each combination was subjected to increasingly high levels of ignition until the failure level was found.

In addition to the ignition test, information on fire spread was obtained by marking the test specimen with a grid and photographing the surface fire spread across the grid at appropriate time intervals. Assessment of surface fire spread versus time was then possible.

Results showed that foam/fabric combinations with the same level of ignitability could differ considerably in their fire spread versus time curves. On further analysis of surface area measurements against peak heat release results from a calorimeter, there appeared to be no definitive relationship between the two parameters. This showed a clear need for a test of fire growth.

6 FUEL GEOMETRY AND FIRE GROWTH

The fire behaviour of an item of furniture may not necessarily be defined by the fire behaviour of the materials used, since the geometry of furniture could influence the fire growth and possibly the peak rate of heat release. In order to assess the importance of "geometric factors" a series of experiments were undertaken beginning with an investigation of the burning behaviour of foam slabs placed in different orientations. The foam slabs ($0.5m^2$) were tested in the horizontal orientation, vertical orientation and 45 degrees from the horizontal. Each slab was ignited at one edge and a video record of the burning behaviour made. Rate of heat release was measured using a fire calorimeter.

As would be expected, the slabs in the vertical orientation burnt faster than those in the horizontal orientation, since the flame front was able to make contact with a larger area of foam. However, it was discovered that slabs in the 45 degrees orientation burnt even faster than the vertical slabs and produced higher rates of heat than the other two orientations. The faster burning time was caused because by rapid penetration of burning through to the rear of the slab allowing flames to establish on the rear and the front of the slab simultaneously. The flames at the rear of the slab caused the foam to melt and form flaming droplets. This produced a liquid pool fire beneath the slab which accelerated the burning of the remaining foam.

This phenomenon was studied further with a short series of real armchair fires. Flaming droplets were again observed falling from the armchair and producing a severe pool fire beneath the armchair which was associated with a marked increase in heat release observed from the calorimeter instruments. Rate of heat release results showed two heat release peaks, one caused by the chair seat and back burning, the other caused by the pool fire beneath the armchair plus the accelerated burning of the remainder of the chair.

In order to investigate the magnitude of the pool fire and its influence on the burning rate of the chair, an identical chair was placed in a shallow tray of water ignited as before. In this test any burning droplets from the chair were extinguished on contact with the water. The rate of heat release results from this test showed just one peak that was caused by the seat and back burning. The peak heat release from this test was less than half that from the original experiment.

A further test was conducted with an identical chair to which was added a sheet of hardboard below the seat cushion. This was designed to shed any liquid decomposition products to the rear of the chair and to protect the underside from any residual pool fire which might occur. This experiment showed an almost identical heat release curve to the water tray test.

These three experiments clearly indicate the high levels of heat release produced due to the development of a pool fire from the melting foam. It was concluded that this influence was so severe that it would probably override any other fuel geometry effects. Further support for this conclusion is provided later in this report.

7 FULL SCALE RATE OF HEAT RELEASE ASSESSMENTS

7.1 Mock armchairs

Once a full range of upholstery materials had been assembled, their fire growth characteristics were assessed. Full scale mock armchair specimens were constructed containing the foam/infill combinations selected. Duplicate specimens were placed under the canopy of a full scale fire calorimeter and ignited at the seat/back junction using a 25kw propane burner. The burner was designed to apply a specific heat transfer rate (50kw/square metre) to the specimen.

The range of results obtained is illustrated in Fig 1. It can be seen that the range of peak heat release levels developed varied from 50 to 900 kilowatts. The highest levels were produced from domestic materials and the lowest from specimens constructed from fire retardant treated (FR) covers, interliners and infills.

