UNITED
NATIONS

ST

Secretariat

Distr.
GENERAL

ST/SG/AC.10/C.3/1997/19
23 April 1997

Original: ENGLISH

COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS

Sub-Committee of Experts on the Transport of Dangerous Goods
(Thirteenth session,
Geneva, 7-17 July 1997,
agenda item (4(a))

DRAFT AMENDMENTS TO PART 1 OF THE MANUAL OF TESTS AND CRITERIA

Test 6(c)

Revised criteria for the UN 6(c) test

Transmitted by the Expert from the United States of America

1. At its nineteenth session, the Committee agreed that discussion on revising UN Test 6(c) should continue into the 1997-98 biennium. The expert from Canada agreed to coordinate those tasks identified by the informal working group that met in Orlando, Florida in document ST/SG/AC.10/R.556. The expert from the United States of America expressed the concern that carrying out the tasks listed in section 15 of -/R.556 was an ambitious program which could lead to prolonged discussions without significant results. Several experts also shared this view.

2. In order to facilitate the discussion, with the aim of achieving practical and meaningful revisions of the UN 6(c) test, without significantly revising the results of the test, the expert from the United States of America considers it necessary to have a base document providing specific proposals for the Sub-Committee in July 1997. This proposal is based on earlier papers, ST/SG/AC.10/C.3/R.641 and -/R.641 Add. 1, which made specific proposals on revised criteria for projection and thermal hazards for the UN 6(c) test. This proposal also takes into account comments made by the informal Florida meeting.

PROJECTION CRITERIA

3. The expert from the United States of America is still of the opinion that projection hazards should be evaluated solely on the basis of effects to standardized witness screens. As explained in -/R.641, criteria based on different projection weights and distances are not practical. As an example, a 10 gram fragment having an energy of 20 Joules could be projected a distance of 400 m. A classification based on finding (or not finding) such a small fragment in a circular area having a diameter of 800 m (½ mile) would be highly suspect and impossible to defend if seriously challenged. On the other hand, witness screen damage is easily observed and quantifiable to a degree of precision necessary for acceptable pass-fail criteria.

Some will argue that witness screen damage is not a simple function of fragment energy but depends on witness screen material, fragment size, shape, etc. This is true and is borne out by recent Canadian research summarized in ST/SG/AC.10/C.3/R.602/Add., Add.2 and Add.3. Nevertheless, there is sufficient information already available to specify a witness screen material and calibration procedure that would allow for conservative estimates of fragment hazards to humans.

4. The expert from the United States of America maintains that the use of 2024-T3 aluminum is still reasonable and recommends that a projection energy level of about 20 Joule corresponding to a 1.75 mm indentation in 2024-T3 aluminum be the upper limit for Division 1.4S since it would preserve the existing 1.4S classification for small arms ammunitions. Since it is generally agreed that Division 1.4 fires would only be fought by fully equipped firemen, a 60-65 Joule level is a reasonable criterion for delineating between Division 1.4 and 1.2. This energy level corresponds to a fracture in 2024-T3 aluminum. An energy level below about 7 Joule, corresponding to an indentation of about 0.5 mm in 2024-T3 aluminum screen, represents so slight a hazard as to warrant possible exclusion from Class 1.

PROPOSAL:

5. On the basis of these considerations it is recommended that the projection hazard criteria of Test 6(c) be revised along the following lines:

.1 That witness screen response be used as the sole means of defining projection hazards;

.2 That 2 mm thick ASTM 2024-T3 aluminum be used as the recommended witness screen material;

.3 That any indentation in the witness screen deep enough to produce fracture be considered indicative of Division 1.2 behavior;

.4 That any indentation in the witness screen deeper than 1.75 mm but with no fracture of the witness screen be considered indicative of Division 1.4 behavior;

.5 That an indentation in the witness screen of a depth greater than 0.5mm and less than or equal to 1.75 mm be considered indicative of Division 1.4S behavior; and

.6 That indentation in the witness screen of 0.5 mm or less, be considered indicative of no projection hazard.

