Flammable Solids & Dusts			
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FLAMMABLE SOLIDS FIRE ASSESSMENT

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Summary

Although flammable solid materials will be found in all places of work, a relatively small range of products have properties that make them a special fire hazard meriting particular process fire precautions precautions under Health and Safety legislation. In addition, the Fire Precautions Act 1971 section 8 makes reference to highly flammable materials as influencing the general fire precautions that may be needed. Various attempts have been made to clarify what is meant by highly flammable materials in the context of solids, and HSE's approach to the subject set out in guidance (now superceded) has been accepted by the Home Office, and recommended to local fire authorities. The main product groups that include highly flammable solid materials are cellular plastics and textiles, and guidance is available for each of these groups.

Background

Since 1990 HSE has used a medium scale fire test in a rig with a room and corridor arrangement to assess the fire risks of a wide variety of solids. The test protocol has been gradually refined, but a significant database of test results are available. More recently an apparatus known as the cone calorimeter has become widely used for studying the fire properties of a range of solid materials. It applies a radiant heat source to a small sample, and studies the time to ignite and subsequent growth of fire as a function of the applied heat source. Its particular feature is the ability to measure the oxygen content of the collected combustion products, and from this calculate the rate of heat release while the sample burns. This is seen by fire scientists as a more fundamental parameter for use in any assessment of the fire risk of building products and building contents. There has been some pressure to use the cone calorimeter in our assessments of fire risk, partly because the test is internationally standardised, (published in the UK as BS 476 part 15) and partly because only small amounts of sample are needed. A major limitation of the cone calorimeter, as far as our interests are concerned is the small size of the test piece, which may prevent composite samples, such as foam backed carpet, or collections of discrete items such as loose fill packaging being tested properly.

Test comparisons

A student at Edinburgh University under contract to HSE has studied how information from the cone compares with the medium scale room test, and also how the arrangement of the sample in the medium scale room test influences the outcome. The work has looked mainly at seven samples of textiles and foamed plastics which tend to cause us most concern. From the experimentalist's point of view, these materials tend to exhibit properties that make testing more difficult, specifically some melt and flow away from the heat source, while others shrink in the early stages of heating.

One important conclusion from this research, is that different tests may be appropriate in different circumstances. The medium scale room test may not provide all the information needed.

A second conclusion is that some form of ignitability test should be used in most cases, although an appropriate form of test was not settled.

The third main conclusion is that the arrangement of the sample within the medium scale room strongly affects the results, and as this was not standardised adequately in the early use of the test, some of the older data from the database is suspect.

To illustrate the first conclusion, we may consider the smoke measurement in the existing test. We know that smoke yields from plastic foams rise very sharply when a test reaches the point that air supply controls the rate of burning. In a full scale fire, where foam was stored in a small room with a small window opening off the workroom, the same effect could occur. If the storeroom door was subsequently opened, vast quantities of smoke would emerge. In a very large open shed, with a high ceiling, and perhaps roof smoke ventilators, the air supply effect should not occur until long after the time available for evacuation, and so judging the foam in this case by a smoke yield alone is unsound.

There are a number of published tests designed to assess ignitability and the very early stages of fire growth. The BS 5852 tests used on furniture are examples which use a mock up of a simple chair. The chair rig is not a good model for the storage arrangements usually found in factories: materials are generally stacked or palleted directly on the floor. However, the set of seven graded ignition sources specified in BS 5852 do form a well established and useful basis for assessing ignition resistance in ad hoc tests where the geometry is chosen to match the conditions in individual stores.

For some time staff at the Fire Section of HSL at Buxton have been carrying out and reporting on ignition tests of this sort, when samples are submitted. These tests are generally carried out under large laboratory extract hoods. A few larger tests have also been done outside. Visual observation of these tests is often helpful in understanding the possible behaviour of large fires. Video of fire spread can be helpful in discussions with occupiers. A larger test rig is available at Buxton. This provides a space 7 x 7 x 7m that is sheltered from the wind and is suitable for large fire tests. The effects of sprinklers or foam on fire development can also be studied if these are provided in the premises of interest.

The importance of arrangement of the fuel was highlighted by recent tests on a rigid pu foam. Essentially, it was shown that large stacks with a separation of only 50mm allowed flame propagation up the full surface very rapidly from a single match ignition. If the separation was increased to 300mm, even with a much larger wooden crib ignition source upward flame spread stopped when the crib burnt out. A video of this test is available from A Tyldesley, HID CTG 5 or Dr G Atkinson, Fire Section, at Buxton.

The test results from a range of textiles and foams examined under a range of conditions in the cone calorimeter were compared with the medium scale room tests. Only poor correlations were found, but the cone may still have some value as an ignitability test, as a screening test if limited quantities of sample are available, or for observing physical properties of the sample like melting, if the apparatus is used with the sample in a vertical orientation. HSL do not have a cone calorimeter, nor do they have any immediate plans to buy one, but external testing can easily be arranged. One off testing of specific samples is reactive support work and should be arranged with HSL, even if they subcontract the actual testing.

HSE Guidance

Current advice on process fire precautions for textile premises, is contained in the TEXIAC publication ' Fire Precautions in the Clothing and Textile Industries' It contains a description of the medium scale room tests, but puts it into context, as not the only method of testing that may be relevant to an assessment of the fire hazard.

For cellular plastics like expanded polystyrene, and polyurethane foam the guidance is contained in booklet HSG 92 Safe Use and Storage of Cellular Plastics'

Nitrocellulose is also considered a highly flammable solid, but its special properties led to the need for specific guidance contained in booklet HSG 135 'Storage and Handling of Industrial Nitrocellulose'

Where inspectors are considering the need for process fire precautions in respect of particualar solids, these may be submitted for laboratory testing at HSL. In order to give best advice, it would be helpful if:

- Any products of particular concern are submitted to Buxton for testing. We would like to extend our database. Some results can be obtained from small samples, but a minimum of 5kgs is needed for a medium scale room test

- as much information as possible about the sample itself accompanies the product, especially trade names, chemical nature, and presence or absence of any flame retardants or other additives

- in addition, in order to undertake the right tests, information about the arrangements in use is needed, e.g. room sizes and ceiling heights, stack heights, block sizes, is it stored on pallets or direct on the floor, is it covered in shrink wrap or similar?

Decisions about the enforceability of any particular precaution lie firmly with the inspector who has visited, but we should base those decisions on the right information about foreseeable fire scenarios.