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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the
Transport of Dangerous Goods

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LISTING, CLASSIFICATION AND PACKING

Classification as a consequence of Net Explosive Quantity (NEQ)

Transmitted by the Expert from the Netherlands

SCOPE
This information paper is meant to draw the attention of the Sub-Committee to a recently performed research project on large scale behaviour of fireworks and to a follow up project that is currently being set up.

RELATED DOCUMENTS
ST/SG/AC.10/C.3/2007/17 - (Australia)
UN/SCETDG/31/INF.7 - (Australia)

Introduction

Documents ST/SG/AC.10/C.3/2007/17 and UN/SCETDG/31/INF.7 from Australia raises, amongst other subjects, questions about the applicability of the results of Test Series 6 tests to transport on a larger scale in closed transport units. Australia's concerns are related to propellants and fireworks.

The Netherlands would like to point out that this concern has been the subject of an EU funded research program that was finalised about one year ago. The project: "Quantification and Control of the Hazards Associated with the Transport and Bulk Storage of Fireworks" (CHAF) showed that in most cases the hazards of an accidental explosion in a 20 foot container corresponded with the hazards as indicated by the transport classification.

The exception to the rule was a container full of waterfalls properly classified as 1.3G which resulted in a violent mass explosion. No explanation for this behaviour could be found within the framework of the project. Detailed information can be found on the internet: www.chaf.info.

At the moment the possibilities for a new project are being investigated. Information about this new project can be found in the annex to this information. paper.

The three partners that performed the CHAF project are very much interested in a possible follow up project. However, these partners believe that the project should be addressed on a global level since the UN classification system is used all over the world and the above described examples of unexpected behaviour apply worldwide. Potential partners interested in participating in (part of) the project are invited to express their interest.

For the time being it was agreed that TNO would coordinate the setting up of the project. See the annex to this paper for contact details.

Outline for a possible follow up project for CHAF

INTRODUCTION

The project "Quantification and Control of the Hazards Associated with the Transport and Bulk Storage of Fireworks" (CHAF) was jointly performed by the Health and Safety Laboratory (HSL) in the UK, the Netherlands organization for Applied Scientific Research (TNO) and the Federal Institute for Materials Research and Testing (BAM) in Germany and was funded by the European Union with match funding from the Health and Safety Executive (HSE, UK) and the Ministry of Housing, Spatial Planning and the Environment (VROM, Netherlands).
The project was aimed at studying the influence of scaling on the explosion effects of fireworks. The transport classification is obtained by subjecting fireworks as packaged for transport to the UN Series 6 tests. The effects on a large-scale can be more severe than anticipated on the basis of the classification and this is reflected in the UN Model Regulations (Note 2 to 2.1.3.2.2.).
The transport classification is the basis for all safety measures (e.g. quantity distances, emergency procedures, security, etc.), it is therefore crucial that Regulators can rely on the classification; whether established according to UN Default Classification Table or actual UN Series 6 tests.

The project generated a large number of results and deliverables. More information can be found on the website www.chaf.info.
In the majority of the cases the classification obtained in the UN Series 6 tests was confirmed by the large-scale tests. There is no immediate reason to change the UN classification system for fireworks.

A number of observations and results were not expected and could only partly be explained in this project. Examples are:

1. Articles selected to represent the most energetic 1.3 articles which were classified as 1.3 according to the 2005 version of the default list (i.e. 150 mm shells and 60 gram rockets without stick) turned out to be mass explosive when tested according to Series 6 tests.
   It was believed that the formulation of these pyrotechnic compositions may have contributed to these unexpected classifications. This observation was one of the reasons to revise the definition of flash powder in Note 2 to paragraph 2.1.3.5.5.
2. For 150 mm shells, propagation velocity between the firework packages as measured in the large-scale tests was 2 to 5 times greater (12 and 35 m/s) than measured in the medium scale test (7 m/s).The causes of the higher propagation velocity (or higher conversion rate of the pyrotechnic material) in the large-scale situation are not fully understood.
   What mechanisms lead to such a fast initiation of a very large number of articles in the container? What circumstances should be avoided in order to have much lower conversion velocities?
3. For one article (waterfalls) the reaction velocity was found to increase with increasing amounts, both in small-scale tests and in large-scale tests. Although all UN Series 6 tests resulted in a 1.3 classification, a container full with waterfalls mass exploded very violently.
   A container full of waterfalls might not be a situation that occurs in practice but it can certainly not be excluded that other articles or combinations of different articles show the same phenomenon.

The above listed examples of unexpected reactions and results justify a more in depth study of the behaviour of fireworks in order to avoid accidents and incidents with consequences more severe than can be expected on the basis of the classification.

APPROACH

The project will include a considerable amount of theoretical and practical work in four stages:

1. substance
2. article
3. package

4. transport/ storage

Ad. 1: In the CHAF project, the characterisation of the pyrotechnic compositions was not included for budgetary reasons. In hindsight it is believed that having knowledge on the properties of the substances might have been useful in explaining the unexpected reactions. A more fundamental and extensive knowledge of the behaviour of the pyrotechnic substances will be crucial for the other levels of tests. Given the number of pyrotechnic compositions a well founded choice will have to be made for the compositions to be characterised.
Examples of characterisation tests are: thermodynamic tests (e.g. DSC and TG/DTA), performance tests (e.g. time/ pressure test, manometric bomb (closed vessel) tests, burning tube test), sensitiveness tests (e.g. to flame, to shock, to electrostatic discharge, to impact, to friction) and behaviour tests (e.g. deflagration to detonation transition, composition of reaction products, presence and composition of intermediate products). Additional characterisation tests may be included to cover other properties or behaviours.
Chemical and physical characterisation of the mixtures involved will also be part of the substance tests in an attempt to find a correlation between the properties.
The data would be used to validate and develop models for combustion, explosive events and container dynamics.
The results of the substance tests will be included in the selection process of articles for the next levels of tests.

