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 **13 June 2012**

Forty-first session
Geneva, 25 June – 4 July 2012
Item 2 (f) of the provisional agenda
Explosives and related matters: miscellaneous

Reporting of Results of Survey on the Test Series 6

Transmitted by the Institute of Makers of Explosives (IME)

Introduction

1. At the thirty-ninth session of the UN TDG Sub-committee, the TDG working group on explosives (EWG) discussed issues of difficulty in conducting tests outlined in the UN Manual of Tests and Criteria, and recommended to the TDG sub-committee[1] that the EWG conduct a review of the tests mentioned in Parts I and II of the manual with a view to:

- Better defining the specifications of the tests,
- Better defining the tolerances associated with those specifications, and
- To remove any unnecessary or over-specifications.

2. Australia offered to coordinate a survey of experts on the basis of permitted variations to Test Series 8 and IME offered to coordinate the work, along with USA and Canada, on Test Series 6.

3. The TDG Sub-committee agreed that this work should be carried out[2].

4. This paper reports on the result of a survey conducted by IME, in consultation with the USA and Canada, as a first step in the process of reviewing Test Series 6.

Discussion

5. A survey was devised by IME, in consultation with the USA and Canada, and was distributed to:

a. All participants at the June EWG
b. CERL
c. USA explosives testing & classification laboratories
d. BAM
e. TNO
f. INERIS
g. HSL
h. IME members
i. SAAMI

[1] UN/SCETDG/39/INF.58, para. 13
[2] ST/SG/AC.10/C.3/78, paras. 24 - 25

j. FEEM
k. AEISG
l. US Department of Defense
m. US Department of Energy

6. An example survey is provided in Annex 1.

7. Twenty-two replies to the survey were received from:

a. National defense ministries
b. National and independent explosives testing laboratories
c. Explosives, fireworks, and automobile supply industry members
d. Explosives and pyrotechnics associations
e. NATO

Survey Results

8. **General comments.** The respondents provided numerous comments regarding Test Series 6. Many concerned confusion of:

- The meaning of terms,
- When to use a detonator and when to use an igniter,
- When to use equipment mentioned in test specifications, and
- How to interpret test results.

9. All of the comments have been collected and are reproduced in Annex 2. In this summary document:

- Each bullet point represents a comment from one of the 21 respondents.
- From question-to-question, there is no correlation between the positions of comments. In other words, the first comment in Test 6(a) question 1 may not be from the same respondent as the first comment in question 2.
- The comments are presented in no particular order.
- A tally of responses is included, along with percentages. You will note that not every respondent replied to every question.
- The source of comments is not identified.

10. **Test 6(a).** Regarding the 6(a) test:

- 62% responded that the test was adequately defined.
- The responses were evenly divided on whether materials needed to perform the test were well defined.
- 55% responded that it was clear when to use a detonator and when to use an igniter.
- 57% responded that a tolerance should not be provided for the thickness of the witness plate.
- 74% were not in favor of allowing other materials to be used for the witness plate.
- The responses were evenly divided on whether there were tolerances associated with the test that could be better defined.
- 671% responded that tolerances associated with the test could not be better defined.
- 72% responded that there were no unnecessary or over-specifications.
- 63% responded that assessment criteria were not adequately defined.

11. **Test 6(b).** Regarding the 6(b) test:

- 65% responded that the test was adequately defined.
- 58% responded that materials needed to perform the test were well defined.
- 65% responded that it was clear when to use a detonator and when to use an igniter.
- 65% responded that a tolerance should not be provided for the thickness of the witness plate.
- 82% were not in favor of allowing other materials to be used for the witness plate.
- 62% responded that there were no tolerances associated with the test that could be better defined.
- 76% responded that tolerances associated with the test could not be better defined.
- 82% responded that there were no unnecessary or over-specifications.
- The responses were evenly divided on whether assessment criteria were adequately defined.

12. **Test 6(c).** Regarding the 6(c) test:

- 85% responded that the test was adequately defined.
- 79% responded that materials needed to perform the test were well defined.
- 53% responded that tolerances should not be provided for the for witness panel size should be provided.
- 68% were not in favor of allowing other materials to be used for the witness plate.
- 61% responded that there were no test specifications that could be better defined.
- 78% responded that there were no tolerances associated with the test that could be better defined.
- 56% responded that there were no unnecessary or over-specifications.
- 52% responded that the assessment criteria were not adequately defined.

13. **Test 6(d).** Regarding the 6(d) test:

- 94% responded that the test was adequately defined.
- 83% responded that materials needed to perform the test were well defined.
- 89% responded that it was clear when to use a detonator and when to use an igniter.
- 56% responded that a tolerance should be provided for the thickness of the witness plate.
- 72% were not in favor of allowing other materials to be used for the witness plate.
- 78% responded that there were no test specifications that could be better defined.
- 94% responded that there were no tolerances associated with the test that could be better defined.
- 94% responded that there were no unnecessary or over-specifications.
- 72% responded that assessment criteria were adequately defined.

Consideration

14. Distribution of the survey was in April, with a reply deadline of 15 May. At the request of several parties, this deadline was extended to 22 May. As noted, numerous

comments were received on all aspects of Test Series 6. Insufficient time was available to fully review those comments prior to preparation of this report.

15. At recent meetings of the IGUS/EPP and the Chief Inspectors of Explosives, it was suggested that the distribution of the survey should be expanded to include attendees to those two meetings.

16. The sub-committee is invited to consider if an additional distribution of the survey to the IGUS/EPP group and the Chief Inspectors of Explosives is desirable. If so, it is suggested that a reply deadline of 1 October 2012 be set, with an additional report to this sub-committee at the forty-third session in 2013.

IME
institute of makers of explosives

The safety and security institute of the commercial explosives industry since 1913

From:	David Boston
Cc:	Ed de Jong, Chris Watson, Duane Pfund, Lon Santis, Noel Hsu, Tim Golian
Date:	9 April 2012

Subject: Survey regarding better defining the UN Test Series 6

Background. The UN Sub-committee of Experts on the Transport of Dangerous Goods, through its Working Group on Explosives (EWG), is conducting a review of the tests contained in Parts I and II of the UN Manual of Tests and Criteria. The intent of the review[3] is to:

- better define the specifications of the tests,
- better define the tolerances associated with those specifications, and
- to remove any unnecessary or over-specifications.

Test Series 6 Survey. The Institute of Makers of Explosives (IME), along with Canada and the USA, agreed to coordinate the work on Test Series 6. To assist the EWG in its task of evaluating Test Series 6, you are invited to complete this survey and to return it, by email, to IME in care of David Boston at david.boston@corelab.com.

The following survey includes a brief description of each test, materials required, and assessment criteria. The complete text of the Series 6 tests may be reviewed at: http://www.unece.org/trans/danger/publi/manual/Rev5/ManRev5-files_e.html.

Deadline. Please submit your completed survey to david.boston@corelab.com not later than 15 May 2012.

Thank you.

[3] UN/SCETDG/39/INF.58, paragraph 13

Test Series 6 Survey

Section 1: 6(a) Test

Purpose: This is a test on a single package to determine if there is mass explosion of the contents.

Description: Depending upon how the explosive is intended to be functioned, either a detonator or an igniter is caused to function in a single package containing an explosive substance or one or more explosive articles. The package to be tested is placed on a witness plate made of 3mm thick mild steel and completely surrounded by confining material. The amount of confining material to be used is dependent up the volume of the package to be tested.

Assessing results: Mass explosion indicates a candidate for Division 1.1; otherwise, the explosive is candidate for an explosive division other than Division 1.1. Evidence of a mass explosion includes:

- A crater at the test site
- Damage to the witness plate beneath the package
- Measurement of a blast
- Disruption and scattering of the confining material

6(a) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(a) test adequately defined? If no, use the space below to explain.	☐	☐
2. Are the materials needed to perform the 6(a) test adequately described? If no, use the space below to explain.	☐	☐

Questions	Yes	No
3. When preparing to perform the 6(a) test, is it clear when to use a detonator and when to use an igniter? If no, use the space below to explain.	☐	☐
4. The test description calls for 3mm mild steel. Should a tolerance for the thickness be provided? If yes, use the space below to explain.	☐	☐
5. Should other materials be considered for the witness plate? If yes, use the space below to explain.	☐	☐
6. Are there any 6(a) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐
7. Are there any tolerances associated with the 6(a) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐

Questions	Yes	No
8. Are there any unnecessary or over-specifications in the 6(a) test? If yes, use the space below to explain.	☐	☐

Questions	Yes	No
9. Are the assessment criteria that are used to distinguish between different explosive Divisions adequately defined? If no, use the space below to explain.	☐	☐

Questions	Yes	No
10. Use the space below to provide any other comments about the 6(a) test.		

Section 2: 6(b) Test

Purpose: This is a test on packages of an explosive substance or explosive articles, or unpackaged explosive articles, to determine whether an explosion is propagated from one package to another or from an unpackaged article to another.

Description: Depending upon how the explosive is intended to be functioned, either a detonator or an igniter is caused to function in the central package of a stack of packages containing an explosive substance or one or more explosive articles. The stack of packages to be tested is placed on a witness plate made of 3mm thick mild steel and completely surrounded by 1 m of confining material. Enough packages are required to give a total volume of 0.15 m^3. If one package or article exceeds 0.15 m^3, then at least one acceptor is required.

Assessing results: Explosion of more than one package (or unpackaged article) indicates a candidate for Division 1.1; otherwise, the explosive is candidate for an explosive division other than Division 1.1. Evidence of a mass explosion includes:

- A crater at the test site appreciably larger than that given by a single package or unpackaged article
- Damage to the witness plate beneath the package which is appreciably greater than that from a single package or unpackaged article
- Measurement of a blast which significantly exceeds that from a single package or unpackaged article
- Violent disruption and scattering of most of the confining material

6(b) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(b) test adequately defined? If no, use the space below to explain.	☐	☐
2. Are the materials needed to perform the 6(b) test adequately described? If no, use the space below to explain.	☐	☐

Questions	Yes	No
3. When preparing to perform the 6(b) test, is it clear when to use a detonator and when to use an igniter? If no, use the space below to explain.	☐	☐
4. The test description calls for 3mm mild steel. Should a tolerance for the thickness be provided? If yes, use the space below to explain.	☐	☐
5. Should other materials be considered for the witness plate? If yes, use the space below to explain.	☐	☐
6. Are there any 6(b) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐
7. Are there any tolerances associated with the 6(b) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐
8. Are there any unnecessary or over-specifications in the 6(b) test? If yes, use the space below to explain.	☐	☐

Questions	Yes	No
9. Are the assessment criteria that are used to distinguish between different explosive Divisions adequately defined? If no, use the space below to explain.	☐	☐

Questions	Yes	No
10. Use the space below to provide any other comments about the 6(b) test.		

Section 3: 6(c) Test

Purpose: This is a test performed on packages of an explosive substance or explosive articles, or unpackaged explosive articles, to determine whether there is a mass explosion or a hazard from dangerous projections, radiant heat and/or violent burning or any other dangerous effect when involved in a fire.

Description:

A stack of packages (with a total volume of at least 0.15 m^3), on a metal grid, are burned using enough fuel to keep a fire burning for at least 30 minutes or, if necessary, until the explosives have clearly had sufficient time to react to the fire. Rigidly mounted aluminum panels (constructed of 2000 mm × 2000 mm × 2 mm 1100-0 aluminum sheets, with a Brinell Hardness of 23 and tensile strength 90 MPa), are placed around the bonfire to act as witness screens in evaluating the energy with which metal projections may be ejected from the burning explosives. Observations are made regarding the presence and size of fireballs and jets of flame, thermal flux, the size of metallic projections, and the distance those projections may be thrown.

Assessing results: Assignment to explosive divisions is based upon results of the test, as follows:

- Division 1.1
    - Mass explosion
- Division 1.2 – none of the above, but any one of the following occurs:
    - Perforation of witness screen
    - Metallic projections with kinetic energy greater than 20 J
- Division 1.3 – none of the above, but any one of the following occurs:
    - Any fireball or jet of flames that extend beyond any witness screen
    - Any fiery projection thrown more than 15 m from the edge of the stack of packages
    - A burning time of less than 35 sec/100 kg net explosive mass
    - In the case of articles, an irradiance greater than 4 kW/m^2 from the edge of the stack of packages
- Division 1.4 other than S – none of the above, but any one of the following occurs:
    - Indentation of any witness panel of more than 4 mm,
    - Any metallic projection with kinetic energy greater than 8 J
    - Any fireball or jet of flames that extend more than 1 m from the flames of the fire

- Any fiery projection thrown more than 5 m from the edge of the stack of packages
- A burning time of less than 330 sec/100 kg net explosive mass.

- Division 1.4S – none of the above, and all of the following conditions are satisfied:
  - Any thermal, blast, or projection effects that occur would not significantly hinder fire-fighting or other emergency response efforts in the immediate vicinity
  - Any hazardous effects that occur are confined within the package

- Exclusion from Class 1 – no hazardous effects at all

6(c) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(c) test adequately defined? If no, use the space below to explain.	☐	☐
2. Are the materials needed to perform the 6(c) test adequately described? If no, use the space below to explain.	☐	☐
3. The test description calls aluminum witness panels that are for 2000 mm x 2000 mm x 2 mm. Should tolerances for the witness panel size be provided? If yes, use the space below to explain.	☐	☐
4. Should other materials be considered for the witness panels? If yes, use the space below to explain.	☐	☐

Questions	Yes	No
5. Are there any 6(c) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐
6. Are there any tolerances associated with the 6(c) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐
7. Are there any unnecessary or over-specifications in the 6(c) test? If yes, use the space below to explain.	☐	☐

Questions	Yes	No
8. Are the assessment criteria that are used to distinguish between different explosive Divisions adequately defined? If no, use the space below to explain.	☐	☐

Questions	Yes	No
9. Use the space below to provide any other comments about the 6(c) test.		