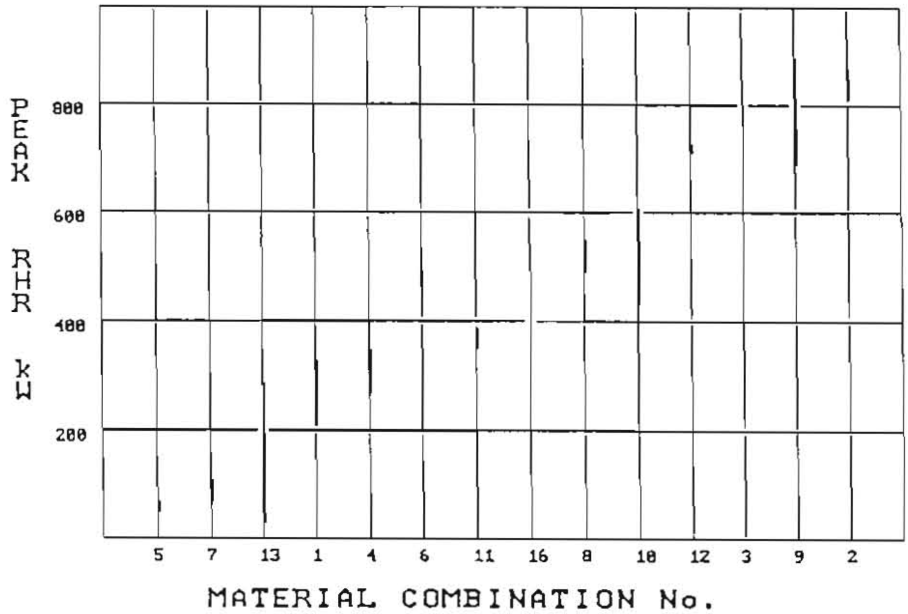

Fig 1 Peak RHR from mock armchairs

In addition to providing heat release information, the calorimeter experiments also provided data on smoke and toxic gas production. This data will not be discussed in detail here but has already made a significant contribution to a parallel Home Office research programme into the hazards of furniture fires in retail premises. The data may also be of value in future studies where full scale data might be needed for the validation of small scale results or as input to mathematical fire models for fire safety engineering studies.

7.2 Real armchairs

Selected foam/fabric combinations were used manufacture "real" production armchairs to assess the effect of chair geometry and study the rate of heat release from "real" armchairs.The foam/fabric combinations selected from the earlier work again ranged from the worst domestic type to the more ignition resistant contract furniture. This range therefore included the 100% polypropylene over standard polyurethane foam,and the 70% wool/ 30% FR viscose cover over an FR cotton interliner over an FR high resilience foam.

With the introduction of the new combustion modified foams to meet the new furniture regulations, two types of this foam were added to the selection. One foam was based on melamine and the other on graphite. The covering materials used with these foams were match-ignitable polyacrylonitrile velour and a more ignition resistant wool/FR viscose mixture.

In order to make some assessment of the effects of design geometry on fire behaviour, two foam/fabric combinations were purchased in different designs. Variations in the amounts of horizontal and vertical surfaces were the main differences between the two designs selected.

Each armchair was ignited using a 25kw propane source beneath the furniture calorimeter and duplicate tests were conducted where possible. The majority of armchairs yielded a peak rate of heat release rate sufficient to produce flashover in a room . Only two combinations produced less than 1000kw and these were made from the graphite-based combustion modified foam differing only in their covering material.The results are summarised in Fig 2.

