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

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Sub-Committee of Experts on the Transport of Dangerous Goods

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Item 2 of the provisional agenda
Explosives and related matters

Report of the Working Group on Explosives

Transmitted by the Chair of the Working Group

Introduction

1. The working group met from 3 – 6 July 2023 in a parallel session to the plenary meeting of the Sub-Committee of Experts on the Transport of Dangerous Goods. This meeting of the working group was well attended, with 36 experts in attendance from Belgium, Canada, China, France, Germany, Japan, Netherlands, Republic of Korea, Spain, Sweden, United Kingdom, United States of America, Australasian Explosives Industry Safety Group (AEISG), Council on Safe Transportation of Hazardous Articles (COSTHA), European Chemical Industry Council (CEFIC), Institute of Makers of Explosives (IME), Responsible Packaging Management Association of South Africa (RPMASA), and Sporting Arms and Ammunition Manufacturers' Institute (SAAMI). Annex 1 of this report provides a list of participants. The group was tasked to discuss technical matters related to official papers and to discuss informal papers as time allowed. Mr. Ed de Jong (Netherlands) served as chair of the working group, and Dr. Joshua Hoffman (IME) as secretariat.

2. Throughout this report, the following abbreviations may be used:

- DGL – Dangerous Goods List
- EWG – Working Group on Explosives
- GHS – Globally Harmonized System
- ICG – Informal Correspondence Group
- UNMR – United Nations Model Regulations
- MTC – Manual of Tests and Criteria
- TDG – Transport of Dangerous Goods

3. As described below, the following documents identified in agenda items 2 and 6 of the revised provisional agenda for the 62nd session[1] were considered for discussion.

[1] ST/SG/AC.10/C.3/123/Add.1.

Document	Title	Paragraph
Agenda Item 2(a)	Review of Test Series 6	
ST/SG/AC.10/C.3/2023/26 (COSTHA, SAAMI), UN/SCETDG/62.INF.25 (SAAMI), UN/SCETDG/62.INF.27 (SAAMI), UN/SCETDG/62/INF.31 (COSTHA), UN/SCETDG/62/INF.32 (COSTHA, SAAMI)	Research in relation to exit from Class 1 and test 6 (d)	5
Agenda Item 2(b)	Improvement of Test Series 8	
UN/SCETDG/62/INF.10 (RPMASA), UN/SCETDG/62/INF.37 (IME)	Further validation of test series 8: applicability of test series 8 (d) Response to informal document UN/SCETDG/62/INF.10	6, 8
Agenda Item 2(c)	Review of tests in parts I, II and III of the Manual of Tests and Criteria	
UN/SCETDG/62/INF.36 (UK, USA)	Explosive Working Group Koenen tube round-robin initial test results	7
Agenda Item 2(d)	"UN" standard detonators	
No document		
Agenda Item 2(e)	Energetic samples	
No document		
Agenda Item 2(f)	Review of packaging and transport requirements for ammonium nitrate emulsions	
ST/SG/AC.10/C.3/2023/16 (IME)	Proposal to remove the requirement of test series 8(d) for assessing the suitability of ammonium nitrate emulsions for transport in portable tanks	8
Agenda Item 2(g)	Electrification and alternative fuels and how they will affect transport of explosives	
No document		
Agenda Item 2(h)	Miscellaneous	
ST/SG/AC.10/C.3/2023/6 (China)	Amendment to section 51.4.4.2 (e) of the Manual of Tests and Criteria	9
ST/SG/AC.10/C.3/2023/12 (Sweden)	Amendment of definition "explosive or pyrotechnic effect"	10
ST/SG/AC.10/C.3/2023/17 (AEISG), UN/SCETDG/62/INF.28 (SAAMI)	Consideration of amendments to chapter 2.17 (Desensitized explosives) of the Globally Harmonized System and section 51 of the Manual of Tests and Criteria	11
ST/SG/AC.10/C.3/2023/18 (AEISG)	Proposal to amend the definition for Class 1 explosives	12
ST/SG/AC.10/C.3/2023/19 (AEISG), UN/SCETDG/62/INF.19 (Sweden)	Proposal to extend the entry for UN 3375 to provide for all potential packing groups	13
ST/SG/AC.10/C.3/2023/25 (SAAMI)	Packing instruction P130 and metal on metal contact between explosives and packaging	14
UN/SCEDTDG/62/INF.3 CEFIC	Polymerizing substances and Self Acceleration Polymerization Temperature	15
UN/SCETDG/62/INF.5 (Chair of the Working group on explosives)	Report of the intersessional correspondence group on fireworks	16

Document	Title	Paragraph
UN/SCETDG/62/INF.29 (USA)	Termination of certain explosive classification approvals due to the Model Regulation Test Series 6(d) requirement	17
UN/SCETDG/62/INF.35 (China)	New special provision and special packing provision of UN 2029	18
UN/SCETDG/62/INF.39 (COSTHA)	Introduction of Division 1.4 Entry for QDO	19
Agenda Item 6(d)	Miscellaneous proposals for amendments to the Model Regulations on the Transport of Dangerous Goods - Other miscellaneous proposals	
ST/SG/AC.10/C.3/2023/2 (Spain)	Units of measurement	20

4. There are two annexes to this report:

- Annex 1 – List of Participants
- Annex 2 – Recommended Changes for the Model Regulations (23rd Revised Edition)

Agenda Item 2(a) – Review of Test Series 6

5. **Subject.** Research in relation to exit from Class 1 and test 6 (d)

Document: *ST/SG/AC.10/C.3/2023/26 (COSTHA, SAAMI)*

Informal document: *UN/SCETD/62.INF.25 (SAAMI), UN/SCETD/62.INF.27 (SAAMI), UN/SCETDG/62/INF.31 (COSTHA), UN/SCETDG/62/INF.32 (COSTHA, SAAMI)*

Discussion: SAAMI introduced its 2023/26 paper which was a statement of intention to transmit additional informal papers containing testing and research on two distinct areas of exit from Class 1 for certain very low-hazard explosives and evaluation of hazardous effects in test 6 (d). These informal papers were introduced and discussed.