Section 4: 6(d) Test

Purpose: This is a test on a single package to determine if there are hazardous effects outside the package arising from accidental ignition or initiation of the contents.

Description:

Depending upon how the explosive is intended to be functioned, either a detonator or an igniter is caused to function in a single package containing an explosive substance or one or more explosive articles. The package to be tested is placed on a witness plate made of 3mm thick mild steel and no confining material is used.

Assessing results: Inclusion in Compatibility Group S requires that any hazardous effects arising from functioning of the articles in this test are confined within the package. Evidence of a hazardous effect outside the package includes:

- Denting or perforation of the witness plate beneath the package;
- A flash or flame capable of igniting an adjacent material such as a sheet of 80 ± 3 g/m² paper at a distance of 25 cm from the package;
- Disruption of the package causing projection of the explosives contents; or
- A projection which passes completely through the packaging (a projection or fragment retained or stuck in the wall of the packaging is considered as non hazardous).

The competent authority may wish to take into account the expected effect of the initiator when assessing the results of the test, if these are expected to be significant when compared to the articles being tested. If there are hazardous effects outside the package, then the product is excluded from Compatibility Group S.

6(d) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(d) test adequately defined? If no, use the space below to explain.	☐	☐

Questions	Yes	No
2. Are the materials needed to perform the 6(d) test adequately described? If no, use the space below to explain.	☐	☐
3. When preparing to perform the 6(d) test, is it clear when to use a detonator and when to use an igniter? If no, use the space below to explain.	☐	☐
4. The test description calls for 3mm mild steel. Should a tolerance for the thickness be provided? If yes, use the space below to explain.	☐	☐
5. Should other materials be considered for the witness panels? If yes, use the space below to explain.	☐	☐
6. Are there any 6(d) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐
7. Are there any tolerances associated with the 6(d) test specifications that could be better defined? If yes, use the space below to explain.	☐	☐

Questions	Yes	No
8. Are there any unnecessary or over-specifications in the 6(d) test? If yes, use the space below to explain.	☐	☐
9. Are the assessment criteria adequately defined? If no, use the space below to explain.	☐	☐

Questions	Yes	No
10. Use the space below to provide any other comments about the 6(d) test.		

Test Series 6 Survey Results

Section 1: 6(a) Test

Purpose: This is a test on a single package to determine if there is mass explosion of the contents.

Description: Depending upon how the explosive is intended to be functioned, either a detonator or an igniter is caused to function in a single package containing an explosive substance or one or more explosive articles. The package to be tested is placed on a witness plate made of 3mm thick mild steel and completely surrounded by confining material. The amount of confining material to be used is dependent up the volume of the package to be tested.

Assessing results: Mass explosion indicates a candidate for Division 1.1; otherwise, the explosive is candidate for an explosive division other than Division 1.1. Evidence of a mass explosion includes:

- A crater at the test site
- Damage to the witness plate beneath the package
- Measurement of a blast
- Disruption and scattering of the confining material

6(a) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(a) test adequately defined? If no, use the space below to explain. • *Mass explosion in the purpose could be better defined - see also results section* • *It is well defined to those who understand that detonators should not be used to test propellants. There is a risk that uneducated regulators will want to test all samples with a detonator.* • *What is an explosion in the context of this instruction? Perhaps it's explained elsewhere. For IM/HC we don't use a word like explosion as it can have many different meanings.* *What is a mass explosion? Is it "mass" if some some of the material or some of the items "explode"? Or, does it require an "explosion" of all the material.* • *Per the Orange Book glossary definition, a "mass explosion" is one "which*	13 62%	8 38%

Questions	Yes	No
affects almost the entire load instantaneously." A load is implied to consist of multiple packages. So when only a single package is tested, how can we be realistically assessing whether a mass explosion is the outcome? • *Yes but the assessment criteria 'explosion' is not robustly defined* • *Para 16.4.1.1. titled "Introduction" should be changed to "Purpose" and changed to read - "The purpose the single package test is to determine the level of reaction violence outside the container when the contents of a single package of articles is subjected to an appropriate stimuli. The test results from test 6(a) are then assessed to determine if the next sequential test in series 6 (the Stack Test) is required, or not, in order to assign an appropriate classification and division as shown in figure 10.3 ".* • *The 6(a) and 6(d) tests also give valuable insights as to whether the reaction is largely confined to the package or not. To imply its value is only in separating 1.1 from other classes is misleading.* • *For testing articles, the package should contain multiple items. Reword definition so that the test on articles is to initiate one single article within the full package. If articles contained within the package are of different sizes, then the largest NEQ should be initiated. If the package only contains a single article, then the 6(a) test is not appropriate, and the 6(b) test should be used.* • *The current purpose is not accurate. Suggest something like: "This is a test on a single package to determine if there is mass explosion of the contents when an explosion is intentionally caused within the package." While defining the purpose better would help clarify the test, our opinion is that whether or not a product mass explodes under the test conditions is not the best determining factor to help define the hazard level of a product if a load is involved in a fire from internal or external sources, or an explosion from internal sources, as stated in 16.1.1. It does not determine the severity and hazard level of an explosion.*		
2. Are the materials needed to perform the 6(a) test adequately described? If no, use the space below to explain. • *confining material should be described elsewhere in the document as inert (non-contributing) material; if not, then a specific description of 'confining material' should be provided in 6(a) language.* • *The standard detonator is not standard. the specifications are inconsistent*	10 50%	10 50%

Questions	Yes	No
and archaic. It is many years since I saw a detonator that had a dimple in the base. And why might one not use a shock tube detonator? • *Put an "or" in between a & b to clarify that both are not required but only one is depending which material using.* • *More definition is needed on confining material (as well as "surrounded"). How confining should it be? As written it allows too much variability.* *What is a package? Is it a single container? Or, is it a pallet of containers as might be found in a logistics configuration? More definition is required.* • *The test should be recorded on video. Blast measurement equipment is described, but the use/accuracy of such gauges can be hampered by the confinement method.* • *Instrumentation is the minimum required: testing organisations can deploy blast measurement gauges; high speed and real time photography; fragment collection, documentation and analysis of acceptor breakup. For complex articles or large items the need for additional instrumentation becomes more important to interpret the response of acceptors, which may not be obvious except if they detonate. For example, the donor explosive effects can mask evidence of the level of acceptor response by disrupting and scattered them. UN TS 6(c) mentions high speed photography but we would propose that it is equally or more important for TS 6(a) and (b).* • *16.4.1.2 "Blast measuring equipment may be used." Can you give examples of what equipment could be used, without making it prescriptive?* • *The type of metal and thickness should not be specified. Rather the purpose for a witness plate should be stated. For example " a metal witness plate of a thickness and material capable of evidencing forces generated external to the package"* • *1) "Sand Confinement" - typically can use boxes of pack of same approximate size and shape filled with confining material.* • *The list of materials reads as though a detonator AND an igniter will be needed. In reality it will be one OR the other. Suggest a) and b) of para 16.4.1.2 are amalgamated to indicate one or the other is used.* • *The result of the test is often contingent on the degree of confinement. The description allows a broad latitude in the type of confinement used and will*		

Questions	Yes	No
result in variable results. The detonator is specified as a "UN detonator". Detonators meeting the exact UN definition are impossible to obtain.		
3. When preparing to perform the 6(a) test, is it clear when to use a detonator and when to use an igniter? If no, use the space below to explain. • *The wording is unclear - whatever initiator is needed to function one device (and I don't think that is clear)* • *It is to me.* • *Actually, it is well defined, but we are aware of instances recently where CAs are requiring use of detonators on devices clearly intended to be initiated by igniters. Although this is within their prerogative, there is no guidance on how to interpret results of such tests.* • *See above explanation (3rd comment in #2). (not sure when (c) applies)* • *My assumption is that an igniter is used if it's a material that's intended to have a burning reaction versus a detonation. But, most such materials will not "explode" even if confined (unless the confinement is too great and the confinement over-pressurizes. And, if it's a package with multiple items it seems only a single item is "ignited". If another item ignites due to the confinement of the exhaust gases is that a "mass explosion"?* • *Describe igniter and detonator, specify the use of elec or non elc dets.* • *It should be better assigned when we have to use detonator and when igniter, specially if the whole munitions includes different components like high explosive or propellant.* • *When per the Test Series 6 introductory paragraph the overarching goal is to determine which hazard division and compatibility group in Class 1 most closely corresponds to the behavior of a load that becomes involved in a fire or an explosion, how the explosive is intended to be functioned is irrelevant because the articles will be subjected to whatever stimuli a mishap generates. And whereas such mishap severity is unpredictable, shouldn't we always be favoring some appropriate conservatism in our assessment of a load's potential misbehavior by insulting our donor with a detonator in at least one trial?*	12 55%	10 45%

Questions	Yes	No
• *It is clear but there is a different concern. Currently, high explosives would often be initiated in a detonation and propellants would be ignited in a burn. A potential problem arises if one considers the response of a detonable propellant which is ignited vs initiated (with a detonator). The first test may eventually give rise to a HD 1.3 vs. the second giving a HD 1.1 classification. We would propose that this is nonsensical because propellant can often be more sensitive to accidental ignition than high explosive. Hence, what is the logic behind exposing propellant to a less severe test? Stringent fuze/igniter design requirements mean that the probability of an accident caused by the igniter or initiator malfunction is much lower than, for example, transportation accidents leading to fire. Contribution of the igniter or initiator to the final response has also been reduced or limited through design or may not be present during transportation. Furthermore, such an approach does not give information on the maximum credibly event and is not a consistent approach to evaluating hazard. Recent accidents have indicated that this may be an important problem.* • *No it is confusing. The phrases "initiating stimulus and initiation" are used throughout to mean functioning by detonation shock (either the item's own means, or a #8 blasting cap for packaged substances), but then in para 16.4.1.5 "Examples of results", the table lists "Initiation Systems" to be either a detonator or and ignitor (see middle column of the example table). Herein lies one point of confusion. Further, there seems to be an error in paragraph 16.4.1.3.5 Currently reads - "The substance or article should be initiated and observations.....". Recommend change to - "The substance or article should be functioned and observations...."* *Rationale for recommended change; the paragraphs proceeding 16.4.1.3.5 take great care to distinguish between the appropriate means of functioning the test article, i.e., either by using an initiating stimulus, or an igniting stimulus (see 16.4.1.3.1,& .2 &.3). Consequently it is recommended that the word "initiated" be replaced by the word "functioned" because the word "functioned" is inclusive of both means of subjecting the test article to the appropriate stimulus; whether the appropriate stimulus is either an initiating stimulus such as a booster or #8 cap that induces shock to the article in the center of the package, or if the appropriate stimulus is an igniting stimulus for inducing a deflagration in the article in the single package.* • *Igniter vs. detonator is currently dependant on intended design. It may be useful to revisit this approach with the goal of ensuring the proper hazard classification for transportation and to ensure that the test criteria continue*		

Questions	Yes	No
to provide classifications consistent with the Model Regulations' Hazard Class/Division definitions. • *Only when testing substances. For testing articles, use similar terminology to 16.4.1.3.2 (a) & (b).*		
4. The test description calls for 3mm mild steel. Should a tolerance for the thickness be provided? If yes, use the space below to explain. • *there should be no tolerance for thickness, and recommend a standard hardness parameter be included in the language.* • *Perhaps. I would be happy with a "nominal thickness" of 3 mm and I don't know what sort of tolerances there are for steel plate. It is too easy to allow +/- 10% without really knowing what the normal variations are.* • *All manufacturing plans allow for tolerances, so it seems reasonable that tolerances for the thickness of the witness plate should be developed. Maybe +/- 0.5mm?* • *But, I would do this only if the rest of the procedure is tightened up. And, I'm not even sure the 3mm would be appropriate for all munition types. Is it supposed to replicate some structure that could be damaged in this "mass explosion"?* • *If you're testing an item where a witness plate will be useful in determining the reaction, I believe you're conducting the wrong test. You should skip the Single Package and move right to the Stack.* • *The optimum material to use for a witness plate depends on the type and velocity of the expected fragments. For heavy articles with steel walls, a steel witness plate with a thickness of at least 25 mm is recommended. However, for articles with aluminium skins or very thin steel skins, an aluminium witness plate may provide better results. For articles with plastic or composite skins, witness plates may not be that useful.* • *The type of metal and thickness should not be specified. Rather the purpose for a witness plate should be stated. For example " a metal witness plate of a thickness and material capable of evidencing forces generated external to the package"* • *1) A tolerance that includes 0.125" (1/8 in.) should be provided since 3mm*	9 43%	12 57%

