

**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**

**Sub-Committee of Experts on the Globally Harmonized
System of Classification and Labelling of Chemicals**

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Item 2 (h) of the provisional agenda

Item 2 (b) of the provisional agenda

**Explosives and related matters:
review of Chapter 2.1 of the GHS**

**Classification criteria and related hazard communication:
review of Chapter 2.1**

Explosives classification in GHS Chapter 2.1

**Transmitted by the expert from the United States of America, the
Institute of Makers of Explosives (IME) and the Sporting Arms and
Ammunition Manufacturer's Institute (SAAMI)**

Background

1. At the thirty-sixth session (December 2018), the GHS Sub-Committee noted and welcomed the progress achieved by the informal correspondence group since the last session, through discussions at the Informal Correspondence group (ICG) meetings and parallel to the fifty-fourth session of the TDG Sub-Committee, jointly with the Working Group on Explosives (ST/SG/AC.10/C.4/72 paragraph 24).
2. Additionally, the GHS Sub-Committee noted that the informal correspondence group had accomplished its mandate to formulate the technical criteria for assignment of explosives to sub-categories 2A, 2B and 2C in the GHS, with examples, as well as for the scope of the hazard class Explosives, without consequential changes to the current classification system in transport (ST/SG/AC.10.C.4/72 paragraphs 25-26).
3. Experts from the United States of America, IME and SAAMI (US task force) appreciate the significant work and progress made by the ICG under the leadership of the expert from Sweden. The US task force has participated in ICG discussions, the 2019 IGUS EPP¹/CIE² meetings, joint UN TDG/GHS meetings, and dedicated significant time intersessionally to discuss and reach consensus on key principles of explosives classification in the context of the GHS.

Introduction

4. In December 2018 in Geneva, the US task force volunteered to finalize detailed criteria, utilizing available transport classification data and protocol to assign explosives in

¹ International Group of Experts on the Explosion Risks of Unstable Substances (IGUS), Explosives, Propellants, and Pyrotechnics working group (EPP)

² Chief Inspectors of Explosives

their primary packaging to the Category 2 Sub-categories 2A (High Hazard), 2B (Medium Hazard), and 2C (Low Hazard) respectively. We have also worked to refine Category 1.

5. This paper builds on the proposals and discussions developed at the December 2018 Sub-Committee's meetings in Geneva and proposes text amendments to Chapter 2.1 Sub-Chapters 2.1.1 and 2.1.2 for discussion (see the Annex). These are intended to supplement the formal paper of Sweden (ST/SG/AC.10/C.4/2019/5 - ST/SG/AC.10/C.3/2019/32).

Classification approach and highlights

6. The intrinsic property of an explosive substance or mixture is the potential to create a blast effect. Explosives are unique in that while entry into the class is based on this intrinsic property, further assignment to a division, category or sub-category is based on the configuration. A definition has been added to describe "configured for transport". Note that:

- (a) Controls for the effectiveness of the configuration reside in the Model Regulations, which are referenced as appropriate.
- (b) Legitimate supply practices using partial packaging are defined as "staging". Addressing potential hazards during staging was a motivating factor for this work.

7. Exclusions from the class of explosives have been collected in a new section:

- (a) the scope of the class is maintained as is, and current exclusions from the class are stated for ammonium nitrate emulsions, suspensions or gels (ANEs), and substances currently excluded by screening.
- (b) To stay within the current scope and maintain alignment within the UN systems for GHS and TDG, substances, mixtures and articles with explosives properties which leave Class 1 based on the configuration will also leave the class of explosives. We are considering hazard communication in the safety data sheet to capture this information. For exclusions based on testing of packages, exit from the class should occur at the point of packaging, not before.

8. The scope of Category 1 includes explosives that have not yet been configured and classified for Category 2. Non-intrinsic key parameters such as configuration, confinement, initiation stimuli, composition and particle size contribute to the potential hazard severity and probability of an unplanned explosive event. The hazard severity and probability may vary dynamically with changing parameters in operations such as processing or assembly until the explosives are configured for transport:

- (a) Category 1 explosives necessitate the application of hazards analysis and risk management specific to an operation, which are outside the scope of the GHS. Hazard communication in the workplace is within the scope of GHS, and in this case will alert workers to the explosive hazard and the need for special precautions. The intrinsic hazard of potential explosivity should be communicated, but not a specific level of hazard, as the hazard and probability of accidental functioning are variable depending on circumstances exterior to the explosive.
- (b) "Unstable explosives" is an inaccurate term, as previously determined by the Explosives Working Group, which will be replaced by the proposed "Category 1". Currently the GHS differentiates unstable explosives as either 1) those for which classification for transport has not been attempted, or 2) those failing Test Series 3 or 4 in the attempt for a transport classification or in the opinion that these tests are required for the workplace.