SAAMI began with INF.27, which reminded the EWG of the work of the 6d-ICG since 2019 and contained test data to facilitate discussion on whether the fourth criterion of Test 6(d) assesses any effects or *hazardous* effects 'emphasis added.' The fourth criterion is "A projection which passes completely through the packaging (a projection or fragment retained or stuck in the wall of the packaging is considered non-hazardous)." Central to SAAMI's case was whether the test currently assesses only "hazardous effects" per its stated intent or whether the test criteria assess any effect, including non-hazardous effects.

The paper presented information on a projection's, specifically small arms projectiles, kinetic energy calculated from high-speed video. The purpose was to inform a discussion on whether these effects should be considered hazardous. The test setup was modified to present the greatest likelihood of projectiles escaping the package, and the results were presented.

Belgium enquired why the kinetic energies of unimpeded rounds were not measured. SAAMI responded that while that testing has been conducted, it would not represent the reduced energies of projectiles having penetrated packaging. Germany noted its past testing and research to contain all effects within the packaging, even for very small amounts of energetics. As Germany holds that to be the requirement for 1.4S classification, it questioned why effects are now being asked to be permissible. The United Kingdom also suggested that developing a criterion that readily and robustly addresses the potential for harm for the full range of articles potentially classified as 1.4S and subject to the special provision could be very challenging if there were not to be inconsistencies in interpretations by different Competent Authorities. The United Kingdom also pointed out that in general across the wider explosives sector it is often easier to categorize no harm than to precisely define conditions that would result in a particular level of harm.

The USA noted several challenges with testing for kinetic energy with instrumentation such as high-speed cameras. Further, it questioned the reproducibility of the provided data given its scatter and pointed out that the shape, sharpness, and hardness of the projectile are also important, not just its kinetic energy. SAAMI responded that these tests aimed to inform the EWG of the relative energies expected from these types of projectiles rather than as a recommended test setup for classification purposes, and that scatter in this type of data is to be expected. The United Kingdom voiced that the practicality and ease of conducting a test should be considered.

COSTHA enquired as to what the expected change might be, and SAMMI responded that it did not believe the current criteria are consistent with the stated objective of the tests and asked the EWG's members its opinion on if an injury no more significant than a first aid injury could be allowable. The Chair asked the group if a first aid injury is an acceptable injury threshold. USA noted that any conservatism in the current criteria brings a high degree of certainty in the safety communicated by being classified as 1.4S. Sweden conveyed that the question of what effects of a projectile are considered hazardous is very challenging as attempts to properly define it are very difficult, and measuring is also complicated as opposed to the current unambiguous criteria. SAAMI responded that the current classification regime is causing hurdles to commerce. AEISG agreed with perceived inconsistencies between the stated intention of the 6(d) test and its criteria. SAAMI voiced that the judgment imparted by competent authorities can become inconsistent without clear criteria. The USA held that any projection effect is considered hazardous with the current criteria.

Germany pointed out that the 6(d) test was developed and proposed by the EWG with specific articles in mind. Belgium noted that this issue seems to only be with small arms cartridges as part of the use of limited quantity exemption and suggested that provisions for just these articles could be developed, and the group briefly discussed hypothetical criteria. The United Kingdom asked what is meant by first aid injury and to what degree or quantity of said injury is believed to be acceptable.

SAAMI continued with INF.25, which contained testing data for unpackaged bonfire tests and the exclusion test in 2.1.3.6.4 of the UNMR to support the addition of different criteria for these existing tests to manage the exit of these very low-hazard energetic articles from Class 1 while retaining them in the dangerous goods system. These tests were on power loads (UN 0014 for tools), blanks (UN 0014 for signal guns), and empty primed cases (UN 0055).

COSTHA introduced INF.31 paper on electro-explosive devices (EED) and their probability of unintended activation by electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD). These devices are designed for harsh conditions and constructions to high standards. The authors searched SAFEX, US Databases, and public sources and found no incidents in transportation connected to EMI, RFI, or ESD in the past 30 years.

AEISG and Germany sought clarification on which devices are being considered with this paper and the intended outcome of this work. SAAMI responded that the goal is to exit from Class 1 into Class 9 through modified testing. Further, past exits from Class 1 to Class 9, such as airbags and other safety devices, have been policy-driven, and there is a need for a standardized system to characterize conditions for exit. USA raised the history of airbags which began with devices operated primarily with compressed gases and eventually energetics, which caused issues with established practices for the original technology that had been classed in Division 2.2. The USA stated that in Class 1 some risk based assessment is already used such as for 1.5 blasting agents or 1.6 insensitive munitions, neither of which justifies exclusion from the entire class and further stated that accidents happen when it is assumed there are no credible initiation pathways. The United Kingdom echoed the USA's comments on likelihood.

Germany voiced that security considerations should be considered as well for potential misuse. The importance of security was also supported by the United Kingdom both in transport and because other legal authorities look to classification for how to handle articles and substances in their jurisdictions. The United Kingdom noted that ESD is often blamed for incidents, and while that may not always be the case, there are instances where it is the root cause. Regarding security, Sweden noted that detonators are hard to acquire in Europe and questioned why another potential initiation source for malicious activity should be made easier to obtain. SAAMI responded that

security is already incorporated into the proposal, and that devices that detonate and disintegrate have already been proposed to be noneligible.

Sweden supported the principle of a general systematic and scientific approach for considering exclusions rather than case-by-case policy decisions. Still, it did not understand the relevance of the tests in the paper as the current classification regime does not consider these initiation routes. Further, probability and therefore risk is not considered, only hazards.