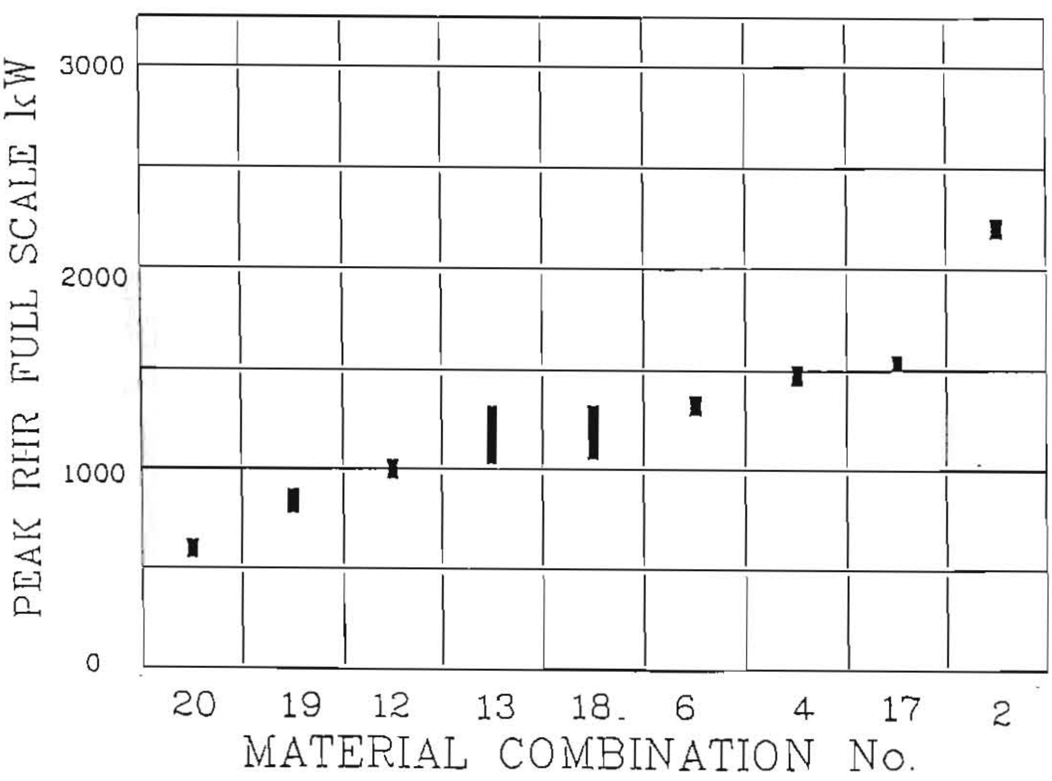

Fig 2. Peak rate of heat release results from duplicate "real" armchair tests

The elapsed time from ignition to peak rate of heat release did however vary considerably. When the polypropylene cover was used over 2000kw was produced in less than 3 minutes, whereas with an FR cotton interliner and wool/FR viscose cover over 18 minutes elapsed before 1200kw was reached.

Duplicate tests with the same design and combination of materials showed good agreement in terms of peak heat release rate measured. The length of the dark bars shown in Fig 2 shows the variation between the duplicate measurements. For example with PVC over standard polyurethane foam the measurements were 1203kw and 1290kw. There was however some variation in the time to reach the peak in duplicate tests due to the burning behaviour of the chair. This was most noticeable when the wool/viscose was used in two different designs and when an FR cotton interliner with FR PVC cover was used with identical designs.

When the peak heat release rate results from the "real" armchair tests were compared with those obtained from the cone calorimeter there was high degree of correlation. The behaviour exhibited in these "real" armchair tests is likely to be similar the behaviour of furniture in "real" fires.

8 BENCH SCALE CALORIMETRY STUDIES

At the start of the programme bench scale calorimetry was not available in the U.K. but one apparatus, the "cone" calorimeter had been developed in the U.S.A. and this was being considered by I.S.O. as a potential International Standard for small scale heat release measurement. To ensure that this potentially important new technique was considered in this study, the U.S. researchers agreed to undertake a series of tests on the selected upholstery materials with no charge to the current programme. Later in the programme a series of measurements were made on new types of foam (reported later) using a cone calorimeter built in a U.K. test laboratory.

The results obtained using the U.S. cone calorimeter were compared to those obtained from the full scale mock armchair test in the large furniture calorimeter. The most important parameter was considered to be peak rate of heat release and a moderate level of correlation was obtained. However the limited data obtained would not be adequate evidence to support its use for the prediction of full scale peak heat release rate without the involvement of full scale testing. The peak heat release results from the cone are shown in comparison to those obtained from full scale calorimetry in Fig 3.

In addition to rate of heat release, measurements were also made of smoke and toxic gas (carbon monoxide) production. The small scale smoke production data correlated closely with the predicted full scale data but there was insufficient full scale carbon monoxide data to provide a reliable comparison.

