

**Committee of Experts on the Transport of Dangerous Goods  
and on the Globally Harmonized System of Classification  
and Labelling of Chemicals**

23 June 2016

**Sub-Committee of Experts on the Transport of Dangerous Goods**

**Forty-ninth session**

Geneva, 27 June – 6 July 2016

Item 2 (c) of the provisional agenda

**Explosives and related matters: review of tests in parts I and II of the Manual of Tests  
and Criteria**

**On the use of the minimum burning pressure test – Test  
Series 8: Tests for “ammonium nitrate emulsion or  
suspension or gel, intermediate for blasting explosives  
(ANE)”**

**First report on progress – Informal Correspondence Group**

**Transmitted by the expert from Canada**

**Introduction**

1. At the forty-eight session Canada submitted a proposal on the use of the minimum burning pressure (MBP) test as a replacement for some of the Series 8 Tests ST/SG/AC.10/C.3/2015/41. Several members of the Explosives Working Group commented that the MBP test could be useful as a possible additional or alternative test. The expert from Canada proposed to establish an informal correspondence group (ICG) to amend the informal document INF.53 (48<sup>th</sup> session).
2. The proposal on the use of the MBP test is being made to help address the considerable dissatisfaction with some of the current Series 8 Tests for ANEs. Test Series 8 (a, b, and c) were initially adopted for ANEs in 2003 into the UN MTC fourth revised edition; these tests existed for other classes and were adopted for ANEs based on limited testing.
3. The Koenen test (8(c)), which is being conducted under significant confinement relative to transport conditions, attempts to assess fire hazards but it does not work well for ANEs, in part because the orifice often becomes blocked with sample during testing. The Koenen test results are based on how the tube fractures or fragments when the substance reacts, which can be after a lengthy period of time for ANEs that contain relatively high water content as opposed to ANEs with lesser water; this may lead to misleading results that can be both false positive and false negative results. For high water content formulation, due to the lengthy process the ANE being tested segregates / water evaporates / Koenen tube weakens as it is being exposed to high heat, and it can result in a positive result even though the high water content is a significant contributing factor to make an ANE insensitive; the test conditions in such cases do not represent well real-life conditions where ANEs in MPUs or tanks are closed systems, that would not allow product

segregation nor water evaporation, with minimal confinement contrarily to Koenen test conditions. Conversely, more reactive ANEs being assessed in a Koenen test may start to react more rapidly than formulations with high water content, and have been shown to allow product to be partially expelled from the Koenen apparatus prior to having main reaction resulting in a false negative result as a result of having lesser material involved when the tube is being split/fragmented. From the recent report of the Working Group on Explosives of the 47th session of the Sub-Committee (informal document INF.53 (47<sup>th</sup> session)) there was a general consensus that the Koenen test is not suitable for evaluating ANEs and that research into what test might be a suitable replacement should be considered. Thus, a repeatable, small-scale test that could assess the hazards posed by exposure of ANEs to fire is highly desirable.

4. The Vented Pipe Test (8(d)), which also attempts to assess fire hazards, requires large test facilities due to the possibility of explosion of the large mass of sample tested (>40 kg) and its repeatability is poor.

5. The MBP test measures the Burning Pressure of an ANE through a localized thermal ignition event, ensuring it is readily ignited while the ANE is in its form as when being transported in tanks; whereas both the Koenen as well as the VPT tests have external heat sources that are also leading to thermal ignition events, but that are occurring over a lengthier period of time since it is an external heat source being applied to ANEs, that are poor heat conductors, that leads to a thermal ignition event. The lengthy period of time allows segregation/expulsion to occur in a manner that can be argued as not representative of transport conditions and potential incidents; both the Koenen and VPT tests allow segregation/expulsion to occur, which is less likely to occur at a much larger scale as for transport conditions in large closed tanks that are designed for providing minimal confinement. The MBP test measures a basic property of the substance being the pressure required for the substance to undergo self-sustained burning, and this is indicative of the potential for deflagration of an ANE when subject to a fire. The Koenen and VPT tests differ from MBP test in terms of methodologies for assessing the potential mass explosion hazard leading to a transport classification, making it challenging to generate comparative results between them, especially that the Koenen and VPT tests are deemed as being not suitable for ANEs.

6. The expert from Canada established the ICG in January which includes 7 CAs and 4 NGOs, and presented outcomes at the IGUS-EPP and CIE conference held in Bern (April, 2016) for further progressing the proposal if deemed appropriate, or explore alternatives. This informal paper is reporting on the progress that has been achieved.

## **First Report on Progress**

7. Three work streams (WS) were initially proposed:
- WS #1: How to include MBP as part of TS 8 (c)
    - Should MBP be a replacement or an alternative to 8 (c) Koenen test?
    - Should either test be a preferred test?
    - Any other suggestion? (e.g. sequential)
  - WS #2: MBP Criteria to determine the suitability of a candidate ANE to be classified in Division 5.1
    - Would you agree with this criterion of 5.6 MPa?

- Would you have test results additional to those presented in above paper (or from prior CERL reports)?
  - Would you want to suggest a different criterion, supported by a rationale?
  - WS #3: should MBP be proposed as an alternative or replacement to 8 (d) Vented pipe
8. Initial outcomes were as follows:
- Re WS #1: How to include MBP as part of TS 8 (c)
    - Preference is to add MBP as an alternative test
    - Some commented that some correlation between MBP and Koenen results should be provided
  - Re WS #2: MBP Criteria to determine the suitability of a candidate ANE to be classified in Division 5.1
    - Agreement with criteria was established, with a recommendation to add the value in square brackets
    - Some commented as having no experience to make a recommendation
  - Re WS #3: should MBP be proposed as an alternative or replacement to 8 (d) Vented pipe
    - Some supported MBP as an alternative
    - Others sought correlation to be made between MBP and VPT
9. The outcomes of the ICG were presented and discussed at the joint IGUS-EPP and 16<sup>th</sup> Conference of CIEs. An extensive discussion occurred amongst participants on this topic. Some of the additional comments received were as follows:
- Additional examples were provided on false positive and false negative results obtained with the Koenen test for ANEs e.g.:
    - false positives were associated with use of waste oil
    - false negatives occur with ANE sensitized with glass microballoons
  - Additional comments were made to compare MBP results to Koenen
  - MBP doesn't measure susceptibility to heat, but the susceptibility to burning
  - VPT more likely to give a positive with very stable emulsifiers
10. The expert from Spain provided a test report from Maxam (UN/SCETDG/49/INF.34) that includes additional MBP test results, specific to ANEs that are emulsions, at elevated temperatures. A similar study was conducted in 2013 and published by CERL as follows:
- S. Goldthorp, C.M Badeen, R. Turcotte, C. Iyogun, and S.K. Chan, 'Influence of Elevated Temperature on the Minimum Burning Pressures of Ammonium Nitrate Emulsions', CERL Report 2013-06, April 10, 2013*

## Next Steps

11. It is proposed to discuss the information contained in this Informal Paper with the Explosives Working Group for seeking guidance prior to submit a revised proposal on the use of the minimum burning pressure test in Test Series 8, if deemed appropriate. Guidance will also be sought for future experimental work that would help resolve the current shortfalls of the Koenen test when it is being used for classification purposes of ANEs. Further work through the ICG is also foreseen.

---