Questions	Yes	No
steel can be a difficult spec to find in the US. *2) In the US, standard steel sheets are designated by gauges. An 11 gauge steel call out corresponds to a thickness of 0.1196 (+/- 0.008). This equates to a 3.04 mm thick plate. The 3 mm requirement would fall within the manufacturing tolerances of this sheet which equate to a range of 2.83 mm to 3.24 mm. The next thinnest gauge available is 12 gauge which corresponds to a thickness of 0.1046 inches (+/- 0.008). This equates to a thickness of 2.66 mm which could be used and would be significantly more conservative. A tolerance on the thickness would allow for the use of 11 gauge material which, in our opinion would be acceptable thickness.* *3) If there is a tolerance it should be wide (~0.5mm), since mild plate steel can vary in both thickness and strength. A tolerance would take into account the inherent tolerances already introduced by the manufacturing process.* *4) If there is a need to tighten the test, better defining "damage" to the witness plate and "disruption" of confining materials are more viable issues to address.* • *Generally, some tolerance should be provided for any dimensional specifications.* • *Yes; ± 0.5mm to permit use of imperial-sized materials. Suggest specifying CR4 grade or similar.* • *If 3.0±0.5 mm is implied there is no problem (see preamble of the UN Recommendations). But if an ISO or equivalent standard is implied, the product may be difficult or expensive to obtain. There would be no benefit to a tighter tolerance on the steel thickness in this test. For clarity, the tolerance should be specified in the test description.* • *In our opinion, to determine whether there is mass explosion the exact thickness is not critical. Current description is adequate.*		
5. Should other materials be considered for the witness plate? If yes, use the space below to explain. • *some discretion could be allowed. we are not looking for detonation in this test, only mass explosion.* • *No good answer to this. If the idea is to have a consistent test for*	5 26%	14 74%

Questions	Yes	No
comparison purposes, then a single material should be specified, and mild steel is not a bad choice. If the idea is to somehow replicate some structure, then there might be a better choice. • *Also aluminium or some fibre materials may be used, specially for small calliber product.* • *If you're testing an item where a witness plate will be useful in determining the reaction, I believe you're conducting the wrong test. You should skip the Single Package and move right to the Stack.* • *The optimum material to use for a witness plate depends on the type and velocity of the expected fragments. For heavy articles with steel walls, a steel witness plate with a thickness of at least 25 mm is recommended. However, for articles with aluminium skins or very thin steel skins, an aluminium witness plate may provide better results. For articles with plastic or composite skins, witness plates may not be that useful.* • *Top level documents, such as the "Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria" should be written with a preference towards less specificity in order to foster the develop of best test and assessment practices, as innovative technologies, application techniques and materials become available over time . Global harmonization of requirements and methods for classification and labelling of chemicals, as well as, energetic devices, does not mean that every test article should be assessed exactly the same way. Each test article is different and proper characterization of their hazards mandates some flexibility in test design as monitor by national authorities and experts. Further, the types and kinds of energetics devices will continue to become evermore board and diverse.* • *Possibly a thinner plate should be used. There is an inconsistency within the test series for determining candidates for less than HC/D 1.1 materials. Series 5a test uses a 1 mm steel plate. If the substance fails this test it stays in HC/D 1.1 realm. However, non-blasting agents/substances (which actually may be easier to ignite) use a 3mm plate in the 6a test.* • *The current witness plate is sufficient to determine if there is mass explosion.*		
6. Are there any 6(a) test specifications that could be better defined? If yes, use the space below to explain. • *Some testing labs and CAs interpret a hole in the witness plate as a failure*	9 50%	9 50%

Questions	Yes	No
of the test and don't give any thought to whether mass explosion has occurred. The test is failed if a mass explosion occurs and not simply because there is a hole in the witness plate or the confinement was scattered. • *For articles, this test requires an item near the center of the package to be functioned. Is this always the best location for the donor? Shouldn't the donor location be the one that gives the maximum probability of propagation and the worse case effects external to the package? If one location doesn't fulfill both of these conditions, then it could change among the test iterations. I'd also recommend that one of the iterations be conducted unconfined to better evaluate effects external to the package.* • *16.4.1.3.2(c) "gives a '-' result..." Please use the word negative, instead of this dash sign. It is pretty vague, particularly to non-native English users.* • *Para 16.4.1.3.2(c) - Suggest better defining/illustrating how and what substance response levels justify waiving of tests with detonators, as well as, justification for waiving tests with ignitors.* *Rationale; It is likely that a person can miss read paragraph 16.4.1.3.2(c). It is overly tricky to follow. Procedures and requirements dealing with explosive safety should not be easily misinterpreted.* • *1) Substances that are tested in the 6(a) test with an igniter, should also be subjected to at least one trial of either a 6(a) (with detonator) or 5(a) test. In my opinion, any substance that is cap sensitive should not be classed as other than a 1.1, regardless of its intended use.* *2) Orientation of packaging on the steel witness plate could be specified. Perforators (shape charges) packed horizontally vs. vertically to steel plate.* • *Under 16.4.1.4 (d) 'Disruption and scattering of the confining material' Define how much is acceptable; for instance, if a sand-filled box is seen to move on the video, is that considered to be disruption?* • *Mild steel covers a wide range of specifications. Suggest tightening this.* • *The result of the test is often contingent on the degree of confinement. The description allows a broad latitude in the type of confinement used and will result in variable results. The detonator is specified as a "UN detonator". Detonators meeting the exact UN definition are impossible to obtain.*		

Questions	Yes	No
• *Disruption and scattering of the confining material is included in the method of assessing results (16.4.1.4), yet the confining material type and amount is not specified well enough to assure that they will not affect the amount of disruption and scattering. Either the confining material should be better defined, assessment of disruption and scattering should be better defined, or disruption and scattering of confining material should be removed as a method of assessing results.*		
7. Are there any tolerances associated with the 6(a) test specifications that could be better defined? If yes, use the space below to explain. • *there should be no tolerance for thickness, and recommend a standard hardness parameter be included in the language.* • *16.4.1.3.3(b) "caused to function in designed mode..." or "caused to function with same effect..." - does this mean the exact amount of initiation or ignition NEW in the design (that is not present in the packaged article) should be used to ignite or initiate the article? 16.4.1.3.5 "evidence of thermal effects..." can this be determined by packaging components' burnt or blackened state? "performed three times" can we re-use undamaged components and containers in the second and third tests?* • *Top level documents, such as the "Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria" should be written with a preference towards less specificity in order to foster the develop of best test and assessment practices, as innovative technologies, application techniques and materials become available over time . Global harmonization of requirements and methods for classification and labelling of chemicals, as well as, energetic devices, does not mean that every test article should be assessed exactly the same way. Each test article is different and proper characterization of their hazards mandates some flexibility in test design as monitor by national authorities and experts. Further, the types and kinds of energetics devices will continue to become evermore board and diverse.* • *16.4.1.2 (d) A better approach would be maximum 3mm thickness, rather than 3.0mm although that in itself implies that a level of tolerance to 1.d.p is acceptable. I have no experience of the 6(a), but considering the extent of confinement around the package is defined, would it be appropriate to also define the size of the witness plate.* • *If, when testing articles, the impulse doesn't propagate to the other articles*	6 33%	12 67%

Questions	Yes	No
in the package, is there a need to carry out the 6(b) test? Clearly if there is no propagation within the package, there will be no propagation to adjacent packages in the 6(b) test. • *If 3.0±0.5 mm is implied there is no problem (see preamble of the UN Recommendations). But if an ISO or equivalent standard is implied, the product may be difficult or expensive to obtain. There would be no benefit to a tighter tolerance on the steel thickness in this test. For clarity, the tolerance should be specified in the test description.* • *Disruption and scattering of the confining material is included in the method of assessing results (16.4.1.4), yet the confining material type and amount is not specified well enough to assure that they will not affect the amount of disruption and scattering. Either the confining material should be better defined, assessment of disruption and scattering should be better defined, or disruption and scattering of confining material should be removed as a method of assessing results.*		
8. Are there any unnecessary or over-specifications in the 6(a) test? If yes, use the space below to explain. • *In certain circumstances, 6D test results could be used in replacement for 6A if there is no mass detonation and effects outside the package are limited.* • *Yes, the need to use a standard detonator.* • *Just the tendency to misapply the results in determining if mass explosion has occurred. See 1st comment under #6 above.* • *16.4.1.4 "otherwise, proceed to a test of type 6(b)..." this contradicts part 16.2.2 that provides examples of when test 6(b) can be waived, even if the results of 6(a) are not a mass explosion.* • *The type of metal and thickness should not be specified. Rather the purpose for a witness plate should be stated. For example " a metal witness plate of a thickness and material capable of evidencing forces generated external to the package"* *Top level documents, such as the "Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria" should be written with a preference towards less specificity in order to foster the develop of best test and assessment practices, as innovative technologies, application techniques and materials become available over time . Global*	5 28%	13 72%

Questions	Yes	No
harmonization of requirements and methods for classification and labelling of chemicals, as well as, energetic devices, does not mean that every test article should be assessed exactly the same way. Each test article is different and proper characterization of their hazards mandates some flexibility in test design as monitor by national authorities and experts. Further, the types and kinds of energetics devices will continue to become evermore board and diverse.		
9. Are the assessment criteria that are used to distinguish between different explosive Divisions adequately defined? If no, use the space below to explain. • *The issue of minor blast (which is consistent with 1.3 even) is not well dealt with.* *Similarly with "disruption" - how is disruption, and how much disruption measure* • *So long as the criteria aren't overly interpreted or misinterpreted.* • *16.4.1.4* *Clarify a-d* *Definition of damage?* *How do you measure a blast? (eliminate or be more specific)* *Duration?* *Scattering?* *Is a sandbag that falls off of a pile considered a "disruption" or a bag that lifts off the pile and then falls back to same location considered a disruption?* • *What is a crater? You can create a hole in the ground from a propulsive reaction.* *What is the damage to the witness plate? Again, this could be caused by a propulsive reaction. And, it could be caused by fragments thrown from a type IV or type III reaction, or from a type II or type I reaction.* *How is the "blast" measured? Is it directional overpressure? This could be caused by propulsion. Blast could also be from type I, II, III reactions or a pressure burst of the case.*	7 37%	12 63%

Questions	Yes	No
A propulsive reaction could scatter the confining material. • *The assessment criteria doesn't make sense for a single package test. The criteria determines if you're a candidate for HD 1.1. If you're a candidate for HD 1.1, why would you be conducting a Single Package. The criteria should be determining whether a Stack test is needed.* • *Additional guidance would be useful on how to interpret the response level of acceptor articles e.g. detonation, deflagration or explosion. the package. A useful starting place would be to consider those developed for UN TS7, which can be provided if required. This would address concerns that terms such as explosion are not robustly defined; even more difficult is mention at 16.2.2 (b) of: or explode so feebly. Linked to this would be improved instrumentation and analysis methods mentioned earlier and below.* *The evidence for mass explosion is defined as follows:* *(a) A crater at the test site;* *(b) Damage to the witness plate beneath the package;* *(c) Measurement of a blast; and* *(d) Disruption and scattering of the confining material.* *However, this could be observed for the initiation of a single donor article (see comments at 2). Hence, there is a need to discriminate donor and acceptor explosive effects.* • *16.4.1.4(a), (b), and (d) are clear. However, 16.4.1.4(c) is too vague - "measurement of a blast". First issue is that 16.4.1.2 states that blast equipment MAY be used (was "blast" suppose to be step (e) under 16.4.1.2?). If it is not used, how can you measure any blast? In addition, blast is not defined and substances and articles with a "minor blast" can be classified as 1.3 [UN Model Regulations, 2.1.1.4(c)]. Please identify a measurable threshold between minor and major blasts, or define its effects (e.g. debris scattered x meters from package).* • *Paragraph 16.4.1.4 says "Mass explosion (see definition in Chapter 2.1 of the Model Regulations).* *However Chapter 2.1 of volume 1 Model Regulation 16th revised edition does not list a definition of Mass explosion in the definitions sections which are 2.1.1 and 2.1.3. Rather the definition of mass explosive is somewhat hidden in paragraph 2.1.1.4(a).*		

Questions	Yes	No
Also suggest consideration be given to changes the phrase "mass explosion" to "mass detonation/explosion" *----------* *The assessment criteria is not adequately defined; for example para 16.4.1.3.2 (c) states; "If a substance gives a "-" result (no propagation of detonation) in the Series 1 Type (a) test, the test with the detonator may be waived."* *For the UN gap test the words "detonation transfer" should be used instead of propagation, because the test assessment criteria, i.e, (a hole punched in the witness plate or tube is fragmented completely) is clearly looking to see if a steady state detonation is occurring (or not occurring) within the substance under investigation. The meaning of the word "detonation" is extensively defined and understood in the scientific literature. Further, the word "propagation" as used in the entire Orange Book should be defined as the transfer/communication of any kind/type of reaction mechanism (burning,deflagration, explosion or detonation) between like substances, articles, items, munitions. Rationale - this change will foster the Orange Book's intent of achieving greater global harmonization of test and labeling, as it will enable testers and developers of energetics / energetic devices to speak in a common language that is based in proven scientific reality.* • *1) Define what a crater is (diameter/depth of hole). Ground conditions may affect whether a crater is formed.* *2) the criteria is "mass explosion". To help aid in this, define what is meant by "disruption and scattering of the confining material". Is "disruption" ok as long as "scattering" does not occur? "Heaving" or "sluffing" of the confining material do not seem to explain a "mass explosion". This example of mass of explosion could be better defined.* *3) The criteria "damage to the witness plate" provides a wide range of interpretation. What is "damage"? any slight discoloration? bowing? well defined indentation? perforation of any degree? or only a definite hole? size of hole or dent?* *4)The criteria "disruption of confining material" provides a wide range of interpretation. How much disruption is allowed? how much is too much? How to define for propellant or smokeless powder or grenade which needs to vent (disrupts sand) yet clearly has no crater?*		