9. There may be a gap in workplace hazard communication, as the current GHS does not recognize Test Series 1 results determining the presence of explosive properties for unintentional explosives (see Figure 2.1.2, Test Series 1 box, “* For classification purposes start with test series 2.”). The Manual of Tests & Criteria (the Manual) was originally written for transport and the need for Test Series 1 in the workplace was not explained. Test Series 2 was noted as being all that was needed for classification in transport (see 10.3.3.3 of the Manual, 6th Revised Edition).

- (a) In the Manual, failure of Test Series 1 determines that the substance or mixture has explosive properties. Test Series 2 determines that it is too insensitive, rather than too low of a hazard, to be classed as an explosive for transport.
- (b) Unintentional explosives have caused significant accidents severely impacting the workplace and the surrounding community.

Therefore, we propose to clarify that Test Series 1 is the threshold for explosives in Category 1, and Test Series 2 is the threshold for Category 2. This fills a gap in the workplace, and does not impact transport. The concept of a de minimis exemption from Category 1 is provided to prevent unintended consequences, which may be useful in solving some challenges already discussed, for example in research and development. The exemption would apply to packages prior to configuration for transport, and for unpackaged quantities.

10. The example in the Manual of the classification of musk xylene (an additive in perfume) provides interesting information relative to classification logic for unintentional explosives. The value of the example may be extended by viewing the treatment of this chemical in the Model Regulations, and the special provisions that still note and control its explosive properties when not classified within Class 1, i.e., labeling and segregation as an explosive and a package quantity limit.

11. Substances, mixtures or articles having explosive properties assigned to Category 2 revert to Category 1 when they are:

- (a) placed into remanufacturing or assembly, restarting the classification cycle.
- (b) removed from the primary packaging other than for immediate use. This is an incentive to avoid bad practice, i.e., unpackaging explosives without justification.

12. Category 2 is comprised of explosives which have been assigned a division, where packaging requirements make the key parameters static.

- (a) The divisions are often used as the basis for regulation and licensing of manufacturing, storage and supply, where additional requirements may take into account quantities, confinement and packaging modifications not present in transport.
- (b) The structure and text of the divisions is proposed for modification as follows.
 - (i) The divisions are discussed first, before the sub-categories, as this follows the order of the classification procedure.
 - (ii) Text describing the divisions in the Model Regulations which describes effects of configurations was omitted in the original transposition of the TDG text to the GHS. We propose this be reconsidered and added to fill safety gaps.
 - (iii) Division 1.4, Compatibility Group S is the foundation of Sub-Category 2C and we propose that it be added.
- (c) When packaging that resulted in assignment to a division is partially removed it is possible for the explosive hazard severity to be altered. The purpose of the sub-categories is to communicate whether the hazard of an explosive which is reduced to its primary package is still commensurate with the hazard of the division, or is more

hazardous. The sub-categories, represent high hazard (2A), medium hazard (2B) and low hazard (2C).

(d) Other than for packaging-independent explosive articles (for which a definition is added), retaining the primary packaging until use is required for all sub-categories in Category 2, otherwise the classification reverts to Category 1.

(i) The primary packaging is a basis for classification in sub-categories 2B and 2C.

(ii) Relative to sub-category 2A high-hazard explosives, this classification logic takes into account that, while the hazard is already the highest, the sensitivity may increase upon removal of the explosive from the primary packaging.

(e) Detonability has been added as a classification factor for Sub-Category 2C, and “detonation” has been defined.

13. Classification is not applied when explosives are in use, which is inherently hazardous but is not practical for triggering reclassification. “Use” has been defined to provide controls on how that term is applied for purposes of Chapter 2.1. The hazard in use is limited for explosives industry personnel by regulation and training, and for general industry and public use by regulatory limitations of the hazard levels of available explosives.

14. We plan to submit an additional informal paper with information for Section 2.1.3 Hazard Communication in support of Sweden’s formal paper.