COSTHA asked for clarification on what the Group considers in the realm of Security and added that societal needs are also an important consideration. IME commented that security considerations for devices or substances that can be used maliciously are ease of use and ease of access, which is Class independent. COSTHA noted that shunting/shorting clips were required on inflators, but they were proved, over time, not to be required; however, the notion of their need persists and that a standardized regime for seeking exclusion from Class 1 would benefit the industry. COSTHA recognized the security concern for devices when excluded from Class 1. However, import and customs authorities and insurers see 1.4S as simply explosives and are apprehensive about dealing with those materials.

The United Kingdom voiced that the challenges being presented are not purely technical and, therefore, it is unlikely that the EWG would be able to come to a consensus on how to exclude articles from class 1 that do not meet the existing exclusion criteria without a clear direction and scope from policymakers. These are decisions to be set by policymakers. Germany noted that it could not solve the problem with insurers or authorities, and to allow substances or articles in Class 9 is problematic since Class 9 items have been seen to of been handled without real consideration or communication of the hazards present.

The Chairman concluded that this is good information, but the Sub-Committee of Experts on the Transport of Dangerous Goods should be the body that decides if a type of device should be considered for exit.

COSTHA then introduced INF.32 detailing the testing of igniters common to the commercial pyrotechnic industry that are currently classed as explosives to present test data that competent authorities would utilize and interpret to determine exclusion or not.

USA pointed out that the report has definitive statements regarding the items meeting exclusion requirements when the competent authority makes that determination, and stated its view that the matches fail the rupture criteria and questioned the ability to accurately measure the temperature profiles of rapid open flame events. On this particular article type, the USA discussed electric match igniters with other Competent Authorities to verify how they interpret the exclusion criteria and ensure a harmonized approach.

AEISG noted that there seems to be a disconnect between classification and regulation, with regulation often excluding specific articles and making exceptions despite their classification. The Netherlands asked for clarification on the purpose of this paper, and COSTHA responded that its purpose was to provide exemplar data on commonly used products in the fireworks industry to illustrate how differing interpretations could be made.

Conclusion: Regarding INF.27, the group was undecided on whether a first aid injury would be acceptable for 1.4S. The EWG listened to the presentation on INF.25 and discussed it, but the group had no proposal to consider. On INF.31, the EWG concluded that risk is not the paramount consideration in transport regulations; however, classification does consider risk to some extent. While some authorities might view safety devices as a security risk, a systematic way of weighing those risks against societal benefits does not exist.

Agenda Item 2(b) – Improvements to Test Series 8

6. **Subject.** Further validation of test series 8: applicability of test series 8 (d)

Document: *None submitted*

Informal document: *UN/SCETDG/62/INF.10 (RPMASA), UN/SCETDG/62/INF.37 (IME)*

Discussion: These papers were taken up during the discussions on 2023/16. See paragraph 8.

Conclusion: See paragraph 8.

Agenda Item 2(c) – Review of tests in parts, I, II and III of the Manual of Tests and Criteria

7. **Subject.** Explosive Working Group Koenen tube round-robin initial test results (UK, USA)

Document: *None submitted.*

Informal document: *UN/SCETDG/62/INF.36 (UK, USA)*

Discussion: USA introduced the paper, which provided updates on the work of the round-robin testing of Koenen tubes. The EWG was reminded of the past work and events leading to the round-robin testing. The experimental design was explained, and data was provided on the testing conducted to date, including the quasi-static bursting pressure results from the various tubes by a third-party lab and the limiting diameter results for the selected standard UN substances obtained to date from each of the 13 participating parties. Germany stated that they are working to provide their test procedure for determining the quasi-static burst pressure to the round-robin lead. Upon receipt of the German procedure, the current procedure will be adjusted if needed and the remaining tubes will be tested.

CEFIC noted that this study was discussed at the recent International Group of Experts on the Explosion Risks of Unstable Substances-Energetic and Oxidizing Substances working group meeting in Washington, D.C., USA. At this meeting, the group showed interest in this work and may wish the round-robin study to be amended to include a substance relevant to that group.

The group discussed the preliminary results, in general, but did not seek to reach any conclusions since all testing is not complete. Germany voiced that perhaps the bursting pressure is not the most crucial factor that governs the results. The Netherlands commented on how the fragment size and quantity of the ruptured tube are important in interpreting test results. It was noted that the dimensions of all present-day tubes do not fully meet the specification of current UN Manual.

Conclusion: There was unanimous consent that this is valid work and should continue. Toward this, Germany will finalize its review of the current quasi-static burst pressure procedure, the remaining quasi-static burst pressure tests will be performed, the labs that have not completed the round-robin tests will do so, and the NOURYON laboratory in the Netherlands will develop a test matrix for diluted quantities of tert-Butyl peroxybenzoate.

Agenda Item 2(f) – Review of packaging and transport requirements for ammonium nitrate emulsions

8. **Subject.** Proposal to remove the requirement of test series 8(d) for assessing the suitability of ammonium nitrate emulsions for transport in portable tanks

Document: *ST/SG/AC.10/C.3/2023/16 (IME)*

Informal document: *UN/SCETDG/62/INF.10 (RPMASA), UN/SCETDG/62/INF.37 (IME)*

Discussion: IME introduced 2023/16, which continued work toward a proposal that Ammonium Nitrate Emulsions (ANEs) that satisfy the acceptance criteria of the 8(e) test should not need to be subjected to the 8(d) test and should be considered suitable for containment in portable tanks. IME presented a slideshow covering the history of the 8(d) test, ANE transport events, computational modeling of ANE, and comparisons between ANE and AN, and began with a question of why does

AN solid not require a bulk thermal test in addition to TS2, adding that this is not an advocacy for such a test. The parallel was drawn since AN is the active ingredient in ANE.