Questions	Yes	No
5) Quantifying percentage of recoverable vs. percentage which functioned- Define "mass detonation" units damaged by pressure wave, not sympathetic detonation. *6) Each product dependent on design has critical parameters that override other keys.* *7) MTC is technical manual written to generically address majority of explosive materials and devices. However, it is a guideline which should allow labs to discern which critical parameters are crucial for any given substance/article.* • *Item b) of para 16.4.1.4 states that damage to the witness plate can be used to indicate that a 1.1 event has occurred. 'Damage' is too vague. This could be small dents, large dents, perforations or tears.* • *The 6(a) test essentially assesses whether the material is a candidate for a 1.1 classification; it doesn't assign into other Divisions at this stage. The 6(c) test is the primary test for assigning Division.* • *This is a test for "mass explosion" only. The possible outcomes are Division 1.1 or not Division 1.1.* *The results can give one an idea as to the suitability for classification as one of the other divisions but that is not the stated purpose in the UN Manual.* *The description does not have specific criteria to judge the results against. It refers to "evidence of such an indication" [of a "mass explosion"] and lists:* *a crater at the test site,* *damage to the witness plate beneath the package,* *measurement of a blast and disruption and* *scattering of the confining material.* *No criteria are listed for the four types of "evidence". The tester has to look at the "evidence" and make a decision. It is also necessary to consult the UN definition of "mass explosion" when coming to a conclusion. Outcomes from the test could vary considerably depending on the conditions of the test and the judgment of the tester.* *Unfortunately setting quantitative criteria for this test would be difficult. Many factors other than properties of sample would affect the output of the test.*		

Questions	Yes	No
• *(1) There is no definition of what constitutes damage to the witness plate that would be evidence of mass explosion.* *(2) Measurement of a blast is listed as a test criteria (16.4.1.4c), but is not included in the procedure and is without guidance for levels that would be evidence of mass explosion.* *(3) There is no definition of what constitutes disruption and scattering of confining material that would be evidence of mass explosion. This is further complicated by lack of clear guidance for type and amount of confining material that would make it possible to fairly assess the results. See Question #6 on that topic.* *(4) Observations are suggested (16.4.1.3.5) for thermal effects, projection effects, detonation and deflagration without guidance for evaluation as evidence of mass explosion. These observations are not included in the test criteria (16.4.1.4) for assessing results, leaving it unclear as to how to apply the observations to the assessment of mass explosion.* *(5) Explosion or damage to explosive articles in the package other than the one intentionally functioned are not included in the test criteria and method of assessing results (16.4.1.4) for evidence of mass explosion, yet are commonly used for that purpose. It is suggested that they be included, with guidance for assessing results as related to evidence of mass explosion.*		

10. Use the space below to provide any other comments about the 6(a) test.

- *There is no definition of what "damage" to the witness plate is. A scratch, a dent, deformation ? A clear definition should be provided.*

- *Why are some articles which have no characteristics of a mass explosion subject to the 6(a) test just because they must pass the series 6 testing. Some way of opting out should be allowed or stated.*

- *I have a problem with confinement. As already noted, it's just too variable as now "specified". In some cases it has been extreme - burial in sand. It that's done it hinders our ability to assess the reaction. But, more importantly, it could get test operators killed. If a single item is tested, we are fairly safe to assume that we initiated that item and it reacted. However, if there are multiple items in the package how can you tell exactly what has reacted under the sand? Is there damaged energetics, perhaps even cooking off? Have safety devices been compromised? I'm sorry, but I hate this test as currently run.*

Questions	Yes	No

- *IM-tests and test for transport should be harmonized within some time.*

- *The 6(a) test has become immaterial. Its results are not useful as an indicator of Division 1.1 mass explosion candidacy, nor are they particularly useful, mainly due to the confinement, in terms of screening for inclusion in Compatibility Group S. The unconfined 6(d) single package test variant seems better suited to fill that latter niche. The relationship between 6(a) and 6(d) should be explained to preclude both tests from being conducted.*

- *Typical techniques to help identify the level of response:*
  It is essential to be able to distinguish between the debris of donor and acceptor articles. Consideration could be given to colour coding the acceptors, for example by painting the external surface of each acceptor munition a different colour.

  Blast over pressure is seen as a key discriminator in determining the level of reaction of acceptor articles, particularly if they are capable of detonating. It is important to estimate before the test the likely response of the article and the associated blast overpressure so that gauges of appropriate scale can be used. It can also be useful to calibrate blast overpressure measurement by measuring the output of the detonation of a single article, which will provide a baseline for comparison in subsequent 6(a) (b) and (c) tests. Typically 2 sets of gauges should normally be sited at 5, 10 and 15 m but this may need to be adjusted to account for the article size or expected severity of response.

  Guidance on the use of witness plates could be improved: it can be useful to site witness plates beneath and on 2 or 3 sides of the articles under test. It is useful to position a witness plate adjacent to or beneath the donor as well as the acceptors, so that the witness damage from the full detonation of the donor can be compared with that of the acceptors.

  A detailed debris map is seen as an essential element for all tests. The map should show the location of each significant item of debris, recording its identity, mass and distance thrown. In order to achieve this, it is essential that the test arena is cleared of all debris from previous tests before any test is performed. Once collected they can be photographed, separated, grouped by individual articles, and weighed (colour coding essential). Fragment size and velocity can also be measured using absorbent material, such as strawboards, fibreboards or soft plaster panels to catch the fragments.

  Additional guidance could be provided for articles which contain more than one major explosive containing component. For example, which component should be reacted (or both simultaneously, or whether individual component tests should be conducted to better understand the interactions.

- *16.4.1.3.5 "If the results of the recommended number of tests (three) do not enable*

Questions	Yes	No
unambiguous interpretation of the results, the number of tests should be increased." Does this mean that if no detonation or explosion occurred on the first two tests, but it does occur on the third test, that we should test again to verify the third test? This would seem to refute the concept of a decisive result meaning you stop testing and declare it 1.1. OR is this intended to mean a partial detonation or partial explosion? • *For some NATO/US military devices, those that contain "smaller" amounts of energetic substances, the series 6(a) test results can be used to justify a passing assessment for the Insensitive Munitions/FHC Sympathetic Reaction test defined by STANAG 4396 Ed2 by applying the same logic as given in para 16.2.2, that is; if the contents of the package respond so feebly as would exclude the possibility of propagation via any form of stimulus(blast, fragments, fire, heat) that could otherwise enable a sympathetic reaction from one package to another in test type 6(b). If this is shown to be true then the likelihood of sympathetic detonation (The IM requirement per AOP-39 Ed3, para 5.5.2 table 1.) Note; From many "larger" munitions the Test 6(b) stack test requirement is often accomplished through conduct of the sympathetic reaction(SR) test prescribed by NATO STANAG 4396 Edition 2, which is called out in MIL-STD-2105D and in TB700.2.* *----------* *I was unable to complete the whole survey in the time I had available to work on it. I did however generate a comparison table, that compares and contrasts key test parameters between orange book test series 6; test 6(c) and NATO STANAG 4240Ed2 ratification draft 1 dtd 2002. The comparison sheet compares; configurations & directional orientations of articles, number of trials, number of articles per test, circumstances for test waiver requests, flame temperature requirements, instrumentation, data collection requirements, test data assessment and passing criteria versus division assignment. I was planning to use the comparison sheet to assist me in providing comments on test 6(c).* *If I have time(post dead-line 15 May 2012) I still plan to fill in the survey for test 6.c and perhaps 6(b) also.* • *A testing program could be readily devised to greatly improve the ability of this test to provide added value to the classification scheme.* *Some baselines using varying amounts of specifically packaged 1.1 and 1.3 explosives could be established.* *These would provide a means of calibrating not so much the test as the test witnesses (and reviewers) in regard to disruption of confining material and damage to the witness plate. This would give some criteria for comparison for using the 6(a) [and at least one trial of a 6(d)] test as a reliable discriminator for more than 1.1.* *In addition, related to Question 3 above, we should ask if there is a gap between the*		

Questions	Yes	No
classification arrived at through testing and the hazard class definitions given in the Model Regulations. • *1. A depth of the dent made on the witness plate and a sound level can be useful criteria for 1.1 classification.* *2. For some countries, It is not easy to prepare a wide proving ground capable of performing test series 6. Therefore, introducing some screening procedure before test series 6 may be preferable.* • *Clarification that the 6(a) test, when testing packaged articles, should only be carried out on packages containing multiple articles. The test is to determine whether there is a mass explosion of the contents; so initiating the sole article in a package of one will obviously result in a 'mass' event! In this case, single-item packages should default to the 6(b) test instead.* *We are often required to carry out one of the three 6(a) tests in an unconfined condition, by our customer (US DOD). This is to assess the degree of package disruption in a similar way to the 6(d) test, even though we may not be seeking a 1.4S classification. Could this be a useful aspect to the testing?* • *The test description says that blast measuring equipment may be used. This is a good idea but no guidance is given. Any measurement recorded would be dependent on the devices used, their setup, and the data treatment. Relating the measurement to the sample may be difficult because energy will be consumed in dissipating the confinement and any shock wave produced may not be propagated in a symmetrical pattern.* *Additional guidance would help. Consideration should also be given to the use of standard blast monitoring equipment that measures both ground vibration and air blast. Such equipment is commercially available and standards exist.* • *1. Section 16.4.1.4 instructs readers to see the definition of mass detonation in Chapter 2.1 of the Model Regulations. More correctly, it should instruct readers to see the definition of mass detonation in the Glossary in Appendix B of the Model Regulations. The procedures (16.4.1.3.1) states "The test is applied to packages of explosive substances and articles in the condition and form in which they are offered for transport." For packages that do not contain a means of explosives initiation or ignition, it is not correct to state that the packages are in the condition and form in which they are offered for transport because the packaging is modified to accommodate a detonator or igniter that is not present during normal transport. Suggest adding a sentence to follow the one referenced above: "For packages that do not contain a means of initiation or ignition, the packages are modified to accommodate a means of initiation or ignition."*		

Questions	Yes	No
2. The procedures (16.4.1.3.1) states "The test is applied to packages of explosive substances and articles in the condition and form in which they are offered for transport." For packages that do not contain a means of explosives initiation or ignition, it is not correct to state that the packages are in the condition and form in which they are offered for transport because the packaging is modified to accommodate a detonator or igniter that is not present during normal transport. Suggest adding a sentence to follow the one referenced above: "For packages that do not contain a means of initiation or ignition, the packages are modified to accommodate a means of initiation or ignition."		

Section 2: 6(b) Test

Purpose: This is a test on packages of an explosive substance or explosive articles, or unpackaged explosive articles, to determine whether an explosion is propagated from one package to another or from an unpackaged article to another.

Description: Depending upon how the explosive is intended to be functioned, either a detonator or an igniter is caused to function in the central package of a stack of packages containing an explosive substance or one or more explosive articles. The stack of packages to be tested is placed on a witness plate made of 3mm thick mild steel and completely surrounded by 1 m of confining material. Enough packages are required to give a total volume of 0.15 m^3. If one package or article exceeds 0.15 m^3, then at least one acceptor is required.