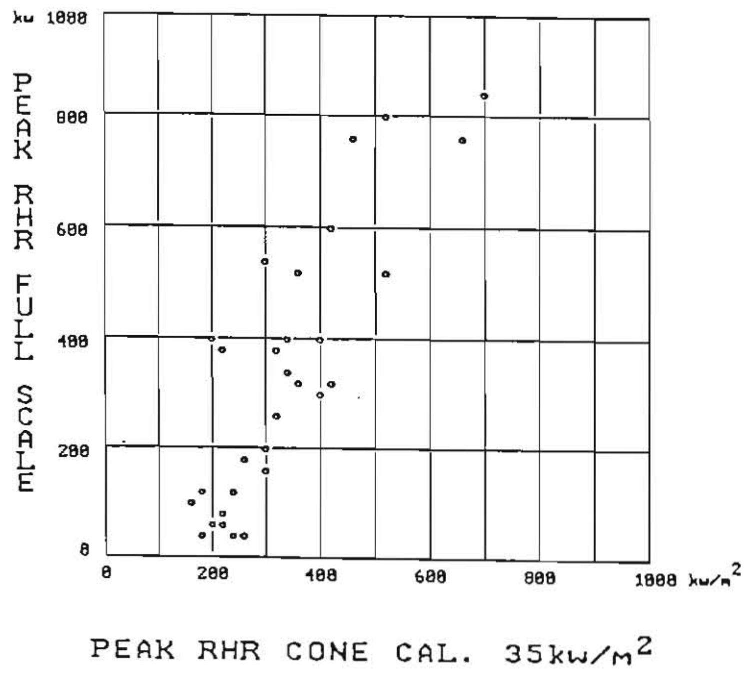

Fig 3 Comparison of cone calorimeter and full scale peak RHR measurements.

9 THE "NORDTEST" CALORIMETER

After the programme of research had begun the National Swedish Testing Institute at Boras published the specification for a full scale rate of heat release test for upholstered furniture (Nordtest No 410). This apparatus was constructed in a laboratory at FRS. It consisted of a 3m x 3m collection hood with horizontal ducting and fan assisted extraction. Instrumentation to monitor heat, smoke and toxic gases was housed in the duct. The test specimen consisting of a large 1.9m long three seat settee unit was also made to the Nordtest specification.

For this series of tests a smaller selection of foam/fabric combinations were chosen from the original selection. This was due to the lack of availability of certain of the original foams selected due to the changes in regulations. The materials tested however still included the worst of the domestic types (polypropylene cover over standard PU foam) and the more ignition resistant of the contract types (wool/FR viscose with FR cotton interliner over a high density foam).

Foam/fabric combinations using the combustion modified foams were also included but unfortunately the duct work in the apparatus proved unable to cope with the amounts of large carbon particles produced by the graphite foams. This foam was therefore not assessed.

A single seat unit was tested in addition to the three seat unit described in the specification to assess whether it would be possible to use a smaller (more economical) specimen. Specimens were ignited with the 25kw propane burner rather than the wood crib specified in the published document, to ensure the most ignition resistant combinations developed into a fire growth stage and for greater reliability of heat output.

The results indicated that the larger three seat specimen was not necessary and that the smaller single seat unit provided adequate information on seat burning behaviour. The degree of correlation between the results obtained using this method and those from the cone calorimeter was poor, probably due to the limited data available from the Nordtest method. In order to obtain a more meaningful comparison, the new combustion modified foams need to be assessed with the different covering materials in the cone calorimeter. To date these foams have only been assessed in the cone with the 100% FR Polyester material. This work could not be undertaken in the time and with the financial resources available in the current research programme.

10 COMBUSTION MODIFIED FOAMS

Some time after the programme began, several manufacturers in the U.K. marketed new foams based on polyurethane but containing additives designed to improved their burning behaviour. Several companies used a formulation containing Melamine as an additive and one company developed a foam containing graphite. They all used the generic name Combustion Modified (C.M.) or Combustion Modified, High Resilience (C.M.H.R.)foams. They were designed to produce upholstered furniture with considerably better fire behaviour than standard polyurethane (P.U.) or high resilience (H.R.) foams for only a modest increase in cost. It was also thought that the U.K. foam industry could convert its production facilities to produce the new foams in sufficient quantities for general domestic use.

During the discussions which followed between D.T.I. and the U.K. industry FRS conducted a series of additional experiments to support the Home Office in negotiations with D.T.I. regarding the way the new materials might be assessed and regulated. The results from these assessments provided valuable additional data for the programme and will also be valuable as a datum reference against which to check trends in performance that might come about by manufacturers designing materials to meet the existing regulations by a narrow margin or exploiting deficiencies in the test method.

In this series of experiments, a standard but unusual covering material was prescribed. A fire retarded polyester fabric was specified by the D.T.I. which would provide little protection for the infill and would not greatly add to the fire growth. Although this fabric did not represent a typical end use formulation, the data provided did add evidence to the main body of the study.

The peak heat release results from the cone calorimeter correlated well with the full scale peak rate of heat release data. Results from exposure levels of 35kw/m^2 provided a closer correlation than those at 50 kw/m^2. This conflicts with the evidence from real armchair studies in which the higher exposure level gave the closest correlation. This conflict of evidence requires further investigation. The work is desribed in detail in FRS Customer report No.CR 49/88.