Members of the EWG had questions about the October 2022 incident in Western Australia involving ANE; however, the answers were yet unknown as the report from the investigation has not been released. AEISG questioned what the Western Australia event does to confidence in the 8(d) test. Canada voiced that perhaps an alternative test is better rather than saying the current 8(d) test is irrelevant. Germany noted that with a wide variety of ANE formulations, it is good that each is currently subjected to the Vented Pipe Test. Further, thermal calorimetry studies of different formulations to better understand the relationship between individual ingredients would be useful.

The USA stated it continued to have questions regarding the Minimum Burning Pressure test since the minimum burning pressure is temperature dependent, emulsions are sometimes transported at elevated temperatures, and there are questions on the extent to which external heating can further raise temperatures. The USA also said there are too many unknowns regarding the Western Australia event to make definitive conclusions about the usefulness of the 8(d) test, to indicate a likelihood for detonation in a fire. Whether or not an ANE detonates in a fire event appears to depend on the fire's intensity and duration. This is a reason to evaluate what assumptions are built into testing and their criteria to ensure they represent current and emerging means of transportation.

The United Kingdom commented that the approach for testing ANEs was developed to seek a reasonable level of confidence in the safe transportation of ANEs, not that they cannot explode in all foreseeable transport incidents. The United Kingdom would like to see validation of the model with larger scale testing and further would like to understand if the modeling and data IME provided could be applied to other ANE formulations bound by SP 309. The Netherlands pointed out that SP 309 was established based on the compositions identified by industry when drafted in 1999. Belgium asked if the modeling showed the minimum heat flux that would lead to decomposition. IME responded that only two heat flux values were modeled: 24 and 80 kW/m^2. Germany responded to the question of why ANE is subjected to 8(d) and Ammonium Nitrate having no similar test with because ANE has both a fuel and an oxidizer.

The group moved on to INF.10, introduced by RPMASA, which also summarized the test data provided in its paper with a slideshow containing videos of the testing. The tests were designed to simulate hot borehole environments because of prior related incidents. The amount of fuel used was to ensure no partial reaction for range safety considerations. Formulations were chosen to be representative of a wide range of formulations. RPMASA's findings were that changes in formulations did affect outcomes, water content did not affect results, and thermal probes showed evidence of high internal convection.

AEISG noted that internal convection is surprising since the transport incidents show crust formation, which conveyance forces would impede. IME responded that this is due to the dimensional configuration of the test, and the convection evident in RPMASA's work is due to large buoyancy effects and high thermal flux due to this configuration in contrast to that of a road tanker. The test pipe's surface area to volume ratio is about four times that of a tanker. IME asked RPMASA how this informed their work on hot boreholes, which was the reason for the tests. RPMASA responded that it intended to use the test as a screener, but the correlation between the fast cook off test and the Vented Pipe Test will allow the use of the Vented Pipe Test as a screener to determine if a product is suitable for use in hot boreholes. Discussions and points raised in INF.37 were included in the above.

Germany, similarly, did not support this proposal as the 8(d) and 8(e) tests measure two different properties. RPMASA echoed this and did not support the proposal. Belgium viewed thermal conductivity as important and wanted to see a measurement of the internal convection or a lack thereof in a test to validate the model and modeling of an 8(d) test. It viewed the modeled heat flux of 24 kW/m^2 as not conservatively high enough nor the model run time long enough. USA does not support the proposal without validation of the model through experimentation; they viewed RPMASA's results as contradictory to the concept that Koenen and VPT are essentially the same test at different scales and said that total fire engulfment of a tanker might be a creditable scenario. The United Kingdom noted that it views IME's work as progressing in the correct direction but

would like to see larger scale validation of the model and sensitivity studies around heat flux before it could support the proposal. Sweden was reluctant to support the proposal without verification through experimentation. Canada questioned the comparison between failures in both Koenen and VPT relied upon in IME's case and suggested edits to the proposal's wording regarding the eligibility criteria for waiving the 8(d) test for ANEs.

IME noted the many recommendations, the desire for testing to validate its model, and opinions about what constitutes an appropriate heat flux. Details for an experimental design need to be agreed upon before IME can commit to testing, and an Informal Correspondence Group was requested to continue this work.

Conclusion: The EWG did not make a recommendation on the proposal and instead supported the establishment of an 8(d)-ICG to continue the work. Germany, RPMASA, USA, Canada, Spain, Belgium, Japan, Sweden, AEISG, CEFIC, and The Netherlands joined the 8(d)-ICG.

Agenda Item 2(h) – Miscellaneous

9. **Subject.** Amendment to section 51.4.4.2 (e) of the Manual of Tests and Criteria

Document: *ST/SG/AC.10/C.3/2023/6 (China)*

Informal document: *No document*

Discussion: China introduced 2023/6, which proposes revising subparagraph 51.4.4.2 (e) in section 51-"Classification procedures, test methods and criteria for desensitized explosives" of the Manual of Tests and Criteria. The current text in 51.4.4.2 (e) is difficult to understand and lacks a definition for $I_{calculated}$ used in the formula in 51.4.4.2 (f).

Belgium agreed with the proposal but had a few suggested edits. Sweden shared that upon review of 51.4.4, the variable "I" is used for different things throughout the section and had several corrections for the section in general. Spain noted they had found similar issues as Sweden.

USA voiced support for the proposal in general, but added there should be additional clarification to ensure consistency in how the total burn time is referenced and defined. It noted it is the beginning of the biennium, and several experts have suggestions and suggested an ICG be established to work through the more extensive corrections. The EWG then kept its discussion only to the section in 2023/6, and the proposal was amended. The United Kingdom suggested the EWG recommend bracketing the proposal, and the EWG agreed.

Conclusion: The EWG agreed, in principle, with the proposal from China and recommended that the proposal, as amended, be placed into square brackets. See Amendment 1 in Annex 2. In their review, further improvements and inconsistencies were identified, which a Burn Rate-ICG will work on, and its findings and suggestions will be considered through subsequent working or informal papers. China will coordinate the Burn Rate-ICG.