Assessing results: Explosion of more than one package (or unpackaged article) indicates a candidate for Division 1.1; otherwise, the explosive is candidate for an explosive division other than Division 1.1. Evidence of a mass explosion includes:

- A crater at the test site appreciably larger than that given by a single package or unpackaged article
- Damage to the witness plate beneath the package which is appreciably greater than that from a single package or unpackaged article
- Measurement of a blast which significantly exceeds that from a single package or unpackaged article
- Violent disruption and scattering of most of the confining material

6(b) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(b) test adequately defined? If no, use the space below to explain. • *"Explosion" could be communicated without the result being 1.1 - perhaps better wording here* • *What is an explosion in the context of this instruction? Perhaps it's explained elsewhere. For IM/HC we don't use a word like explosion as it can have many different meanings.* *What is a mass explosion? Is it "mass" if some some of the material or some of the items "explode"? Or, does it require an "explosion" of all the material.* • *Where "mass explosion" can now be assessed, that term is not included.* • *Yes but the assessment criteria 'explosion' is not robustly defined*	13 65%	7 35%

Questions	Yes	No
• *Para 16.5 .1.1 "introduction" should be changed to "Purpose", and the words mass explosion changed and/or defined. Rationale The words "determine whether an explosion is propagated from one package to another" are not determinable. Normally when a package explodes the neighboring like packages are thrown about and destroyed and sometimes energetic material in the acceptor article react by burning, deflagration, but will seldom explode(sub-detonatively). The phenomenon that propagates in mass for a donor packaged substance/article to like acceptors is known a the detonation phenomenon.* *Note for consideration: It would benefit all nations if the Orange Book would adopt the definitions for words and phrases used by NATO to describe various reactions that energetic substances and devices containing energetics can exhibit when subjected to various stimulus. Here the words detonation, and explosion are properly distinguished.* • *There needs to be a maximum size package or Net Explosive Weight for an individual package. Perhaps the 110 gal non-bulk packaging limit.* • *The stated purpose is to determine if there is propagation of explosion from package to package, but why would you proceed to this test if the product has already been found to be 1.1 in the 6(a) test?* • *The current purpose is not consistent with the stated criteria and method of assessing results (16.5.1.8). While defining the purpose better would help clarify the test, our opinion is that whether or not a product explosion propagates from one package to another is not the best determining factor to help define the hazard level of the product, as it does not determine the severity of the explosion.*		
2. Are the materials needed to perform the 6(b) test adequately described? If no, use the space below to explain. • *confining material should be described elsewhere in the document as inert material (non-contributing); if not, then a specific description of 'confining material' should be provided in 6(b) language.* • *the quantity of material is not clear. If I have packaged propellant for example, do I test 0.15m3 of packages or 0.15m3 of powder?* *Yes, the need to use a standard detonator.* • *16.5.1.2*	11 58%	8 42%

Questions	Yes	No
Need "or" between a & b to help clarify that both the detonator and igniter are not used but one "or" the other only. • *More definition is needed on confining material (as well as "surrounded"). How confining should it be? As written it allows too much variability.* • *The test should be recorded on video.* • *16.5.1.2 "Blast measuring equipment may be used." Can you give examples of what equipment could be used, without making it prescriptive?* • *The list of materials reads as though a detonator AND an igniter will be needed. In reality it will be one OR the other. Suggest a) and b) of para 16.4.1.2 are amalgamated to indicate one or the other is used.* • *The result of the test is often contingent on the degree of confinement. The description allows a broad latitude in the type of confinement used and will result in variable results. The detonator is specified as a "UN detonator". Detonators meeting the exact UN definition are impossible to obtain.*		
3. When preparing to perform the 6(b) test, is it clear when to use a detonator and when to use an igniter? If no, use the space below to explain. • *It is to me* • *Actually, it is well defined, but we are aware of instances recently where CAs are requiring use of detonators on devices clearly intended to be initiated by igniters. Although this is within their prerogative, there is no guidance on how to interpret results of such tests.* • *See above explanation (3rd comment in #2). (not sure when (c) applies)* • *My assumption is that an igniter is used if it's a material that's intended to have a burning reaction versus a detonation. But, most such materials will not "explode" even if confined (unless the confinement is too great and the confinement over-pressurizes. And, if it's a package with multiple items it seems only a single item is "ignited". If another item ignites due to the confinement of the exhaust gases is that a "mass explosion"?* • *Describe igniter and detonator, specify the use of elec or non elc dets.* • *It should be better assigned when we have to use detonator and when igniter, specially if the whole munitions includes different components like*	11 65%	6 35%

Questions	Yes	No
high explosive or propellant. • *When per the Test Series 6 introductory paragraph the overarching goal is to determine which hazard division and compatibility group in Class 1 most closely corresponds to the behavior of a load that becomes involved in a fire or an explosion, how the explosive is intended to be functioned is irrelevant because the articles will be subjected to whatever stimuli a mishap generates. And whereas such mishap severity is unpredictable, shouldn't we always be favoring some appropriate conservatism in our assessment of a load's potential misbehavior by insulting our donor with a detonator in at least one trial?* *For all packaged substances, both a detonator and an igniter should be used (on separate trials). For articles where propellant poses the predominant hazard, is own means of initiation appropriate for all? An initiation sources capable of stimulating the donor in excess of its own means should be considered (e.g. detonator, shaped charge).* • *Igniter vs. detonator is currently dependant on intended design. It may be useful to revisit this approach with the goal of ensuring the proper hazard classification for transportation and to ensure that the test criteria continue to provide classifications consistent with the Model Regulations' Hazard Class/Division definitions.* • *Paragraph 16.5.1.4(c) says to use a detonator if you obtained a "+" in the 6(a) test. By the text, there is no "+" outcome in the 6(a) test. I presume that "mass explosion" was intended. Why would you be doing this test if you had a "mass explosion" in the 6(a) test?*		
4. The test description calls for 3mm mild steel. Should a tolerance for the thickness be provided? If yes, use the space below to explain. • *Perhaps. I would be happy with a "nominal thickness" of 3 mm and I don't know what sort of tolerances there are for steel plate. It is too easy to allow +/- 10% without really knowing what the normal variations are.* • *All manufacturing plans allow for tolerances, so it seems reasonable that tolerances for the thickness of the witness plate should be developed. Maybe +/- 0.5mm?* • *But, I would do this only if the rest of the procedure is tightened up. And, I'm not even sure the 3mm would be appropriate for all munition types. Is*	6 35%	11 65%

Questions	Yes	No
it supposed to replicate some structure that could be damaged in this "mass explosion"? • *Instead of a tolerance, the capability to use different thicknesses and different materials based on the item you're testing should be included. One size may not fit all. An appropriate witness plate for a 155mm HE projectile may not be right for blasting caps.* • *1) A tolerance that includes 0.125" (1/8 in.) should be provided since 3mm steel can be a difficult spec to find in the US.* *2) In the US, standard steel sheets are designated by gauges. An 11 gauge steel call out corresponds to a thickness of 0.1196 (+/- 0.008). This equates to a 3.04 mm thick plate. The 3 mm requirement would fall within the manufacturing tolerances of this sheet which equate to a range of 2.83 mm to 3.24 mm. The next thinnest gauge available is 12 gauge which corresponds to a thickness of 0.1046 inches (+/- 0.008). This equates to a thickness of 2.66 mm which could be used and would be significantly more conservative. A tolerance on the thickness would allow for the use of 11 gauge material which, in our opinion would be acceptable thickness.* *3) If there is a tolerance it should be wide (~0.5mm), since mild plate steel can vary in both thickness and strength. A tolerance would take into account the inherent tolerances already introduced by the manufacturing process.* *4) If there is a need to tighten the test, better defining "damage" to the witness plate and "disruption" of confining materials are more viable issues to address.* • *Generally, some tolerance should be provided for any dimensional specifications.* • *Yes; ± 0.5mm to permit use of imperial-sized materials. Suggest specifying CR4 grade or similar.* • *If 3.0±0.5 mm is implied there is no problem (see preamble of the UN Recommendations). But if an ISO or equivalent standard is implied, the product may be difficult or expensive to obtain. There would be no benefit to a tighter tolerance on the steel thickness in this test. For clarity, the tolerance should be specified in the test description.*		

Questions	Yes	No
5. Should other materials be considered for the witness plate? If yes, use the space below to explain. • *Such as?* • *No good answer to this. If the idea is to have a consistent test for comparison purposes, then a single material should be specified, and mild steel is not a bad choice. If the idea is to somehow replicate some structure, then there might be a better choice.* • *Also aluminium or some fibre materials may be used, specially for small calliber product.* • *Instead of a tolerance, the capability to use different thicknesses and different materials based on the item you're testing should be included. One size may not fit all. An appropriate witness plate for a 155mm HE projectile may not be right for blasting caps.* • *Possibly a thinner plate should be used. There is an inconsistency within the test series for determining candidates for less than HC/D 1.1 materials. Series 5a test uses a 1 mm steel plate. If the substance fails this test it stays in HC/D 1.1 realm. However, non-blasting agents/substances (which actually may be easier to ignite) use a 3mm plate in the 6a test.* • *A single material with a tight specification should be used so that data from all test labs are comparable.* • *The current witness plate is sufficient to determine if there is mass explosion.*	3 18%	14 82%
6. Are there any 6(b) test specifications that could be better defined? If yes, use the space below to explain. • *Emphasis needs to be better on what this test is about and what is a failure. A failure is communication from package-to-package, not simply occurrence of one of the example events.* • *For articles, this test requires an item near the center of the package to be functioned. Is this always the best location for the donor? Shouldn't the donor location be the one that gives the maximum probability of propagation and the worse case effects external to the package? If one location doesn't fulfill both of these conditions, then the location could change among the test iterations. I'd also recommend that one of the*	6 38%	10 62%

Questions	Yes	No
iterations be conducted unconfined to better evaluate effects external to the packages. • *16.5.1.4(c) "gave a '+' result..." Please use the word positive, instead of this plus sign. It is pretty vague, particularly to non-native English users.* • *Mild steel covers a wide range of specifications. Suggest tightening this.* • *The result of the test is often contingent on the degree of confinement. The description allows a broad latitude in the type of confinement used and will result in variable results. The detonator is specified as a "UN detonator". Detonators meeting the exact UN definition are impossible to obtain.* • *Disruption and scattering of the confining material is included in the method of assessing results (16.5.1.8), yet the confining material type and amount is not specified well enough to assure that they will not affect the amount of disruption and scattering. It is helpful that the method of assessing results states "violent disruption and scattering . . ." but the amount of disruption and scattering still depends on the type and amount of confining material. Either the confining material should be better defined, assessment of disruption and scattering should be better defined, or disruption and scattering of confining material should be removed as a method of assessing results.*		
7. Are there any tolerances associated with the 6(b) test specifications that could be better defined? If yes, use the space below to explain. • *there should be no tolerance for thickness, and recommend a standard hardness parameter be included in the language.* • *As per comments for the 6(a) test regarding "3.0mm" Its a minor point but some of the other tests define what an acceptor is where the term is included - e.g. Series 7 & 8 (b)* • *If 3.0±0.5 mm is implied there is no problem (see preamble of the UN Recommendations). But if an ISO or equivalent standard is implied, the product may be difficult or expensive to obtain. There would be no benefit to a tighter tolerance on the steel thickness in this test. For clarity, the tolerance should be specified in the test description.* • *Disruption and scattering of the confining material is included in the method of assessing results (16.5.1.8), yet the confining material type and*	4 24%	13 76%

Questions	Yes	No
amount is not specified well enough to assure that they will not affect the amount of disruption and scattering. It is helpful that the method of assessing results states "violent disruption and scattering . . ." but the amount of disruption and scattering still depends on the type and amount of confining material. Either the confining material should be better defined, assessment of disruption and scattering should be better defined, or disruption and scattering of confining material should be removed as a method of assessing results.		
8. Are there any unnecessary or over-specifications in the 6(b) test? If yes, use the space below to explain. • *In certain circumstances, 6D test results could be used in replacement for 6B if there is no mass detonation and effects outside the package are limited.* • *Just the tendency to misapply the results in determining if mass explosion has occurred. See 1st comment under #6 above.* • *The procedure (16.5.1.3) requires a total volume of 0.15 cu. m. of packages for the test. The volume as specified is too specific. The value of 0.15 cu. m. is stated without basis, and may be unnecessary.*	3 18%	14 82%
9. Are the assessment criteria that are used to distinguish between different explosive Divisions adequately defined? If no, use the space below to explain. • *The criteria seem to be more defined and more strict than the 6a test - could be more consistent.* • *I have done some 6b tests and had little difficulty with them.* • *So long as the criteria aren't overly interpreted or misinterpreted.* • *What are the definitions for "appreciably" and "significantly"? Is that double, or 50% more, or 10% more?* *You will disrupt the confining material just from the reaction of the donor.* • *IM-tests and test for transport should be harmonized within some time.* • *The violent disruption and scattering of most of the confining material criterion is not necessarily indicative of HD 1.1. For large articles (e.g. missiles, bombs) this could have been caused by the intentional function of*	9 50%	9 50%

Questions	Yes	No
the donor article. With the current procedure of three confined tests, comparing the measured blast to a single article could be misleading. Changing one of the tests to unconfined (as proposed above) and using the blast measurements from that test for comparison would be appropriate. Projections should be mapped and used along with the external fire test data to determine the HD. • *16.5.1.8(a), (b), and (d) are clear. However, 16.5.1.8(c) is too vague - "measurement of a blast which significantly exceeds that from a single package or unpackaged article". First issue is that 16.5.1.2 and 16.4.1.2 state that blast equipment MAY be used. If it is not used, how can you measure any blast or compare to the single package test? In addition, blast is not defined and substances and articles with a "minor blast" can be classified as 1.3 [UN Model Regulations, 2.1.1.4(c)]. Please identify a measurable threshold between minor and major blasts, or define its effects (e.g. debris scattered x meters from package). Also, what does "significantly exceeds" mean? Of course several packages of something that blasts are going to have a bigger blast than a single package. Are you talking about synergistic effects?* • *1) Define what a crater is (diameter/depth of hole). Ground conditions may affect whether a crater is formed.* *2) the criteria is "mass explosion". To help aid in this, define what is meant by "disruption and scattering of the confining material". Is "disruption" ok as long as "scattering" does not occur? "Heaving" or "sluffing" of the confining material do not seem to explain a "mass explosion". This example of mass of explosion could be better defined.* *3) The criteria "damage to the witness plate" provides a wide range of interpretation. What is "damage"? any slight discoloration? bowing? well defined indentation? perforation of any degree? or only a definite hole? size of hole or dent?* *4)The criteria "disruption of confining material" provides a wide range of interpretation. How much disruption is allowed? how much is too much? How to define for propellant or smokeless powder or grenade which needs to vent (disrupts sand) yet clearly has no crater?* *5) Quantifying percentage of recoverable vs. percentage which functioned- Define "mass detonation" units damaged by pressure wave, not sympathetic detonation.*		

Questions	Yes	No
6) Each product dependent on design has critical parameters that override other keys. *7) MTC is technical manual written to generically address majority of explosive materials and devices. However, it is a guideline which should allow labs to discern which critical parameters are crucial for any given substance/article.* • *The 6(b) test essentially assesses whether the material is a candidate for a 1.1 classification; it doesn't assign into other Divisions at this stage. The 6(c) test is the primary test for assigning Division.* • *Note that the stated purpose is to determine package to package, or unpackaged article to unpackaged article propagation of explosion.* *The criteria are fuzzy for the same reasons as given for the the 6(a) test.* • *(1) Observations are suggested (16.5.1.7) for thermal effects, projection effects, detonation and deflagration without guidance for evaluation as evidence of propagation of an explosion from one package to another. These observations are not included in the test criteria (16.5.1.8) for assessing results, leaving it unclear as to how to apply the observations to the assessment of propagation from one package to another.* *(2) Explosion or damage to explosive articles in the package other than the one intentionally functioned are not included in the test criteria and method of assessing results (16.5.1.8) for evidence of propagation of explosion from one package to another, yet are commonly used for that purpose. It is suggested that they be included, with guidance for assessing results as related to evidence of propagation.*		
10. Use the space below to provide any other comments about the 6(b) test. • *Why are some articles which have no characteristics of a mass explosion subject to the 6(a) test just because they must pass the series 6 testing. Some way of opting out should be allowed or stated.* • *Like in the 6(a) test, I have a problem with confinement. As already noted, it's just too variable as now "specified". In some cases it has been extreme - burial in sand. It that's done it hinders our ability to assess the reaction. But, more importantly, it could get test operators killed. If a single item is tested, we are fairly safe to assume that we initiated that item and it reacted. However, if there are multiple items in the package how can you*		

Questions	Yes	No

tell exactly what has reacted under the sand? Is there damaged energetics, perhaps even cooking off? Have safety devices been compromised? I'm sorry, but I hate this test as currently run.