15. Some ideas regarding decision logic and guidance are included in square brackets in Section 2.1.4 of the Annex to this paper. These provide additional insight, and might be useful in sections 2.1.1, 2.1.2 or 2.1.4. Section 2.1.4 can be drafted later after discussions in Geneva.

Proposal

16. The authors of this paper would like the subcommittee to consider this approach in development of the detailed principles and text of a new GHS amendment to Chapter 2.1, sub-chapters 2.1.1 and 2.1.2, as shown in the Annex.

Annex

Chapter 2.1

Explosives

2.1.1 Definitions and general considerations

2.1.1.1 Definitions

An *explosive substance* (or mixture) is a solid or liquid substance (or mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases.

A *pyrotechnic substance (or mixture)* is a substance or mixture of substances designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative self-sustaining exothermic chemical reactions.

An *explosive article* is ~~an article~~ a device containing one or more explosive substances or mixtures.

~~A *pyrotechnic article* is an article containing one or more pyrotechnic substances or mixtures.~~

Configured for transport refers to the complete package or unpackaged article as presented for classification and assigned a class or division or exempted, also meeting any associated requirements, according to the UN Recommendations on the Transport of Dangerous Goods, Model Regulations and Manual of Tests and Criteria. This configuration includes the design of an explosive article, packaging specification and design, and occasionally, special orientation for cancellation of explosive effects.

Detonation means a supersonic reaction propagating by shock.

The *primary packaging* is the minimum level of packaging that will be retained until use of the explosive when not packaging-independent. Such packaging is often the immediate or innermost layer and may include attenuating properties which mitigate hazardous effects. Flexible inner packaging such as a thin-wall plastic bag or otherwise unsubstantial material which provides negligible attenuation of explosive effects should not be considered the primary packaging. The primary packaging is part of the explosive package presented for testing and classification.

Packaging-independent refers to an explosive article where the classification relies on testing of an explosive article with no packaging, other than a bag, between one or more initiated explosive articles in direct contact with each other and surrounding explosive articles in Test 6(a) (or Test 6(b) or Test 6(d)), and Test 6(c) (Section 16 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*). For a packaging-independent explosive article, packaging may be unnecessary for safety purposes, or the packaging may be disposed of in staging without reclassification.

Staging is storage where the explosive is packaging-independent or is in its primary packaging, but is no longer configured for transport, for example in display for sale or awaiting installation.

Use, for the purposes of this chapter, is the preparation and intentional functioning of an explosive, including installation or deployment in readiness for functioning.

2.1.1.2 Except as provided in 2.1.1.3, the class of explosives comprises:

- (a) Explosive substances and mixtures;
- (b) Explosive articles, except devices containing explosive substances or mixtures in such quantity or of such a character that their inadvertent or accidental ignition or initiation shall not cause any effect external to the device either by projection, fire, smoke, heat or loud noise; and
- (c) Substances, mixtures and articles not mentioned under (a) and (b) above which are manufactured with the view to producing a practical explosive or pyrotechnic effect.

2.1.1.3 The following substances, mixtures and articles are excluded from the class of explosives:

- (a) Ammonium nitrate based emulsions, suspensions or gels which meet the criteria for classification as ANEs of Category 2 oxidizing liquids (Chapter 2.13) or Category 2 oxidizing solids (Chapter 2.14) according to Test Series 8 of the UN Manual of Tests and Criteria.
- (b) Desensitized explosives which have been classified in classes 3 or 4 according to the UN Recommendations on the Transport of Dangerous Goods, Model Regulations, and further classified for the GHS according to the criteria of Chapter 2.17.
- (c) Substances and mixtures which have not been manufactured with the view to producing an explosive or pyrotechnic effect and which according to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria:
 - (i) are deemed not to have explosive properties on basis of the screening procedures in Appendix 6;
 - (ii) do not have explosive properties according to Test Series 1 testing; or
 - (iii) are explosives configured for transport and are excluded from assignment within Class 1 based on results in Test Series 6.
- (d) Explosives configured for transport that are classified outside of Class 1 or are not regulated according to Sections 3.2 and 3.3 of the UN Recommendations of the Transport of Dangerous Goods, Model Regulations.

2.1.2 Classification criteria

2.1.2.1 Explosive substances, mixtures and articles of this class are classified into one of two categories according to following table.