10. **Subject.** Amendment of definition "explosive or pyrotechnic effect"

Document: *ST/SG/AC.10/C.3/2023/12 (Sweden)*

Informal document: *None Submitted*

Discussion: Sweden introduced 2023/12. Amendments to the term "*Explosive or pyrotechnic effect"* were adopted by the SCETDG at its sixty-first session and the SCEGHS at its forty-third session in paragraphs 2.1.1.1 (c) of the UNMR and 2.1.1.2.1 (c) of the GHS. However, as adopted, the definition only applies to the specific contexts of paragraphs 2.1.1.1(c) of the UNMR and 2.1.1.2.1(c) of the GHS. The expert from Sweden searched the United Nations Model Regulations, GHS, and MTC for all places where the term "*Explosive or pyrotechnic effect"* appeared to

determine if the adopted definition would cause any issues if applied in those instances. In the expert's opinion, they did not find any cases where there would be unintentional effects.

The paper asks the EWG to consider whether the definition of the term "explosive or pyrotechnic effect" should only be applied in a specific context or if it can be applied throughout the UNMR, GHS, and MTC.

France indicated support for the proposal to remove the limited application of the definition. CEFIC was concerned that if the definition was applied throughout the entirety of all the documents, it cast too broad a definition and would capture many chemical processes and chemicals. Germany voiced that expanding the definition to apply throughout would be too universal as the term is also used in test results in MTC. USA disagreed with Germany interpretation and believes the definition applies in the context in which the term is used in the UNMR. The United Kingdom agreed with the USA that when the term is used, it is related to explosives and desensitized explosives in the UNMR, MTC and GHS. Canada voiced the opinion that any chemical reaction that may produce one of the effects in the definitions does not automatically place a substance or mixture into the class of explosives, but rather one can determine the substance is not, in fact, an explosive.

After additional deliberation, the EWG was divided on opinions. Some felt it would cause the definition to be applied too universally and risks pulling in unintended substances which should not be considered explosives. Others saw the applications in the UNMR, MTC, and GHS only in instances where the term is used in the context of explosives or desensitized explosives.

After review and compilation, Sweden presented the EWG with a list of places where the term appeared in the UNMR, MTC, and GHS. It was decided that the EWG would continue to review the locations where the term is used to determine if it is appropriate in those instances.

Conclusion: Many experts supported this proposal, and some opposed it. However, those opposed were willing to continue the discussion at the next meeting. EWG recommends accepting Proposal 1A in square brackets and continuing the work to review the locations where the term is used to determine if it is appropriate in those instances. See Amendment 2 in Annex 2.

11. **Subject.** Consideration of amendments to chapter 2.17 (Desensitized explosives) of the Globally Harmonized System and section 51 of the Manual of Tests and Criteria

Document: *ST/SG/AC.10/C.3/2023/17 (AEISG)*

Informal document: *UN/SCETDG/62/INF.28 (SAAMI)*

Discussion: AEISG introduced 2023/17, which raised several issues of potential confusion or unintended consequences related to the changes adopted in Chapter 2.17 (Desensitized explosives) of the GHS and to section 51 of the Manual of Tests and Criteria. USA appreciated the clarification from AEISG and stated that in the current GHS scheme the burning rate test overrides Test Series 2 regarding the determination if an explosive is sufficiently desensitized. CEFIC noted that the purpose of the burning rate test in the GHS was intended for storage, not transportation. The group discussed if the burning rate alone, as written, can determine if a substance is an explosive regardless of the results of Test Series 2.

AEISG displayed the decision logic diagram 2.17.1 and called attention to specific language in the diagram: "Not classified as desensitized explosive Classify in accordance with chapter 2.1 "Explosive" and stated this is inconsistent with "NOTE 2.17.2.2: Phlegmatized explosives which do not meet the criteria of 2.17.2.2 should be classified as explosives (see chapter 2.1)." Germany disagreed.

Regarding the proposal in paragraph 14 of 2023/17 to delete the note on nitrocellulose, CEFIC suggested alternatively naming specific known diluents to the note rather than striking it. The United Kingdom stated that while there is confidence in the diluents in the suggested change, the current wording may not ensure future diluents deliver an equivalent level of safety. SAAMI stated

that full deletion of the note would result in unintended consequences. With SAAMI dissenting, the group agreed to recommend that the Proposal in paragraph 14 be accepted.

The group discussed the proposal regarding the burning rate test in paragraph 15 of 2023/17, and no opposition to it was voiced.

SAAMI asked the group's view on it writing a paper on the GHS burning rate test and Test 6(c). AEISG supported the idea but noted that the two sets of criteria would need to be harmonized. USA does not support this concept as the GHS burning rate test was never intended to be used for transport classification. Further the USA stated some jurisdictions do not implement GHS, yet they could be asked to make transport decisions based on the test with uncertainty on whether it represents transport configurations as required in the 6(c) test. Germany noted that in their experience, results are higher in the 6(c), but if those conservative results are acceptable to the tester, then those results could satisfy GHS. The EWG supported a discussion on the matter at future meetings.

SAAMI then asked the EWG what factors needed to be considered to align UNMR with the GHS's de minimis value of 300 J/g, below which a mixture would not be a desensitized explosive. The USA noted it had started a research project to look at the matter and believes an energy content threshold alone is insufficient as it does not account for the separation or stratification of material in transit or consider total volumes being transported. Germany voiced concerns about security considerations.

Conclusion: The EWG did not reach a consensus for a recommendation for the proposal in paragraph 13 of 2023/17. AEISG will take the comments from the EWG and revise its proposal for the next session. The EWG recommended that the proposals in paragraphs 14 and 15 be accepted. See Amendment 3 in Annex 2.

