Communications

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Use of the Term Sensitiveness to Describe the Response of Pyrotechnic Compositions to Accidental Stimuli

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ABSTRACT

This paper clarifies the differences between the terms sensitivity and sensitiveness, highlights the adoption of the latter by the United Nations, and proposes that sensitiveness could usefully be employed in describing certain hazard characteristics of pyrotechnic compositions.

Keywords: sensitiveness, sensitivity, hazard, pyrotechnic

Introduction

The Sensitiveness Collaboration Committee of the United Kingdom Ministry of Defence has produced a manual[1] that describes the standard test procedures and apparatus used to assess the safety of "energetic materials" (in this context, high explosives, propellants and pyrotechnics) for Service use. The manual defines a number of hazard parameters and uses the terms sensitiveness and explosiveness for characterising the response of explosive systems in accident situations. In a different sense, sensitivity is used to describe the deliberate application of a stimulus.

Sensitiveness, as used in the United Kingdom (UK), can be defined as a measure of the relative probability of an explosive being ignited or initiated by a prescribed stimulus. The stimuli are those considered relevant to accident situations and include impact, friction and electric spark. The word sensitiveness is therefore used in relation to assessing the hazard characteristics of the explosive material.

Sensitivity, on the other hand, is used in the UK to designate a measure of the stimulus required to cause reliable functioning of an explosive material in its designed mode. Detonators provide a good example, since the conditions for reliable initiation are specified in terms of a minimum current. Similarly, for pyrotechnic compositions, it is likely that the sensitivity to flame is considered at the design formulation stage.

Whereas the UK uses the terms as described above, other countries adopt a different approach. In Japan,[2,3] Canada[4] and Croatia,[5] for example, sensitivity is used in the same sense as sensitiveness in the UK.

United States (US) usage of the term sensitivity has recently been defined[6] for pyrotechnics but it is not clear whether the stimuli are in relation to design mode or accidental functioning.

Cook[7] proposes a different terminology in which the term precariousness is used to refer to "hazard sensitivity" (i.e., sensitiveness, as defined above) and "sensitiveness" is used to designate "performance sensitivity".

Clearly, the wide-ranging use of similar words to describe different characteristics of explosives creates the potential for confusion.[8] The latest edition of the Manual of Tests and Criteria[9] relating to the United Nations (UN) scheme for the transport of dangerous goods has almost universally used the term sensitiveness which is helpful, although some inconsistencies remain.

The areas of inconsistent terminology in the UN manual appear to be largely editorial in origin (e.g., whereas Test Series 3 refers to type (a) tests as being for determining the sensitiveness to impact and type (b) for determining the sensitiveness to friction, the descriptions of the boxes in the flow chart assessment scheme (ref. 9, p. 21) refer to impact sensitivity and friction sensitivity). Another anomaly relates to test methods 3 (a) (vi) and 3 (b) (iv) which are titled impact and friction sensitivity tests, respectively, but from their introductory descriptions are clearly used to measure mechanical sensitiveness.

Discussion

Although the UN manual provides the first global test scheme for explosives, it strictly relates only to transport situations and is part of the process by which packaged explosives goods and articles are classified. However, since it provides well accepted and widely used explosives test methods, the test procedures have been adopted for other uses.

Examples are the use of sensitiveness information obtained from the UN-recommended, German Bundesanstalt für Materialforschung und -prüfung (BAM) tests in relation to the notification, supply and use of bulk chemicals under European Community (EC) legislation,[10] and the inclusion of BAM mechanical sensitiveness tests in the harmonised European Committee for Standardisation [Comité Européen de Normalisation (CEN)] test methods[11] that are currently being developed as a means of assessing whether commercial sector explosives meet the essential safety requirements of the European Civil Uses Directive.[12] Other examples are the use of the BAM tests in the classification of explosives substances under the Chemical (Hazard Information and Packaging for Supply) Regulations 1994 (CHIP 2) and for the categorisation of explosives under the draft Control of Major Accident Hazards involving Dangerous Substances Directive (COMAH)[13] as part of large scale hazard evaluation.

Quantification of the sensitiveness of pyrotechnic compositions is needed for UN purposes (i.e., transport classifications) but the information can also be valuable in assessing hazards involved in handling (e.g., dropping) and manufacturing (e.g., pressing).

Surveys of accidents involving pyrotechnics[14] and, more generally, explosives[15] have indicated that they are often caused by mechanical stimuli, particularly friction.

The Health and Safety Laboratory provides a support service to the UK Explosives Inspectorate and one of its functions is to provide laboratory assistance to the technical investigation of accidents involving explosives. Studies in recent years have clearly demonstrated the role that mechanically sensitive pyrotechnic compositions have had in certain accidents and have highlighted the importance of measuring sensitiveness.[16]

Examples are provided by: the initiating pyrotechnic material involved in the explosion of 800 kg of mixed explosives and detonators at Peterborough in March 1989;[17] accidents during the pressing of titanium/blackpowder mixtures for gerbs;[18] and the ignition during processing of a thiourea/chlorate white smoke mix.[19]

When evaluating the hazards posed by explosive materials, the explosive response in a defined system should be considered as well as the likelihood of the initiation occurring as a result, for example, of a given mechanical stimulus.

While sensitiveness covers the latter, in the UK the term explosiveness is defined as "the degree of violence shown by an explosive material when it responds to a prescribed stimulus relevant to an accident situation".[1]

The plot of sensitiveness against explosiveness, Figure 1, is useful in illustrating the hazards posed by traditional types of explosives, but for certain modern materials the regions of correlation no longer apply.[20] For this reason it is advantageous to measure explosiveness together with sensitiveness. Pyrotechnic compositions exhibit a range of explosiveness and sensitiveness ("some can be sensitive enough to be classed as primary explosives"[1]) and they can occur throughout the sensitiveness/explosi-

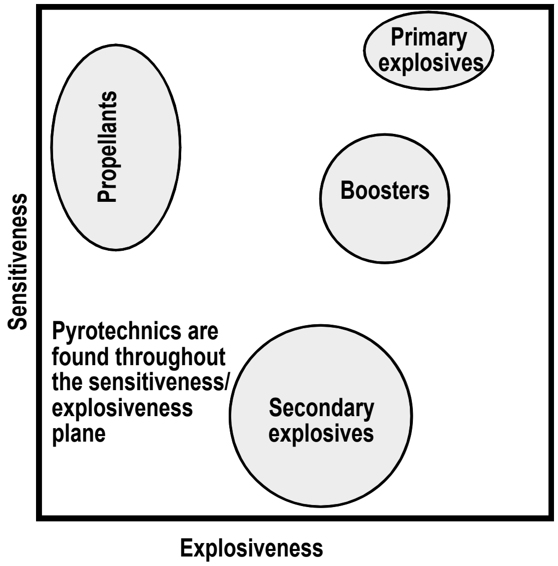

Figure 1. The relationship between sensitiveness and explosiveness for different types of explosives.

veness plane illustrated in Figure 1. The existence of this variable behaviour reinforces the need to undertake practical measurements since there are no other means of accurately predicting the hazard.

Conclusion

This short paper advocates use of the UN-accepted term sensitiveness to describe the response of pyrotechnic compositions to accidental stimuli.

Evaluation of the sensitiveness of pyrotechnics (particularly to friction and impact) is important since the results can provide a means of assessing the hazards involved in different manufacturing and handling processes.

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