<u>Category</u>	<u>Criteria</u>
<u>1</u>	<u>Explosive substances, mixtures, and articles that have not been configured for transport and have not been assigned to a division within Class 1.</u>
<u>2</u>	<u>Explosive substances, mixtures, and articles that have been configured for transport and assigned to a division within Class 1.</u>

Note: Assignment of explosives to a category proceeds in sequence with their life cycle and lessening potential hazard.

2.1.2.2 Category 1

Category 1 comprises explosives in scenarios of unknown or varying hazard and sensitivity. Hazard communication should accommodate the results of hazards analysis and risk management outside the scope of the GHS. These explosives include:

a) explosives that have not proceeded through the GHS classification process to a classification of the particular configuration either in Category 2 or outside of the class of explosives, and which are:

(i) Substances, mixtures and articles manufactured with the view to producing an explosive or pyrotechnic effect; or

(ii) Substances and mixtures not manufactured with the view to producing an explosive or pyrotechnic effect, that:

- exceed a de minimis quantity of [X] g and have a positive result in Test Series 1 (Section 11 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*); or

- are assigned Category 1 based on additional data or considerations.

b) explosives which have been assigned to Category 2, but which are:

(i) placed into processes in manufacturing or assembly, restarting the classification cycle; or

(ii) removed from their primary packaging other than when removed for immediate use or for packaging-independent explosive articles.

2.1.2.3 Category 2

~~2.1.2.1 Substances, mixtures and articles of this class, which are not classified as an unstable explosive, are assigned to one of the following six divisions depending on the type of hazard they present:~~

2.1.2.3.1 Candidates for classification in Category 2 are first placed in a division of Class 1 (see *UN Recommendations on the Transport of Dangerous Goods, Model Regulations, Chapter 2.1*). For those substances, mixtures, and articles assigned to Class 1, the divisions describe the explosive hazard of the configuration as presented for classification. The classification is frequently only valid in that particular configuration, and modifications may require additional classification.

(a) Division 1.1 Substances, mixtures and articles which have a mass explosion hazard (a mass explosion is one which affects almost the entire quantity present virtually instantaneously);

(b) Division 1.2 Substances, mixtures and articles which have a projection hazard but not a mass explosion hazard;

(c) Division 1.3 Substances, mixtures and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard:

(i) combustion of which give rise to considerable radiant heat; or

(ii) which burn one after another, producing minor blast or projection effects or both;

(d) Division 1.4 Substances and articles which present no significant hazard: substances, mixtures and articles which present only a small hazard in the event of

ignition or initiation. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package;

(e) Division 1.4 Substances, mixtures and articles so packed or designed that any Compatibility hazardous effects arising from accidental functioning are confined within Group S the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder fire-fighting or other emergency response efforts in the immediate vicinity of the package.

~~(e)~~(f) Division 1.5 Very insensitive substances or mixtures which have a mass explosion hazard: substances and mixtures which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions. The probability of transition from burning to detonation is greater when large quantities are present;

~~(f)~~(g) Division 1.6 Extremely insensitive articles which do not have a mass explosion hazard: articles which predominantly contain extremely insensitive substances or mixtures and which demonstrate a negligible probability of accidental initiation or propagation. The hazard from articles of Division 1.6 is limited to the explosion of a single article.

~~2.1.2.2~~ [The existing section 2.1.2.2 including Table 2.1.1 is deleted, except the notes as edited and renumbered]

NOTE 1: The divisions are the appropriate classification to be used for storage and licensing considerations while the explosive remains configured for transport; the categories and sub-categories are not designed for this purpose. Additional requirements may be applied in storage regulations to account for scenarios exceeding the environment of transport.

NOTE 1 2: Explosive substances or mixtures in packaged form and articles may be classified under divisions 1.1 to 1.6 and, for some regulatory purposes, are further subdivided into compatibility groups A to S to distinguish technical requirements (see UN Recommendations on the Transport of Dangerous Goods, Model Regulations, Chapter 2.1).

NOTE 2 3: Some explosive substances and mixtures are *diluted with solids or liquids, or wetted with water or alcohols, diluted with other substances* or dissolved or suspended in water or other liquid substances to suppress or reduce their explosives properties. They may be a candidate for classification as desensitized explosives (see Chapter 2.17) or may be treated differently from explosive substances and mixtures (as desensitized explosives) for some regulatory purposes (e.g. transport), see 1.3.2.4.5.2.