But, in this case, we plan to have "unreacted" material left over. It's even worse.

- *For military munitions, using the stack test only for assessing for mass explosion and then, if not 1.1, classing based on the fire test results is no longer viable---unless you believe that numerous large high explosive bombs and warheads belong in 1.3 and 1.4. They must be 1.2 at a minimum from my perspective.*

  The cause for the above is the past 30 years or so of technology development towards "insensitive munitions." Through success down that path, an explosion is no longer propagated from one package to another of many high explosive or detonable configurations, and in fire testing those configurations only burn.

  So to preclude 1.3 and 1.4 assignments of those high explosive and detonable configurations, the output of the donor and any acceptors violently reacting in the stack test must be what qualifies the article for 1.2 (or 1.1 if most acceptors present promptly detonate with the donor). One stack test trial needs to be conducted unconfined so that the mass-distance relationship curve normally applicable for fire testing can be utilized to assess whether the projections generated exceed 20J or not.

- *The 6b test seems redundant since worst case would be 6a in intimate contact:*

  Fail 6a --> 6b is waived and classification is 1.1

  Pass 6a --> if items are packed in intimate contact within package and no propagation, proceed to 6c. items packed in intimate contact within package.

- *Again, introducing some screening procedure before test series 6 may be preferable.*

- *If an article fails to propagate to others within a package during the 6(a) test, is it necessary to also carry out a 6(b) test? It is highly unlikely that an item which doesn't propagate to other items within a package, will then go on to propagate between adjacent packages.*

  When testing packages containing only one article, we are often required to carry out one of the three 6(b) tests in an unconfined condition, by our customer (US DOD). This is to assess the degree of package disruption in a similar way to the 6(d) test, even though we may not be seeking a 1.4S classification. Could this be a useful aspect to the testing?

- *The rationale for this test should be more clearly stated that greater quantities of sample*

Questions	Yes	No
and greater confinement are more likely to lead to a mass explosion. It should more clearly stated that it should be applied to samples that do not mass explode in the 6(a) test but react sufficiently violently to breach their packagings in the 6(a) test, or cause their packagings to burn in the 6(a) test. • *The procedures (16.5.1.3) states "The test is applied to a stack of packages of an explosive product or a stack of unpackaged articles, in each case, in the condition and form in which they are offered for transport." For packages that do not contain a means of explosives initiation or ignition, it is not correct to state that the packages are in the condition and form in which they are offered for transport because the packaging is modified to accommodate a detonator or igniter that is not present during normal transport. Suggest adding a sentence to follow the one referenced above: "For packages that do not contain a means of initiation or ignition, the packages are modified to accommodate a means of initiation or ignition."*		

Section 3: 6(c) Test

Purpose: This is a test performed on packages of an explosive substance or explosive articles, or unpackaged explosive articles, to determine whether there is a mass explosion or a hazard from dangerous projections, radiant heat and/or violent burning or any other dangerous effect when involved in a fire.

Description:

A stack of packages (with a total volume of at least 0.15 m^3), on a metal grid, are burned using enough fuel to keep a fire burning for at least 30 minutes or, if necessary, until the explosives have clearly had sufficient time to react to the fire. Rigidly mounted aluminum panels (constructed of 2000 mm × 2000 mm × 2 mm 1100-0 aluminum sheets, with a Brinell Hardness of 23 and tensile strength 90 MPa), are placed around the bonfire to act as witness screens in evaluating the energy with which metal projections may be ejected from the burning explosives. Observations are made regarding the presence and size of fireballs and jets of flame, thermal flux, the size of metallic projections, and the distance those projections may be thrown.

Assessing results: Assignment to explosive divisions is based upon results of the test, as follows:

- Division 1.1
    - Mass explosion
- Division 1.2 – none of the above, but any one of the following occurs:
    - Perforation of witness screen
    - Metallic projections with kinetic energy greater than 20 J
- Division 1.3 – none of the above, but any one of the following occurs:
    - Any fireball or jet of flames that extend beyond any witness screen
    - Any fiery projection thrown more than 15 m from the edge of the stack of packages
    - A burning time of less than 35 sec/100 kg net explosive mass
    - In the case of articles, an irradiance greater than 4 kW/m^2 from the edge of the stack of packages
- Division 1.4 other than S – none of the above, but any one of the following occurs:
    - Indentation of any witness panel of more than 4 mm,
    - Any metallic projection with kinetic energy greater than 8 J
    - Any fireball or jet of flames that extend more than 1 m from the flames of the fire

- Any fiery projection thrown more than 5 m from the edge of the stack of packages
- A burning time of less than 330 sec/100 kg net explosive mass.

- Division 1.4S – none of the above, and all of the following conditions are satisfied:
  - Any thermal, blast, or projection effects that occur would not significantly hinder fire-fighting or other emergency response efforts in the immediate vicinity
  - Any hazardous effects that occur are confined within the package

- Exclusion from Class 1 – no hazardous effects at all

6(c) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(c) test adequately defined? If no, use the space below to explain. • *the sentence as written is ambiguous because of how the term hazard is used; recommend reconstruct the sentence so it is more clear that the hazard the test is undertaken to determine is the unwanted presence of the test item / test item constituent and not the unwanted presence of ambient / environment on the test item* • *What is a mass explosion?* • *The purpose includes determination of "other dangerous effect when involved in a fire," without defining what is meant by other dangerous effect, and without including assessment of other dangerous effects in the criteria and method of assessing results (16.6.1.4).*	17 85%	3 15%
2. Are the materials needed to perform the 6(c) test adequately described? If no, use the space below to explain. • *The main issue is mesh size of the metal grid on which the product being tested sits. It is not defined in the test description and it can very significantly change the results of the test. Specifically, if the mesh size is not tight enough, product will quickly fall into the core of the bonfire before detonation and combustible material (burning wood) will stop most of the projections, thus giving a "pass" when it should be a "fail". Mesh size should be sized and defined such that product cannot fall into the fire. Alternatively, the fire should be a defined pool of burning hydrocarbon liquid, such that it does not provide a barrier to horizontal projectiles.*	15 79%	4 21%

Questions	Yes	No
This issue is disadvantaging Orica because the Canadian Authorities declare the test void if product falls into the mass of burning wood and is 'contained' by it, whereas Authorities in some other countries ignore this effect and will grant a 'pass' to product which would clearly fail were it kept above the fire. • *the quantity of material is not clear. If I have packaged propellant for example, do I test 0.15m3 of packages or 0.15m3 of powder?* • *Strapping-why allowed-could affect the test results to better the outcome. When might this be applied?* • *But, if the fire is strong enough in one direction, might not an aluminum panel melt, destroying evidence of fragment impacts?* • *Metal grid must be sufficiently above the height of the selected fuel to allow proper mixing of air into the flame/fire prior to reaching the test material.* *Fuel supply: Using a wood (stacked boards, not pallets) or liquid fuel fire, most of the material is consumed or reacted within 15 minutes of starting the fire. The currently described wood fire set up lasts only about 10-15 minutes. A 20 minute fire is usually more than adequate.*		
3. The test description calls aluminum witness panels that are for 2000 mm x 2000 mm x 2 mm. Should tolerances for the witness panel size be provided? If yes, use the space below to explain. • *Dimensions are OK but witness panels should extend closer to the ground (distance to be defined). Currently there is no specification for the maximum distance of the panel from the ground. The issue is that projectiles can pass below the panel and thus 'pass' a product which falls through the grid, into the fire, and detonates on the ground or close to it.* • *it should be made clearer that aluminium with different properties may be used if the results can still be interpreted.* • *Witness panel description in the procedure is pretty well done. However, some reasonable tolerances should be established for panel size.* • *They should only be provided if 1) any variance from those exact dimensions would result in a "no test" ruling or 2) dimension differences*	9 47%	10 53%

Questions	Yes	No
would affect the test results. In some cases, they might. If tolerances are given, they need to make sense - not like the too strict tolerance on bullet velocity for the BI test. • *Depending on the wind conditions during test, witness plates some times simply melt down. Alternative materials could be adequate.* • *An option to eliminate the witness panels and collect projections should be added. The witness panels can block video views. And they are not calibrated to tell you what the depth of dents from strikes by plastic, wooden, rubber, etc. projections mean.* • *Think the hardness and tensile specifications would keep wide variations from the nominal dimensions from occurring.* • *Tolerances could be used to make it possible to buy panels based on the inch system.* • *The witness panel of this dimensional specification is not available in Japan. Some tolerance of dimensions should be provided.* • *Sheets of this size are expensive to procure (especially if they need mm tolerances are important. 2000 x 2000 +/-5mm would be fair. Stating a maximum thickness of 2mm with a tolerance would be pragmatic.* • *By the UN Recommendations' preamble, ±0.5 mm is implied. This is clearly unreasonable. The edge length tolerances should be in the order of ±100 mm. The thickness tolerance should be set so that common manufactured gauge thicknesses, in all parts of the world, of aluminium sheeting are included.* • *Tolerances not needed, and would overspecify the material.*		
4. Should other materials be considered for the witness panels? If yes, use the space below to explain. • *The specification states "or equivalent". That should be adequate.* • *Only if there is a concern as I noted on the aluminum melting.* • *Depending on the wind conditions during test, witness plates some times simply melt down. Steel would probably withstand this better.* • *Additional witness panels should be used to help determine the response*	6 32%	13 68%

Questions	Yes	No
level of the articles. The optimum material to use for a witness plate depends on the type and velocity of the expected fragments. For heavy articles with steel walls, a steel witness plate with a thickness of at least 25 mm is recommended. Normally, witness plates should not be in direct contact with the test item since this might alter the heat flow into the round and the confinement of the energetic material. Ideally, there should be at least 200mm between the witness plate and the test munition so as not to interfere with the uniform heating of the munition. • *Possibly. The failure criteria based on witness panels and the fragment mass/distance relationship should match. At times it appears that they do not. In addition, the 1100-0 aluminum (pure aluminum) is hard to find. A modern alloy with the appropriate thickness should be identified.* • *Including provision for sheets of mild steel (including galvanized to allow designers to build in better durability/weatherability of the test area) would be useful for saving cost where frequent witness panel changes become necessary. Although provision is made for equivalent an additional defined alternative material would help without having to go down the route for materials testing prior to setting your test site up.* • *In the past it has been very difficult to obtain the correct specification of aluminium sheets; offer an alternative material specification which is more readily obtainable.* • *Although aluminium sheets are handy to use, denting and perforation may not be as regular and measurable as desirable. Fragment traps composed of layers of various materials would be easier to assess and would better measure kinetic energy and velocity.* • *Other methods of determining projection energy level should be considered. It has not been established that aluminum panels result in consistent results for varying projectile shapes.*		
5. Are there any 6(c) test specifications that could be better defined? If yes, use the space below to explain. • *The importance of the total volume (minimum of 0.15 m3) is not always well understood. If fewer products are used it increases the likelihood of not having any perforation / indentation on witness panels.* • *the test temperature of at least 800 C needs clarification. does it have to be above 800 for the entire time? Perhaps the 800 only applies to liquid or*	7 39%	11 61%