12. **Subject.** Proposal to amend the definition for Class 1 explosives

Document: *ST/SG/AC.10/C.3/2023/18 (AEISG)*

Informal document: *None submitted.*

Discussion: AEISG introduced 2023/18 with a proposal to rectify a potential inconsistency in the treatment of articles too dangerous to transport. The USA had concerns that the amendment could be interpreted to mean the article itself would need to be changed rather than the packaging. AEISG responded that the reader would go to the MTC, which would guide them through that process, which has the option of reworking the packaging. The USA agreed that the testing regime and process are clear and achieve the goal without needing to amend the definition, which does not contain every contingency provided in the MTC. Sweden noted that the word "devices" is used in the definition in GHS, which would require amendment there as well if the word "devices" is deleted. CEFIC voiced support for the proposal. AEISG stressed that the amendment to the definition of Class 1 explosives has no impact on the definition of the Class of explosives in the GHS and the EWG confirmed this.

Conclusion: The majority of the EWG supported the proposal as amended. See Amendment 4 in Annex 2.

13. **Subject.** Proposal to extend the entry for UN 3375 to provide for all potential packing groups

Document: *ST/SG/AC.10/C.3/2023/19 (AEISG)*

Informal document: *UN/SCETDG/62/INF.19 (Sweden)*

Discussion: AEISG introduced 2023/19 and commented on the appropriateness of the O2 and O3 tests despite ANEs being relatively oxygen balanced, however, AEISG was following guidance from the EWG during the 43rd session and further pointed out that the tests conducted do show differences in burning rates between the various ANEs tested. Given the variation in results

amongst the different ANE formulations, a single packing group should be questioned. AEISG clarified that its intention was not to enable ANEs to escape from entry UN 3375 even when the oxidizer tests lead to the conclusion of "not an oxidizer."

Sweden stated that it does not believe a test for oxidizer is appropriate given the oxygen balance and the fact that ANEs have all the ingredients of an explosive, albeit very insensitive. Sweden considers the analogy to AN (UN 1942 and UN 2067) not to be appropriate, since AN is not oxygen balanced. Sweden currently does not support the proposal.

The USA agreed with Sweden that oxidizer tests are not relevant and does not support the proposal to add additional packing groups. USA noted that upon review of historical documents they believe PG II was decided as a default reflecting that ANEs are desensitized explosives. Further, if there was a need to delineate the risks of different ANE formulations, then testing to address the properties of emulsions as desensitized explosives rather than oxidizers would be more appropriate. Germany did not support the proposal in 2023/19 and supported INF.19 and continued that the placement of ANEs into 5.1, while it was not the best place to put it, was the best solution working within the existing system and Ammonium Nitrate, by contrast, is clearly an oxidizer. AEISG voiced the opinion that the original decision for PG II was arbitrary at the time and during the discussion provided additional oxidizer test results which demonstrate differences in ANE behavior.

United Kingdom voiced support for INF.19 and questioned if the oxidizer test can accurately diagnose the differences in formulation. The United Kingdom suggested that should any revised proposal be submitted a more detailed conversation with a packaging expert will be required if appropriate Instructions or SPs are to be specified. AEISG agreed.

AEISG asked for opinions on what a better means of testing would be to distinguish between ANEs. USA stated that this could also mean that ANEs would require additional testing to prove they do not belong in PG I and rather PG II. The USA stated that delineating relative risk of various ANEs may require testing that takes into account both the ANE and the type of tank or configuration e.g. related to how long a tank can subjected to fire before it is a problem. CEFIC commented on the complexity of how formulations will change a host of effects, and the oxidizer test does not capture these.

Conclusion: There was insufficient support to accept this proposal, but the EWG supported AEISG in pursuing other avenues and further work in this area.

14. **Subject.** *Packing instruction P130 and metal on metal contact between explosives and packaging*

Document: *ST/SG/AC.10/C.3/2023/25 (SAAMI)*

Informal document: *None submitted.*

Discussion: SAAMI introduced 2023/25, in which they requested clarification on the Special Packing Provisions for Class 1 concerning the filling of metal packaging with explosives articles made of metal. Specifically, it asked whether plastic bags or other inner packaging should be required to prevent contact between metal packaging and metal explosive articles when the metal explosive articles are allowed to be in contact with each other in large quantities according to packing instruction 130.

CEFIC noted that dissimilar metals could cause triboelectric effects and possibly act as an ignition source. SAAMI stated this is not a credible initiation scenario. COSTHA pointed out that this would be beneficial for applications beyond ammunition. The United Kingdom noted that the photo depiction of ammo in a steel drum is a painted drum, and this paint causes it not to be metal to metal. The United Kingdom's experience with metal packaging have shown hundreds of approvals of articles directly in metal containers with no issue and would support further discussion. USA held that it is not mutually exclusive to say there is no requirement for an inner packaging and no metal-to-metal contact. Further, ensuring shifting is avoided by dunnage or packing material may be just or more important than avoiding metal-to-metal contact, though someof these concerns are addressed on a case by case basis through the drop test. US DOD best practice is to avoid metal on

metal, so if exceptions are made they should be explicit. Belgium echoed the opinion that paint is a valid barrier, and if the packaging is reused, it needs to be periodically inspected. Sweden suggested that specific UN numbers be identified in any proposal for which it is appropriate. Canada commented that if there is a specific provision for small arms ammunition, a provision to coat the metal packaging would be a good idea.

AEISG noted that their Australian defense contacts indicated contact between metal articles and metal packaging has been used for a long time with no issue. AEISG supported addressing ammunition but not necessarily all metal-to-metal scenarios.

Conclusion: The EWG supported the submission of a paper. The EWG agreed that, in general, metal-on-metal contact should be avoided but recognized situations where it is not an issue, such as in painted drums or ammo cans. If a proposal is made, the EWG suggested that only specific UN numbers should be included. This could include small arms or others if appropriate.