11 DISCUSSION

11.1 BS5852 ignition tests

The results from these tests showed that with the additional mass loss measurements, a broad separation of the better and poorer materials could be obtained. However the use of mass loss as an indication of rate of heat release was clearly discredited during the large and small scale calorimeter tests which showed that the effective heat of combustion of materials changes greatly from minute to minute in a single test. Thus mass loss gives a poor indication of heat release. Furthermore, mass loss restrictions would tend to limit the use and stifle the further development of a range of valuable fire retardant systems (e.g. alumina tri-hydrate) which use sacrificial mass loss as a protection mechanism. The visual assessment of surface flame spread during the test did not provide any useful data.

11.2 Cone Calorimeter tests

The cone calorimeter is a new tool and little experience had been obtained in its use in the U.K. prior to this project. Although no regulations call upon the test, such is the interest in the technique that around 50 of these devices have been purchased worldwide including seven in the U.K. The experimental data obtained in this project indicated that it could provide a prediction of the most important fire growth parameter, peak heat release rate.

The cone calorimeter data correlated well with the full scale data. However,the performance of U.K. upholstery products may become compressed into a narrow band by the new regulations. This would make differentiation more difficult. In which case it would be prudent in any cone calorimeter assessment scheme to provide three bands; pass, fail and marginal. The marginal materials could then be assessed by full scale tests using mock or real set specimens. The exact levels at which these bands were set would depend on the intended application of the furniture and would need further detailed analysis of the results obtained here and in other studies.

Only two levels of heat transfer were assessed using the cone calorimeter. Other levels should be assessed to ensure that the correct level should be adopted in any assessment scheme.

11.3 Full scale furniture calorimetry

This technique is the most reliable for predicting full scale fire behaviour. Even though it is the most costly form of assessment of those selected there is clearly a place for this approach in any future assessment scheme. The method provides incontrovertible proof of performance and it should be available to specifiers and regulators as the "ultimate proof" should this be required, for example in relatively very high risk areas or where a novel material or construction technique is proposed. As previously suggested materials which give results close to the pass/fail limit in small scale tests could be referred for full scale assessment.

Mock-up seat specimens can be used to provide full scale data on materials and combinations and "real" chairs can be used to assess a particular design geometry. The broad philosophy which should be adopted is that materials which are shown to have unsatisfactory behaviour from small scale calorimetry are unlikely to be safe in any design configuration but materials of marginal small scale performance could be acceptable if proof of the behaviour can be demonstrated using mock or real piece of furniture in a large scale calorimeter. Attempts to study geometric effects showed that the formation of pools of burning polyurethane decomposition products below the specimen has a much stronger influence on the burning behaviour than the effects of fuel geometry.