Questions	Yes	No
gas fires? that could be made clearer. • *Additional information on the equipment and procedures used to measure thermal flux would be beneficial.* • *1. There is no mention of use of thermocouples for flame temperature measurement or where this should be measured (propose it is at the article)* *2. Whether the 800DegC is an appropriate value and whether this should be a minimum or average temperature (suggest an average is specified) after an induction period.* • *16.6.1.2 "Blast gauges,..." be noted as step (i) under this section?* *16.6.1.3.1 "encircled with a steel strip" we use the term steel strap in the US and strip implies weak tensile strength - is strip a more European term? "a flame temperature of at least 800 degrees C" how long does this temperature need to be maintained - the whole 30 minutes? 10 minutes? a brief spike anytime in the test?16.6.1.4.4(c) should refer to Table 16.2* • *16.6.1.2. - What constitutes a high speed video camera? (e.g. 60fps could be considered adequately high speed when choosing a consumer camera to film the effects expected with a 1.3G or 1.4G result (to catch projections on film). but this definition is too loose - some would consider high speed to be 2000fps so a camera spec would help. 50fps would be a figure that is achievable for modest budgets with semi-pro equipment (e.g. a £1000 camera) and with the evolution of digital video, would it be appropriate to specify a quality level or at least include guidance e.g.. 720p@50fps has proved to be adequate based on our observations from selecting equipment from our own tests. What's 'cine'?* • *Yes - fiery projections.* • *Method of constructing the fire should be less specific and focused on what the resultant fire should be (temperature range, need to engulf the packages, etc.). Currently the listing of methods to build the fire is incorrectly taken by some testers to define the only ways that a fire can be built.*		

Questions	Yes	No
6. Are there any tolerances associated with the 6(c) test specifications that could be better defined? If yes, use the space below to explain. • *The flame temperature* • *More details on the heating profile; suggest specifying an average value that is achievable for the fuel sources specified. Also detailing an acceptable induction period.* • *16.6.1.3.8 "leaving a significant quantity of unconsumed explosive substance in the remains or in the vicinity of the fire" what is a significant amount - 50% of the NEW in the packages? 30%? 10%?* • *Although aluminium sheets are handy to use, denting and perforation may not be as regular and measurable as desirable. Fragment traps composed of layers of various materials would be easier to assess and would better measure kinetic energy and velocity.* *The Brinell Hardness 23 and tensile strength 90 MPa are specified without tolerances. The alloy is already specified. The chances of getting all three parameters to line up for a particular lot of aluminium are pretty slim. Why is the flame temperature specified? There is not a lot you can do to adjust it. The overall size of the fire is more important than the temperature of flames in an unspecified part of the fire,*	4 22%	14 78%
7. Are there any unnecessary or over-specifications in the 6(c) test? If yes, use the space below to explain. • *Only one perforation / indentation on witness panel can result in test failure. It is very severe because witness panels are far from covering the whole volume, passing or failing the test is often a matter of luck.* • *fire duration is overspecified. if testing powder and it all burns in 5 minutes, whey do I have to have a fire for 30 minutes?* *Unfortunately, (because it shouldn't be necessary to spell it out) the wood mass could perhaps be used as a guide to allow different wood configurations. For example, when I used old pallets for the fire, I calculated how much wood was in the model lattice then used that much wood in pallets.* *When testing propellants, why must the gas fire extend 1 m in all*	8 44%	10 56%

Questions	Yes	No
directions? • *The required minimum burn time is 30 min, this is in the area of twice as much as needed (based on experience). If there was a point describing that the burn time could be decided by the test house, based either on experience from previous tests or calculations, the test houses should be allowed to perform in accordance with this, at their own risk.* • *The measurement of thermal flux is not necessary or the measurement is very difficult to do.* • *Why is 800degC a necessary temperature when most timber cribs only hit 700degC? Is this for Gas/fuel pyres? When testing with timber, provided the packages are engulfed in flame does it really matter what the temperature is? (cribs made from pallets can sometimes come in less than 800degC, but still result in a thorough burn.* • *For the wood fire - can alternatives to the very expensive kiln-dried wood, such as pallets, be used? The caveat would have to be that the intensity and burning time of the fire can be achieved for an adequate test result.* • *The Brinell Hardness 23 and tensile strength 90 MPa are specified without tolerances. The alloy is already specified. The chances of getting all three parameters to line up for a particular lot of aluminium are pretty slim. Why is the flame temperature specified? There is not a lot you can do to adjust it. The overall size of the fire is more important than the temperature of flames in an unspecified part of the fire,* • *(1) 16.6.1.2 requires a total volume of packages or substances or articles to be not less than 0.15 cu. m. Volume is not necessarily the determining factor for resultant hazardous effects in a fire, and no basis is given for this minimum volume.* *(2) Metal grid to support packages in fire is over-specified.* *(3) In the procedure, the example methods to construct a fire require at least one meter of fuel beyond the packages. This over-specifies the requirement of 16.6.1.3.1 that the fire engulf the packages.* *(4) 16.6.1.3.6 states that tests should not be performed where the wind speed exceeds 6 m/s, without giving a basis for that requirment, and with disregard for the requirement that the packages be engulfed in flame that would seem to make the wind speed requirement unnecessary.*		

Questions	Yes	No
8. Are the assessment criteria that are used to distinguish between different explosive Divisions adequately defined? If no, use the space below to explain. • *"Mass explosion" not well defined* • *some thoughts and observations:* ➢ *fireball or jet of flame beyond the witness screens can be hard to assess of the jet is small.* ➢ *16.6.1.4.5.e is very hard to calculate for packages of propellants. And I found the scaling calculations to be impossible to follow.* • *Division 1.1 - what is a mass explosion? How is that determined?* *Division 1.2 – how are you going to determine if the kinetic energy is greater than 20 J?* *Division 1.3 – what if the fireball or jet of flames hits the witness screen and so can' extend beyond it? Would not the irradiance be a function of the material as well as the severity?* *Division 1.4 other than S – where does the 4 mm value come from? How would you determine if the KE > 8 J?* *Division 1.4S – How can someone possibly determine if a thermal, blast, or projection effect would significantly hinder firefighting or other emergency response efforts in the immediate vicinity? What's "immediate vicinity"?* • *For the 1.4S criteria, what is considered a hazardous effect that needs to be confined within the package? The other criterion implies that you can have some thermal, blast, or projection effects outside of the package (provided they don't hinder firefighter or emergency response efforts), so what hazardous effects or what level of hazardous effects need to be contained? What is considered to be the immediate vicinity?* • *Suggest that some improved response descriptors would help with the consistency of assigning the hazard classification. Those used in UN TS7 are again suggested.* *The discrimination between 1.1 and 1.2 using 'mass explosion' or 'a substantial proportion explodes' is difficult to work with and is likely to lead to differences in classification between national authorities.*	10 48%	11 52%

Questions	Yes	No
Perhaps a good discriminator would be UN TS7 response descriptors for detonation, partial detonation, and explosion response lead to HD 1.1. For HD 1.2 this would correspond to the deflagration response level. *Logically 1.3 would then correspond to burning response. However, the current criteria include 'fiery projection' which are generally accepted to include articles projected by burning propellant under the current definition. It is entirely possible that these would have a mass and velocity equating to a kinetic energy in excess of the 20J criteria which should precluding entrance into 1.3 accordingly. Perhaps it might be acceptable to add some words to account for intact articles containing a propulsion component which could be expected to leave the test site.* • *16.6.1.4.4(c) and 16.6.1.4.5(e) "a burning time of the product measured…" we have no way to measure how long it took the article or substance packaged inside containers to burn. We can only measure the quantity of NEW in the package before the burn and NEW that may be remaining in the packages after the external fire test is complete, the cans have had time to cool, and a safety period of 24 hours has elapsed and we open the container to examine the remains. There is no way to determine whether the explosive burned off in the first few minutes or it took the entire 30 minutes or so of the burn.* *How do you intend this to be measured? Any instrumentation inside the package would negate the intent of testing the packages as they would be configured for shipment.* • *1) The allowed wind speed may affect how far out a fireball travels. Fireballs that may extend beyond the screen when running tests with a wind (up to 6 m/s), may not have such an effect when the test is run with no wind. Compensation of the wind should be discussed when assessing the fireballs.* *2) Define fireball/jet/flame, fiery projection, and metallic projection. Each of these 3 has a clearly defined distance allowable (with different distances for each). How to discern between the effects is not always clear. (see #4)* *3) a) Division 1.2- what happens if testing large quantity of units and not recovering items for weight? Can this be ruled out in the calculation of 20J for max distance? Projections can easily exceed tested area for articles designed to perform this way.*		

Questions	Yes	No
b) Division 1.3- difference between "fiery projection" (15m) from the package vs. "fireball or jet flame" (4m, past the witness screen) seems contradictory. What is the criteria for evaluating fireballs or jets which do not pass the witness screen but exceed 4m in a vertical or angled direction? *c) Division 1.4- differences of fireball/jet of flame or fiery projection, or metallic projection (Question 3 above). Items not recovered- how can they be ruled out in 8J equation (assuming you cannot locate articles exceeding test area).* *d) 1.4S- "not hindering fire fighters and first responders" is vague. How does 8J limit/equation relate to first responders?* *4) Appears to be a broad variety of interpretation in calculation of burning time and thermal flux evaluation. Note 3 of Section 16.6.1.4.8 refers to "separate events" to be measured, if possible. If not possible, however, is the calculation useful at all? Would it be possible to measure burn time on a single inner packaging and scale up the results?* • *For 1.1 to 1.4 excluding compatibility group S the definitions are clear, but for 1.4S, what would be considered a hazardous effect for determination of whether or not its confined to the package?* • *For a 1.4S classification to be awarded, one of the conditions of the 6(c) test to be met is that the hazardous effects are to be confined within the package; how does that work with a fibreboard or wooden box, which is quickly consumed in the fire?* • *1. 16.6.1.4.2 states that if mass explosion occurs then the product is assigned to Division 1.1. Depending on the severity of the explosion and subsequent hazard level, this may be an inappropriate assignment.* *2. 16.6.1.4.3(b) specifies projection kinetic energy of less than 20J. What is the basis for this requirement? Is it, or should it be directional (is the hazard level the same in all directions)?* *3. 16.6.1.4.4(c) states requirment for burning time of a product. What is the basis for those requirements?* *4. 16.6.1.4.5(a) includes specifications for a jet of flame. For clarity, suggest that the statement be "a fireball or jet of flame emanating from the packages or product ..." to distinguish events from the fuel or fire itself.*		

Questions	Yes	No
5. 16.6.1.4.5(c) includes the criteria of no indention in the aluminum witness screens of more than 4 mm. What is the basis for this requirement? Is this depth, or length/width? *6. 16.6.1.4.5(d) includes the criteria of no projection kinetic energy exceeding 8 J. What is the basis for this requirement? Is it , or should it be directional (is the hazard level the same in all directions)?* *7. 16.6.1.4.5(e) includes burning time criteria. What is the basis for this requirement?* *8. 16.6.1.4.6 - Define "effects that would not significantly hinder fire-fighting or other emergency response efforts in the immediate area."* *9. 16.6.1.4.6 - Requires hazardous effects to be confined within the package. In a fire, some types of packaging will burn. How does one tell if hazardous effects have been contained within burned packaging?* *10. 16.6.1.4.6 - Requires hazardous effects to be confined within the package. This requirement is overly restrictive - many non-explosive consumer products cannot meet this criteria.* *11. What is the basis for the distance-mass relationships of Figure 16.6.1.1?*		

9. Use the space below to provide any other comments about the 6(c) test.

- *The main issue remains the decision made by some Authorities to waive the test and approve 1.4 hazard classification by analogy. In particular, the type of projection from copper and copper alloy detonators is not well understood and leads to improper 1.4 classification. It is hard to believe that full strength copper detonators without base charge protection can be granted a 1.4B or 1.4S hazard classification if the 6(c) test is performed correctly.*

  It is very hard to assess " a fireball or jet of flame which extends more than 1 m from the flames of the fire".

  The following needs a better definition and a method to measure: "an indentation in any of the witness screens of more than 4mm": in which direction do you measure and how?

  Where is says: " a metallic projection with a kinetic energy of..." if what is projected is an assembly with metal parts (i.e. an attenuator + wire + detonator), what do you measure?, would it be considered a metallic projection?

Questions	Yes	No

- *16.6.1.2*
  The device used to determine outcome of 16.6.1.4.4(c) should be specked out and described in this section. Previous experience has shown that most radiometers are not affective for continuous use.

  16.6.1.4.5
  Distance isn't defined but mass and energy only. Where did 4 m come from for a distance when it should be driven by the mass energy table.

  Nothing stated about Class 9 only "out of Class 1". Needs to be more specific to encompass Class 9.

- *Bonfire / FCO tests and their outcome and repeatabilty are highly depending on local conditions and weather. Perhaps it could be mentioned, one way or another, that this is a fact, and that results from tests therefore may vary more than expected, even with almost similar test objects and hearths.*

- *It should be possible to use gas burner instead of liquid fuel and wood to avoid the oil spill in case of explosion.*

- *Previously I've recommended an unconfined single package and stack test. Recommend the assessment criteria for the external fire test be utilized for these unconfined tests as well.*

- *16.6.1.3.6 - "test should not be performed…wind speed exceeds 6 m/s."*
  Is this speed for the entire test or just at the start of the test?

  non-flaming gas releases? 16.6.1.4.7(ii) article intended to produce an effect, but has no effect sounds like a dud to me?

- *1) Sometimes the 0.15m^3 requirement is cumbersome for customers who sell a small amount of product per year. This requirement can represent more material than they might manufacture in a decade. It would be advantageous to have a way to test less material and perhaps give the company a maximum amount they could ship based on such a test.*

  2) A test program could be developed where the existing witness screen is subjected to various well defined projectiles (mass, shape, energy at impact) and the damage assessed. Candidate replacement materials could then be subjected to a reduced set of the same tests to determine if it qualifies by providing a similar response.