15. **Subject.** Polymerizing Substances and Self Acceleration Polymerization Temperature

Document: None submitted

Informal document: *UN/SCEDTDG/62/INF.3 (CEFIC)*

Discussion: CEFIC presented a slideshow to introduce INF.3. Background was a proposal submitted to IMO CCC8, document CCC8/6/11, in which it was proposed to require the SAPT to be included in the transport documentation. SAAMI noted that rocket motor stability studies look at the time, temperature, and stabilizer depletion to determine an expiration date, and an expiration date would be a good idea for those receiving and storing polymerizing substances after transport. CEFIC requested an ICG to continue this work. CEFIC noted that SAPTs do not ensure safety, and there are industry best practices for ensuring stabilizer is present, and this works very well, but regulation needs to recognize these practices.

Conclusion: The EWG agreed that specific SAPTs do not ensure the safe transport of these polymerizing substances. The EWG agreed that an ICG could work on evaluating industry best practices for ensuring stabilizer is present and effective to ensure safety in transport. COSTHA, Spain, France, Germany, Netherlands, Canada, USA, SAAMI, and CEFIC agreed to participate in this ICG.

16. **Subject.** Report of the intersessional correspondence group on fireworks

Document: *None submitted*

Informal document: *UN/SCETDG/62/INF.5, (Chair of the Working group on explosives)*

Discussion: The Chair of the ICG reported on the work of the ICG on fireworks as detailed in INF.5. and went on to request comments and suggestions for the next steps from the EWG.

The United Kingdom noted that the key changes it has encountered in fireworks relate to nitrocellulose-based compositions and evaluating default classifications for these types of fireworks appropriate. Market surveillance has encountered quality control or complete off-specification issues in products where products would meet the 1.1 default. Spain noted that smoke-generating devices are not in the default table, and this has caused issues. Further, the witness screen specified material is not available on the market, which is a problem for Spain. Germany commented that there is concern about the testing language related to securing articles for testing as this may induce undue confinement in the articles being tested. There are also challenges with reorienting plates for testing to capture the directional effects of fireworks.

SAAMI commented on work by US DOD/NATO on confined Division 1.3 and a new effects curve is being developed for confined Division 1.3. The Integrated Violence Model used by US DOD takes into account loading density in storage. The United Kingdom noted that it has done modeling for Seveso sites storing large quantities of fireworks, and better understanding of the 1.3 to 1.1

transition would be helpful. AEISG agreed. Canada would also like to explore nitrocellulose compositions and the 1.3 to 1.1 transition. Germany noted it is encountering problems with uncertainty (i.e., tolerances) in default tables. COSTHA shared that in the US, there is the American Pyrotechnic Association's standards for default tables, and these will be shared with the ICG on fireworks.

Conclusion: The ICG Chair thanked the EWG for the input and intends to continue as the chair of the ICG on fireworks. The EWG supported its continued work and his continuation as its Chair. The chair of the ICG intends to schedule another online meeting in the coming months.

17. **Subject.** Termination of certain explosive classification approvals due to the Model Regulation Test Series 6(d) requirement

Document: *None submitted.*

Informal document: *UN/SCETDG/62/INF.29 (USA)*

Discussion: As a matter of informing the EWG of actions taken by the USA, INF.29 was discussed. USA communicated the options for listed approval holders to either upgrade the classification to 1.4, verify UN 6(d) compliance, or terminate approvals if they are no longer needed. Anyone with comments or concerns was invited to contact US DOT.

Conclusion: The EWG thanked the USA for the explanation.

18. **Subject.** New special provision and special packing provision of UN 2029

Document: *None submitted*

Informal document: *UN/SCETDG/62/INF.35 (China)*

Discussion: China introduced INF.35 and presented a slideshow and videos to support the paper, which proposed amendments for the entry for Hydrazine anhydrous (UN 2029) by adding special provision 132, special packing provision PP5, and a new special provision. With recent hydrazine anhydrous-based propellant accidents, it is China's intent to provide these provisions to mitigate their reoccurrence.

IME asked what over-confined means and if this should be defined. China responded that it did not have a value pressure that would be overly confined and is asking for a warning to communicate the potential hazard.

The United Kingdom commented that the special prevision looked more like guidance and suggested alternative approaches for drafting. AEISG pointed out that many substances would react this way if packed like this. USA supported adding special packing provision PP5 but did not see the purpose of the new special provision since P001 is assigned to the entry and already restricts to packaging that prevent confinement, and any other packaging that does not meet P001 would require separate consideration.

SAAMI added that the substance is very toxic and caustic and is packaged like this to prevent release. CEFIC noted that other containers are possible. SAAMI responded that some groups use them, but some do not feel that sort may be safe enough to prevent the release of a toxic substance. The EWG supported the addition of SP 132.

Conclusion: The EWG does not support the proposal as written and agreed that it needs additional development. It was recommended that China engages with those members who had suggestions for improvements.

19. **Subject.** Introduction of Division 1.4 Entry for QDO

Document: *None submitted*

Informal document: *UN/SCETDG/62/INF.39 (COSTHA)*

Discussion: INF.39 was introduced by SAAMI on behalf of COSTHA, which sought input from the EWG regarding 1,4-benzoquinone dioxime (QDO) and a potential proposal for new entries in the dangerous goods list.. QDO is produced globally and shipped internationally under various classifications, including being undeclared. In preparation for bringing a paper, CEFIC requested the EWG's views on how QDO should be handled based on the test results in the paper indicating that it is a Division 1.4 material.

COSTHA would like to provide guidance to Competent Authorities and would like to propose two entries for QDO: 1.4 and 4.1 Flammable Solid when desensitized. CEFIC supported both entries. The United Kingdom noted that it would be helpful to understand the driver for this effort and the requirement for additional entries rather than the use of N.O.S. entries. COSTHA responded that these entries would ensure proper classification and better communication of hazard. USA would be open to a 1.4 entry and further consideration of a 4.1 entry. France noted that it had tested this substance as a phlegmatized material with 30% QDO and recommended classification as 4.1 PG II. France recently was approached to test pure QDO and would support a proposal to create two new entries.