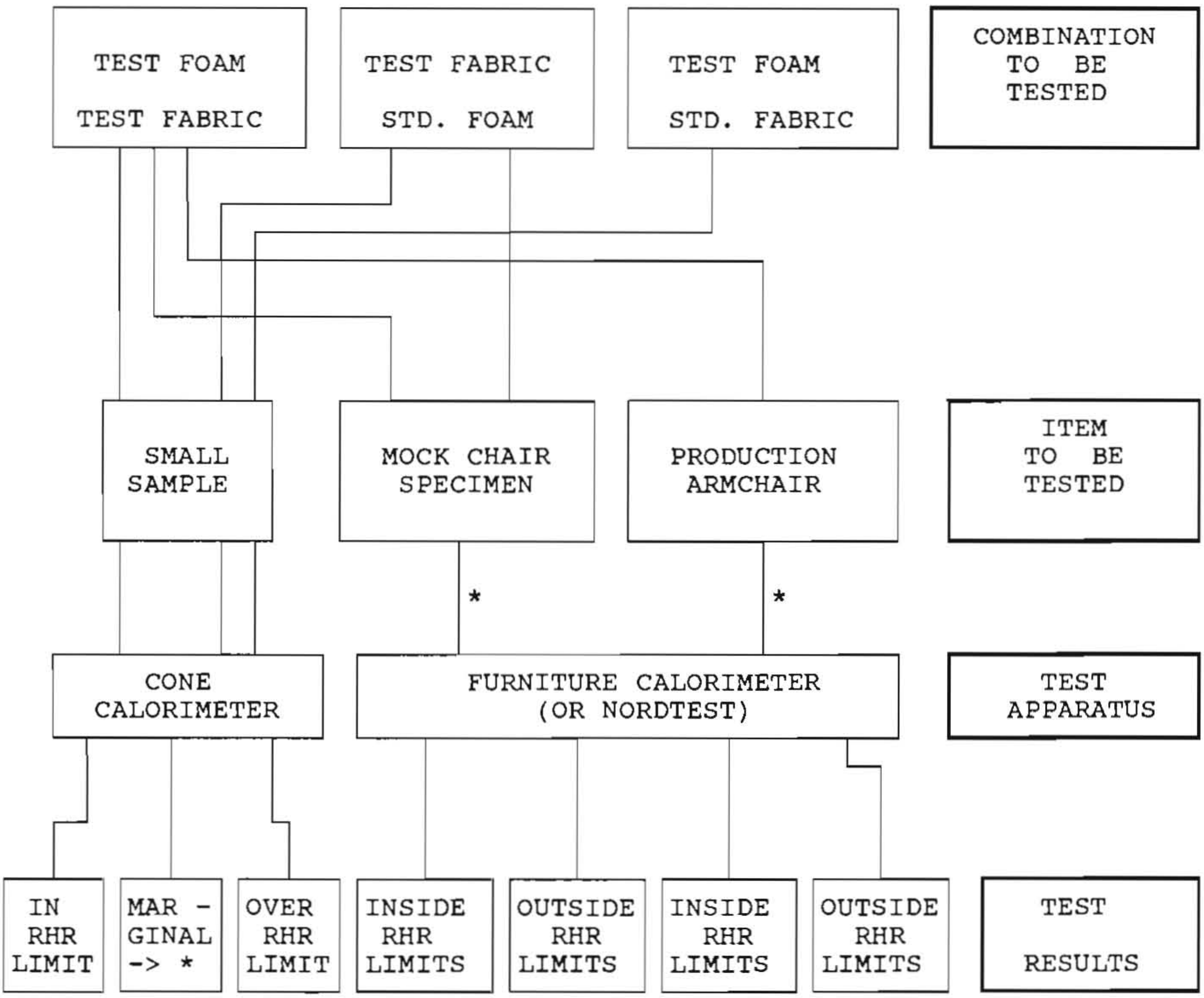

Fig 4 Alternative methods of assessment

During the study, a full scale furniture calorimeter test specification was published in Sweden as part of the "Nordtest" system. The study indicated that this apparatus is a reliable assessment tool but that some aspects of the procedure such as the specimen size and the ignition source could be improved. Unfortunately, owing to problems with availability of materials and the limitations of time and money, it was not possible to undertake a thorough assessment of this test. It was concluded, however, that the apparatus did provide an acceptable method for the assessment of real furniture and that mock-up specimens could probably be designed which would give a good correlation with real fire behaviour. Because full scale calorimeters were thought to provide data which are not apparatus dependent, it is likely that any well designed large scale calorimeter could be used for full scale furniture assessments.

11.4 A scheme for assessment.

In order to make fullest use of the test techniques described, it will be necessary to draw up a testing scheme which makes best use of the different types of assessment. An outline of how such a scheme could operate is shown in Fig 4. Acceptance criteria would need to be applied to the rate of heat release (RHR) data obtained from the tests. Attention would need to be paid to the rate of heat release at different times after ignition, and hazard levels would need to be defined.

In a domestic room it is possible to determine what level of heat release would cause a threat to life. This level should not be exceeded in the time it might take occupants to escape from the room. Secondly there should be a further limit placed on the heat release over a longer period of time which would allow occupants to escape from the building. And finally an absolute limit should be placed on the peak heat release in order to prevent flashover from occurring. A template could be applied to the heat release curve which embodied all of these criteria, See Fig 5.