Ad. 2: Communication tests on a firework article were also included in the CHAF project. Many useful results have been obtained. It was also found that the measurement techniques often did not work in the relevant time frame because of the relatively slow reactions, thermal effects and reaction rates. Part of the effort will be aimed at finding better measurement techniques in order to assess how the articles interact with each other and what the propagation mechanisms are. Mitigation of the reaction propagation, for instance to simulate inner packages, could be part of the programme. These tests will greatly improve the understanding of the ignition/propagation of fireworks within a firework package.

Ad. 3: The communication between packages will be studied . The medium-scale pressure vessel test has been able to distinguish between those fireworks that exhibit 1.1 behaviour in large scale storage and those that do not.
The medium scale test is also able to determine the relative violence of reaction in large scale storage. The medium scale tests were performed in a steel vessel capable of withstanding the pressures generated by 3 boxes of fireworks articles. This vessel also has a number of disadvantages such as cost, complexity, labour intensive and the ability of the vessel to withstand very violent reactions. Alternatives to the test can be explored and UN Series 6 tests will be carried out to validate these tests. The experiences from the CHAF project and the tests mentioned above will be included in these tests, e.g. extra instrumentation, alternative measurement techniques and conditions causing or preventing certain reactions.

Ad. 4: Large-scale tests are quite expensive but are indispensable for the validation of the findings of the project. Naturally, the experiences of the CHAF project shall be included such as the quality of the containers used, the preparation of the doors to obtain an known and reproducible failure pressure and the initiation techniques. Measurements obtained from inside the containers should receive special attention. The number of large-scale tests should be limited.

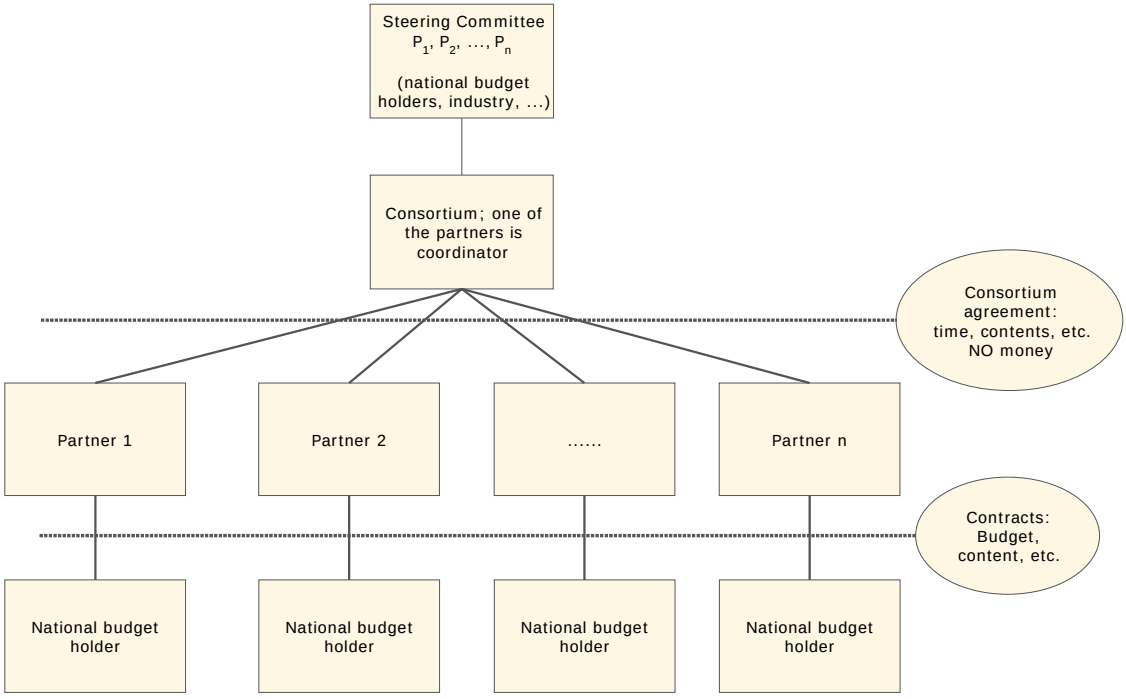
The results of the project are used to further improve the fireworks regulations for transport and storage.
Separation distances of stores to public may be validated by the project or new criteria derived from the results.
The project may also result in alternative, less expensive UN classification methods and other tests to screen out potentially mass explosive fireworks.

ORGANISATION

The three partners that performed the CHAF project are very much interested in a possible follow up project. However, these partners believe that the project should be addressed on a global level since the UN classification system is used all over the world and the above described examples of unexpected behaviour apply worldwide.

We therefore invite other partners who are interested in participating in (part of) the project to express their interest. Participation in the project can be realised in many ways: by doing research in all or part of the four stages outlined above, by providing facilities (e.g. for large scale tests), funding, materials and/ or personnel or other contributions to the total project.

The structure of the project is not yet decided upon, but a working model is displayed in the figure below.



It is for now assumed that each partner will take care of its own finances from its national budget. Possibilities for additional funding (e.g. by the UN or EU) are being explored at the moment.

Partners will have access to the results and data obtained by the consortium.

The starting date of the project is anticipated to be July 2008.

CONTACTPERSONS

Parties wanting further information or who directly interested in participating in the project can contact:

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