Conclusion: The EWG supported that COSTHA submit a proposal based on the input it received from the EWG members.

Agenda Item 6(d) – Miscellaneous proposals for amendments to the Model Regulations on the Transport of Dangerous Goods - Other miscellaneous proposals

20. **Subject.** Units of measurement

Document: *ST/SG/AC.10/C.3/2023/2 (Spain)*

Informal document: *None submitted.*

Discussion: Spain introduced 2023/2 and focused on Proposal 6 in the paper regarding "net explosives weight" and its proposed deletion from 1.2.1 from the UNMR.

USA opposed its removal, noting its prevalent use in the US. The United Kingdom indicated it would be reluctant to remove it due to its ubiquitous use. CEFIC would oppose it as would cause confusion within the industry.

Sweden, to be scientifically accurate, would support its removal. France and Belgium noted they do not use weight but rather mass. Germany conveyed that as this is an international document it would not be in favor of keeping the term. SAAMI stated it prefers net explosives mass, but that the benefit of this change should be considered vs burdens of implementation. COSTHA noted that globally net explosives weight causes confusion in shipping logistics. The Netherlands indicated it does not oppose its removal.

Conclusion: The opinions of the EWG were divided on whether the term should be removed from the Model Regulations. There was unanimous agreement that NEM is scientifically correct but recognized the widespread use of the term net explosives weight.

Annex 1
Working Group on Explosives (3 - 6 July 2023)

List of Participants[2]

Name	Representing
Nicolas Alonso	Spain
Kaylee Baker	RPMASA
Jun-Hwa Ban	Korea, Rep. of
Ben Barrett	SAAMI
Kyle Barrett	SAAMI
Richard Bilman	AESIG
Marie-France Dagenais	SAAMI
Gabriele Dudek	Germany
Bob Ford	SAAMI
Jason Ford	SAAMI
Dieter Heitkamp	CEFIC
Josh Hoffman	IME
Noel Hsu	IME
Ed de Jong	Netherlands
Jason Kennedy	CEFIC
Michael Lafleur	Canada
Werner Lange	CEFIC
Dave Madsen	COSTHA
Heike Michael-Schulz	Germany
Ken Okada	Japan
Michael O'Lena	USA
Brian Osowiecki	SAAMI
Ryan Paquet	COSTHA
Florent Pessina	France
Lucas Petit	France
Andre Pienaar	RPMASA
Ken Price	AEISG
William Schoonover	USA
Peter Schuurman	CEFIC
Xu Sen	China
Jackson Shaver	COSTHA
Bob Sheridan	AESIG
Nie Shulin	Sweden
Martyn Sime	UK
Arnaud Vandenbroucke	Belgium
Brian Vos	USA

[2] It is recognized that some experts only participated in part(s) of the session.

Annex 2

Working Group on Explosives (3 – 7 July 2023)

Changes for the Model Regulations (22nd Revised Edition)

Notes: Source of proposed change is indicated by *italicized text (Source: XXX)*
Unless otherwise indicated, ~~Red~~ indicates deleted text
Unless otherwise indicated, **Blue** indicates inserted text

Amendment 1.

A. Amend the description of 51.4.4.2 (e) in the Manual of Tests and Criteria as follows:

"[(e) $I_{relevant}$ is obtained from the maximum of the **smoothed and corrected** curve of **the measured** heat radiation. **$I_{calculated}$** **is** ~~calculated as~~ **the** average value of the radiation **obtained** by converting the integrated area in a rectangle of equal ~~size~~ **area** during the same **total burning** time ~~span~~**; see Figure 51.4.1**.]"

Source: ST/SG/AC.10/C.3/2023/6 para. 4 as amended and para. 9 of this report.

Amendment 2.

A. In the UNMR, amend the definition of "explosive or pyrotechnic effect" in Chapter 2.1 subparagraph 2.1.1.3 (e), as follows:

"(e) Explosive or pyrotechnic effect [~~**in the context of 2.1.1.1 (c)**~~] means an effect produced by self-sustaining exothermic chemical reactions including shock, blast, fragmentation, projection, heat, light, sound, gas and smoke."

Source: ST/SG/AC.10/C.3/2023/6 para. 11 para. 10 of this report.

Amendment 3.

A. Chapter 2.17 of the GHS, delete the note to paragraph 2.17.2.3, as follows:

~~"NOTE: Nitrocellulose mixtures containing no explosives other than nitrocellulose, do not need to meet the criterion of 2.17.2.2(b)(ii)."~~

B. In section 51, subparagraph 51.4.1.2 (b) of the MTC, delete "Division 1.1" as follows:

"(b)The substance or mixture, as packed for supply and use, is assigned to the hazard class "Explosives"~~, Division 1.1~~.":

Source: ST/SG/AC.10/C.3/2023/17 paras. 14 and 14 and para. 11 of this report.

Amendment 4.

A. The definition for Class 1 explosives as outlined in 2.1.1.1 of the Model Regulations as follows:

"2.1.1.1 Class 1 comprises:

(a) Explosives substances (a substance which is not itself an explosive but which can form an explosive atmosphere of gas, vapour or dust is not included in Class 1), except those that are too dangerous to transport or those where the predominant hazard is appropriate to another class;

(b) Explosives articles, except **those that are too dangerous to transport or** devices containing explosive substances in such quantity or of such a character that their inadvertent or accidental ignition or initiation during transport shall not cause any effect external to the device either by projection, fire, smoke, heat or loud noise (see 2.1.3.6); and

(c) Substances and articles not mentioned under (a) and (b) which are manufactured with a view to producing a practical explosive or pyrotechnic effect.".

Source: ST/SG/AC.10/C.3/2023/18 para. 7 and para. 12 of this report