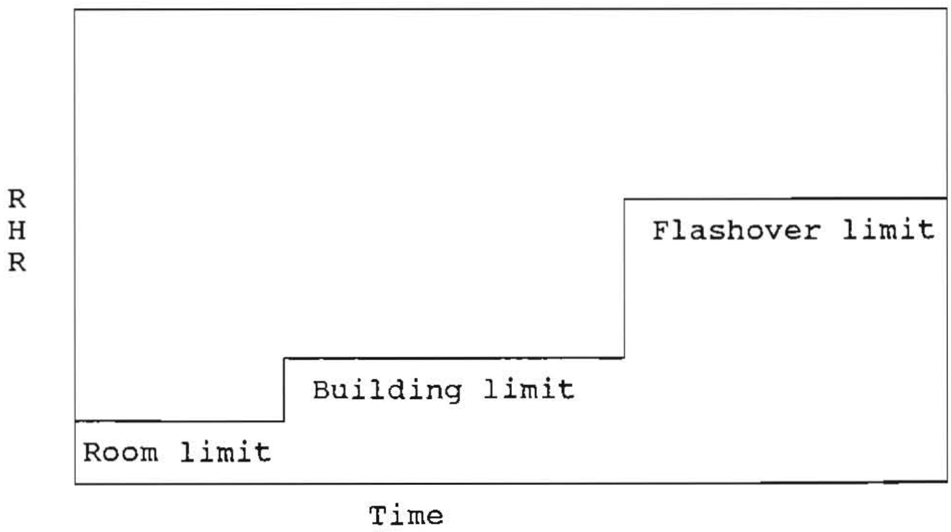

Fig 5. Suggested Rate of Heat Release acceptance template

11.5 Input to mathematical models

The value of the data obtained in this study is not limited to test technique development. It is reasonable to assume that Home Office research will continue into fire and the importance of the engineering data obtained here is likely to increase as greater use is made of mathematical models in predicting fire behaviour. The data has already been input to a current study connected with furniture fires in department stores.

11.6 Smoke and toxic gas

Although the main objective of the study was the assessment of fire growth, both smoke production and toxic gas release were routinely measured during most of the tests. The fact that it is relatively easy to add smoke and toxic gas analysis to both the small and large scale calorimeter test clearly indicates the long term potential for this type of assessment.

12 CONCLUSIONS

1. Fire growth in most domestic upholstered furniture was, at the start of the programme so rapid and the peak heat release so high that many items were likely to induce flashover in a domestic room within a few minutes of ignition. Some of the "real" armchairs tested with CMHR foams and match resistant covers also produced sufficient heat to induce flashover.

2.Rate of heat release measurement from full size specimens in a furniture calorimeter give a reliable indication of fire growth hazard. "Real" furniture provides an accurate model of real fire behaviour but valuable data can be obtained from mock chair specimens. Oxygen depletion measurements should be used rather than any other technique to assess heat release.

3.Full scale calorimeter data is of considerable value in the assessment of hazard in a given environment because the data produced may be input to a range of predictive computer fire models. Only this type of assessment provides data in a form suitable for use in this way.

4.The bench scale "cone" calorimeter provides a good correlation with full scale rate of heat release and is suitable as a basic test for materials. However the pass / fail criteria will need to be established carefully. Marginal results would need to be confirmed using large scale calorimetry.

5.The full scale Swedish Nordtest spec. No.410 appears to embody the desirable requirements but because of problems with materials supplies etc. it was not possible to confirm the correlation of the method with other full scale data.

6. The work on Combustion Modified foams provided a valuable input to new regulations which were enacted during the study. The data obtained will provide a datum against which to monitor trends in U.K. production.

7. A scheme of assessment involving the cone calorimeter, and full scale assessments of mock-ups and real furniture is suggested but details will need to be established by further work.

8.The results from the BS 5852 ignition test with additional mass loss measurements provide a means of broadly separating standard and Combustion Modified foams but a more precise technique would be desirable to prevent unfair discrimination against certain fire retardancy techniques.

9. A database of heat release information from a range of typical upholstery products would be a valuable resource in making decisions concerning acceptance levels and trends in product performance.

10. The materials used on the underside of chairs plays an important role in protecting the chair from attack by burning liquids which often form below the chair.

13 RECOMMENDATIONS

13.1 A scheme of assessment should be prepared based on small and full scale calorimetry. Levels should be set for specific environments and the method discussed with both regulatory and industrial groups with a view to encouraging the collection of further data on fire growth with which to tune in the acceptance criteria.

13.2 A fire performance database should be set up and additional data collected to provide a statistically more reliable basis for comparisons. The co-operation of industry would be an advantage.

13.3 A further series of measurements should be made of current production foams in one or two years time to assess any change in the performance of CM foams. This will provide the means of assessing the effectiveness of the test method used in current regulations.

13.4 The cone calorimeter could be used to assess other materials which make up the contents of buildings and consideration should be given to extending its use to other products.

13.5 Fire performance requirements should not be limited to infills and covers used on the top of the chair. The materials attached to the underside also play an important role in fire growth.