- *Test 6(c) is not suitable for shell fireworks because ignition of one of shells results in a*

Questions	Yes	No
projection of other shells inevitably. • *A diagram to describe 16.6.1.3.5 would be helpful, showing preferred positions of video equipment for evidence gathering.* • *The test description suggests that blast gauge and radiometers should be used but gives no guidance at to what specific model should be used, how to set them up, or how to assess the results. The measurements resulting form such devices depend on the type/model of device, their mode of use, and the data treatment. Without a standard procedure, there is no point in using them.* • *1. The procedure gives an overview of the test method in 16.6.1.3.1, and then lists three possible methods to construct the fire in 16.6.1.3.2, 16.6.1.3.3 and 16.6.1.3.4. The three possible methods are options for 16.6.1.3.1, and hence should be identified organizationally as 16.6.1.3.1.1, 16.6.1.3.1.2 and 16.6.1.3.1.3 so that they do not appear as additional steps of the procedure.* *2. Video cameras should require more than one camera, and cameras should be aimed so that significant events will be recorded sufficient to identify what is happening.* *3. Flame temperature of at least 800 degrees C is required, without basis for that minimum and without specifying a procedure to measure the flame temperature.*		

Section 4: 6(d) Test

Purpose: This is a test on a single package to determine if there are hazardous effects outside the package arising from accidental ignition or initiation of the contents.

Description:

Depending upon how the explosive is intended to be functioned, either a detonator or an igniter is caused to function in a single package containing an explosive substance or one or more explosive articles. The package to be tested is placed on a witness plate made of 3mm thick mild steel and no confining material is used.

Assessing results: Inclusion in Compatibility Group S requires that any hazardous effects arising from functioning of the articles in this test are confined within the package. Evidence of a hazardous effect outside the package includes:

- Denting or perforation of the witness plate beneath the package;
- A flash or flame capable of igniting an adjacent material such as a sheet of 80 ± 3 g/m² paper at a distance of 25 cm from the package;
- Disruption of the package causing projection of the explosives contents; or
- A projection which passes completely through the packaging (a projection or fragment retained or stuck in the wall of the packaging is considered as non hazardous).

The competent authority may wish to take into account the expected effect of the initiator when assessing the results of the test, if these are expected to be significant when compared to the articles being tested. If there are hazardous effects outside the package, then the product is excluded from Compatibility Group S.

6(d) Test Survey:

Questions	Yes	No
1. Is the purpose of the 6(d) test adequately defined? If no, use the space below to explain. • *The purpose should be re-worded "This is a test on a single package to determine if there are hazardous effects outside the package arising from intentional ignition or initiation of some of the contents." The test does not determine effects from accidental ignition or initiation. As worded, the purpose seems to imply an analysis of accidental ignition or initiation.*	17 94%	1 6%

Questions	Yes	No
2. Are the materials needed to perform the 6(d) test adequately described? If no, use the space below to explain. • *Why is a steel witness plate needed. Shouldn't you be able to determine whether effects are contained in the shipping container by a post test evaluation of the container itself?* • *Where possible, initiate using the article's own initiating device. The use of an additional detonator or initiator needs to be quantified and negated for the test result to be representative.* • *The list of materials reads as though a detonator AND an igniter will be needed. In reality it will be one OR the other. Suggest a) and b) of para 16.4.1.2 are amalgamated to indicate one or the other is used.*	15 83%	3 17%
3. When preparing to perform the 6(d) test, is it clear when to use a detonator and when to use an igniter? If no, use the space below to explain. • *Actually, it is well defined, but we are aware of instances recently where CAs are requiring use of detonators on devices clearly intended to be initiated by igniters. Although this is within their prerogative, there is no guidance on how to interpret results of such tests.* • *Igniter vs. detonator is currently dependant on intended design. It may be useful to revisit this approach with the goal of ensuring the proper hazard classification for transportation and to ensure that the test criteria continue to provide classifications consistent with the Model Regulations' Hazard Class/Division definitions.* • *The description needs to expand on the circumstances under which each device may be used.*	16 89%	2 11%
4. The test description calls for 3mm mild steel. Should a tolerance for the thickness be provided? If yes, use the space below to explain. • *steel down to 0 mm should be permitted.* • *All manufacturing plans allow for tolerances, so it seems reasonable that tolerances for the thickness of the witness plate should be developed. Maybe +/- 0.5mm?*	10 56%	8 44%

Questions	Yes	No
• *A steel plate shouldn't be used if a & c have been performed. Serves no purpose.* • *Since the criteria is any dent, the thickness likely doesn't matter.* • *The steel witness plate isn't needed. See my comment for question 2.* *1) A tolerance that includes 0.125" (1/8 in.) should be provided since 3mm steel can be a difficult spec to find in the US.* *2) In the US, standard steel sheets are designated by gauges. An 11 gauge steel call out corresponds to a thickness of 0.1196 (+/- 0.008). This equates to a 3.04 mm thick plate. The 3 mm requirement would fall within the manufacturing tolerances of this sheet which equate to a range of 2.83 mm to 3.24 mm. The next thinnest gauge available is 12 gauge which corresponds to a thickness of 0.1046 inches (+/- 0.008). This equates to a thickness of 2.66 mm which could be used and would be significantly more conservative. A tolerance on the thickness would allow for the use of 11 gauge material which, in our opinion would be acceptable thickness.* *3) If there is a tolerance it should be wide (~0.5mm), since mild plate steel can vary in both thickness and strength. A tolerance would take into account the inherent tolerances already introduced by the manufacturing process.* *4) If there is a need to tighten the test, better defining "damage" to the witness plate and "disruption" of confining materials are more viable issues to address.* • *Generally, some tolerance should be provided for any dimensional specifications.* • *Yes; ± 0.5mm to permit use of imperial-sized materials. Suggest specifying CR4 grade or similar.* • *If 3.0±0.5 mm is implied there is no problem (see preamble of the UN Recommendations). But if an ISO or equivalent standard is implied, the product may be difficult or expensive to obtain. There would be no benefit to a tighter tolerance on the steel thickness in this test. For clarity, the tolerance should be specified in the test description.* • *Since the criteria is indentation of the witness plate, a tolerance is not*		

Questions	Yes	No
needed.		
5. Should other materials be considered for the witness panels? If yes, use the space below to explain. • *Any witness plate is redundant. if anything gets outside the package, the material is not 1.4S. why bother with the steel witness plate?* • *Shouldn't be used.* • *Since the criteria is any dent, the type of material likely doesn't matter.* • *The steel witness plate isn't needed. See my comment for question 2.* • *A single material with a tight specification should be used so that data from all test labs are comparable.*	5 28%	13 72%
6. Are there any 6(d) test specifications that could be better defined? If yes, use the space below to explain. • *A flash or flame capable of igniting an adjacent material such as a sheet of 80 ± 3 g/m² paper at a distance of 25 cm from the package. I'm not comfortable with "capable of". Why not just require that piece of paper as part of the test equipment and the criteria is that it doesn't ignite?* • *Additional information regarding the placement of the sheet of paper is needed. Should it be surrounding the package or just in the direction you expect flash/flame?* *For articles, this test requires an item near the center of the package to be functioned. Is this always the best location for the donor? Shouldn't the donor location be the one that gives the maximum probability of propagation and the worse case effects external to the package? If one location doesn't fulfill both of these conditions, then it could change among the test iterations.* • *"Video equipment MAY be used" should this be step (d)?* • *16.7.1.4 (b) 'Adjacent material such as' ....80gsm paper. Is this an appropriate specification? if accidental ignition has occurred, would it would be more prudent to test against the typical transport packaging*	4 22%	14 78%

Questions	Yes	No
material, or is 80gsm paper selected because goods in compatibility group 1.4S can be transported and stored in wider circumstances so a more easily ignited material is deemed appropriate?		
7. Are there any tolerances associated with the 6(d) test specifications that could be better defined? If yes, use the space below to explain. • *steel down to 0 mm should be permitted.*	1 6%	17 94%
8. Are there any unnecessary or over-specifications in the 6(d) test? If yes, use the space below to explain. • *steel down to 0 mm should be permitted.*	1 6%	17 94%
9. Are the assessment criteria adequately defined? If no, use the space below to explain. • *Denting or perforation of the witness plate needs better definition. How deep the denting, what about a scratch?* • *Quite clear* • *We heard of instances where the package exterior was blown away in the test, but all of the contents remained within the area of the confines of the package. Consideration should be given as to what level of blast pressure might be deemed a hazardous effect, and how to measure that.* • *A flash or flame capable of igniting an adjacent material such as a sheet of 80 ± 3 g/m² paper at a distance of 25 cm from the package. I'm not comfortable with "capable of". Why not just require that piece of paper as part of the test equipment and the criteria is that it doesn't ignite?* • *Eliminate the witness plate criterion. Why is a steel witness plate needed. Shouldn't you be able to determine whether effects are contained in the shipping container by a post test evaluation of the container itself?* • *1) It is unclear as to how to classify something in which the tape on the packaging breaks.* *2) "Disruption of the package"- Any blast effects that compromises the integrity of the package should also be a basis for failure in the test.*	13 72%	5 28%

Questions	Yes	No
3) Specify that the fire effects at 25 cm are due to reaction of the substance / article, not due to a burning package. • *A relatively violent explosion can blow the packaging apart without producing inert projectiles and without scattering the "explosive contents". It could be argued that the result is 1.4S. The wording should be modified if the packaging should stay intact for the sample to be considered 1.4S.* *It would be helpful if the document made it clear that reactions that lead to slow quiet burning of a package were not acceptable.* • *1. 16.7.1.4(a) - denting should be defined more clearly (is a scratch a dent?).* *2. 16.7.1.4(b) - how does one determine if a flash or flame is capable of igniting a sheet of paper?* *3. 16.7.1.4(c) - disruption of the package is not clear. In the example of an electric detonator in 16.7.1.5 the reaction caused the box to break open and release some of the assemblies, yet that product was classified as 1.4S. Based on 16.7.1.4(c) the results seem to clearly eliminate the product from 1.4S. The example is in conflict with the stated criteria.*		

10. Use the space below to provide any other comments about the 6(d) test.

- *The only seriously bad thing about this test was the way the CAs applied it without adequate thought to the consequences.*
- *Good examples would be nice with the 6(a), (b), and (c) tests. Similar to the kind given on the 6(d).*
- *I have the following remarks / questions:*
  - *In all test series: what is mild steel? Is this a specification and do we have the same understanding about this stell all over the world?*
  - *Tolerances need not be specified, see also international agreements about this.*
  - *Test series 6(b): "surrounded by 1 m of confining material." At what distance to the munitions and what material shall be used???*
  - *Test series 6(c): what fuel shall be used, what is the minimum temperature to de*

Questions	Yes	No

obtained, if nothing happens within 30 minutes, how long do we have to continue the test, who decides this??? At what distance are the witness screens??? What is with Hazard Division 1.3: any fiery projection??? With the definition of HD 1.4 from MP20-21 (national Netherlands regulation (EdJ)) and AATSP-1 (NATO publication (EdJ)) I have a different felling then the reactions described.

- *I am missing test series 6(e) for some UN numbers (pyrotechnic articles) for determining HD 1.4S or does this merge with 6(d)??*
- *Are we going to change AASTP-3???? Or do we refer in STANAG 4123 to the orange book??*

- *It is completely unclear and seemingly illogical why there are now two sets of criteria for 1.4S, with one of those sets only applying to a handful of articles based on which UN number they are assigned. The tendency now might be to shy away from using those unlucky "special" UN numbers when another suits the purpose as well.*

  Was the driver of the relatively new 6d test concern about 1.4S articles being allowed on passenger aircraft? Why not be equally stringent in assigning 1.4S to all articles?... Only one set of criteria, regardless of UN number, for 1.4S would make much more sense. And the preference would be to do unconfined 6d testing over confined 6a trials, because in both you should be investigating the reactions of smaller less-violent articles (not 1.1), and the benefit provided by no confinement is very helpful in viewing actual effects external to the packaging.

- *Inclusion for group S requires that all effects remain confined within the package, if required effects are demonstrated in 6(a), why can't this test be waived? both test seem to be testing the same theory.*

  Special provision 347, how can SP347 apply to 6(d) if SP347 states to use results from test 6(d)?

- *When developed, this seemed to be a simple test to apply. In reality, its application is not straightforward. Products that were unquestionably classified as 1.4S unexpectedly fail the test.*

  Consideration should also be give to a similar test to better determine products' suitability for assignment to 1.4D. In general, 1.4D products should not produce an air blast not greater that the equivalent of the detonation of [100±??] g of PETN in free air.

- *1. This test is applied only to a select, small number of products. It should apply to all products under consideration for 1.4S.*

Questions	Yes	No
2. Consideration should be given to broadening this test to determine the hazardous effects outside the package arising from accidental ignition or initiation of the contents, with testing being done by a method that simulates actual accident scenarios. This should replace determination of mass detonation as a criteria for Test Series 6. Whether or not a product mass detonates does not necessarily relate to the hazard level, and can be misleading. For example, two large devices packaged together may not mass detonate, yet the hazard level of one initiating might be severe. Alternately, some small devices may mass detonate yet pose only a very small hazard level. The current system does not distinguish between them.		