THERMAL EFFECTS CRITERIA

6. The concept of using burning time measurements as an alternative to thermal flux measurements was also put forth in -/R.641 and -/R.641 Add. 1. While some concern over the relatively low heat of combustion (1,000 cal/g) used in calculating the burning time equivalent (12.2 second) of the current thermal criterion of 4 kw/m^2 at 15 m was expressed at the Florida meeting, the expert from the United States of America believes that the computational scheme outlined in -/R.641 Add.1 is still valid and would produce reasonable results with substances having heats of combustion greater than 1,000 cal/g. For example, for substances having heats of combustion ranging from 2,000 to 3,000 cal/g, the burning time equivalent of 4 kw/m^2 would scale to burning times ranging from 24.4 to 36.6 seconds. Since the submission of -/R.641 Add.1, some additional data on burning propellants has been obtained that strongly supports the idea of using burning time as an alternative to thermal flux measurements in UN Test 6(c) (see Annex 1). Taking into account the additional test data and comments raised at the Florida meeting, a burning time of 37 seconds is now proposed. The value of 37 seconds is based on an assumed heat of combustion of 3,000 cal/g and may be corrected if the true heat of combustion is significantly different.

PROPOSAL:

7. On this basis, it is recommended that the criteria for Division 1.3 substances and articles be revised as follows:

.1 A fireball (definition given in Annex 2) which extends beyond any of the three witness screens;

.2 A jet of flame which extends more than 3 meters from the flame of the fire; or

.3 The burning time of the product is measured to be less than 37 seconds for 100 kg net weight scaled on the basis of $(mass)^{1/3}$. (Note: The value of 37 seconds is based on an assumed heat of combustion of 3,000 cal/g and may be corrected if the true heat of combustion is significantly different).

ANNEX 1

Since the submission of -/R.641 Add. 1, some additional data has been obtained on the thermal flux from burning propellants (1). It seems worthwhile to review this data in terms of the simplified computational scheme presented in -/R.641 Add. 1. The data on the two military propellants are especially amenable to this treatment since the heats of combustion are given. The following table provides burning times and thermal flux measurements for these two propellants from reference (1) along with calculated values of thermal flux using the method outlined in -/R.641 Add. 1.

PROPELLANT		WEIGHT (kg)	BURN TIME (seconds)	MEASURED THERMAL FLUX* (kw/m^2)	CALCULATED FLUX** (kw/m^2)
TYPE	Heat of Combustion				
MR-5010	2,402 k cal/g	45.4	20	2.0	2.64
		90.7	35	2.3	3.01
		181.4	72	2.1	2.91
M1-8-SP	2,727 k cal/g	49.9	15	4.6	4.42
		99.8	28	4.9	4.73
		199.6	52	4.6	5.08

* *5 second averages reduced to 15 m.*
** *Calculated using the method outlined in -/R.641 Add 1 and the quoted values of heats of combustion.*

* * * * *

As can be seen the calculated values of thermal flux agree with the measured values. In view of the fact that the current UN criterion of 4 kw/m^2 at 15 m is somewhat arbitrary to begin with, we can see no reason why complicated thermal flux measurements should not be replaced by simple burn time measurements.

References:

1. Scaling Studies of Thermal Radiation Flux from Burning Propellants, J. Edmund Hay and R. W. Watson presented at the Twenty-fifth DoD Explosive Safety Seminar, CA, 8/18 -8/20/92.

ANNEX 2

DEFINITION FOR FIREBALL

Incandescent sphere of hot mass formed as a result of a detonation, deflagration, or burning of explosives which radiates part of its energy away as thermal radiation (to include visible light). The fireball boundary is identified by a marked decrease in the intensity of the visible radiating reactants and products. Inside the fireball volume, combustibles may be ignited by conduction, convection, and radiation from the surrounding hot reactants and products. Beyond the fireball surface, nearby unshielded combustibles are generally only at risk of ignition by radiation.