~~**NOTE 3:** For classification tests on solid explosive substances or mixtures, the tests should be performed on the substance or mixture as presented. If for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance or mixture must also be tested in the new form.~~

NOTE 4: As noted in section 2.1.1.3, ammonium nitrate emulsions, suspensions, or gels (ANEs) that meet the criteria for classification as Category 2 oxidizing liquids (see Chapter 2.13) or as Category 2 oxidizing solids (see Chapter 2.14) according to Test series 8 of the UN Manual of Tests and Criteria (see Figure 2.1.4) are not included in the class of explosives. Such ANEs require sensitization to change from an oxidizing solid or liquid into an explosive.

2.1.2.3.2 Explosive substances, mixtures, and articles in Category 2 are assigned to one of three sub-categories in accordance with the following table:

<u>Sub-category</u>	<u>Criteria</u>
<u>2A</u>	<p><u>Explosive substances, mixtures and articles in Category 2 which have been assigned:</u></p> <ul style="list-style-type: none"> (a) <u>Division 1.1, 1.2, 1.3, 1.5, or 1.6; or</u> (b) <u>Division 1.4; and failed to meet the criteria for Sub-category 2B or 2C; or</u> (c) <u>Sub-category 2A based on additional data or considerations that supersede the criteria for Sub-category 2B or 2C.</u>
<u>2B</u>	<p><u>Explosive substances, mixtures and articles in Category 2 which have been assigned to Division 1.4 and a compatibility group other than S, and which:</u></p> <ul style="list-style-type: none"> (a) <u>exhibit no high hazard event in Test Series 6(a) or 6(b) (Section 16 of the <i>UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria</i>); and</u> (b) <u>do not require the following to mitigate a high hazard event:</u> <ul style="list-style-type: none"> - <u>additional attenuating features at any level above the primary packaging; or</u> - <u>any packaging, in the case of a packaging-independent explosive article.</u>
<u>2C</u>	<p><u>Explosive substances, mixtures and articles in Category 2 which have been assigned to Division 1.4 Compatibility Group S, and which:</u></p> <ul style="list-style-type: none"> (a) <u>exhibit no high hazard event in Test Series 6(a) or 6(b), or in the absence of these test results, similar results in Test 6(d) (Section 16 of the <i>UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria</i>);</u> (b) <u>do not require the following to mitigate a high hazard event:</u> <ul style="list-style-type: none"> - <u>additional attenuating features at any level above the primary packaging; or</u> - <u>any packaging, in the case of a packaging-independent explosive article; and</u> (c) <u>do not detonate as a complete system when functioned as intended.</u>

Note: Certain explosives in Category 2 are sometimes evaluated for possible assignment to Sub-categories 2B and 2C before proceeding to classification in Sub-category 2A.

2.1.2.3.2.1 A high hazard event is exhibited when performing Test Series 6(a) or 6(b), according to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria by

- (a) a significant change in the witness plate shape (e.g., perforation, gouge, substantial dent/bowing, etc.); or
- (b) instantaneous scattering of most of the confining material.

2.1.2.3.2.2 Classification in a division or a sub-category is based on testing. However, explosives may be classified without testing, where appropriate, based on analogy to tested explosives. The use of analogy should take into consideration whether changes to configuration may affect the hazard compared to the tested configuration.

[2.1.2.3.2.3 Parking lot item for niche of data inadequacies]

2.1.3 Hazard communication

The US may submit a separate proposal in this regard.]

2.1.4 Decision Logic and guidance]

[This section has not been drafted, but some of this information may be useful for placing in sections 2.1.1, 2.1.2 or 2.1.4.]

[Consider the text in the “Classification Approach and Highlights” section of this informal paper for inclusion in section 2.1.4, as appropriate.]

[Note: Division classifications are valid within the environment of transport, and are also commonly used outside that environment, e.g. in storage and staging, with additional controls.]

[Note: Category 1 is not always more hazardous than Category 2, but the controls resulting in a lower hazard are not fixed and the potential for reactions is greater, thus the reason that this category comes first. Explosives tend to be the most uncontrolled and potentially dangerous at the beginning of their life cycle in unpackaged, dynamic manufacturing scenarios. Formation into a package and/or explosive article provides a level of protection from outside stimuli and fixes the sensitivity and hazard magnitude to certain levels.]

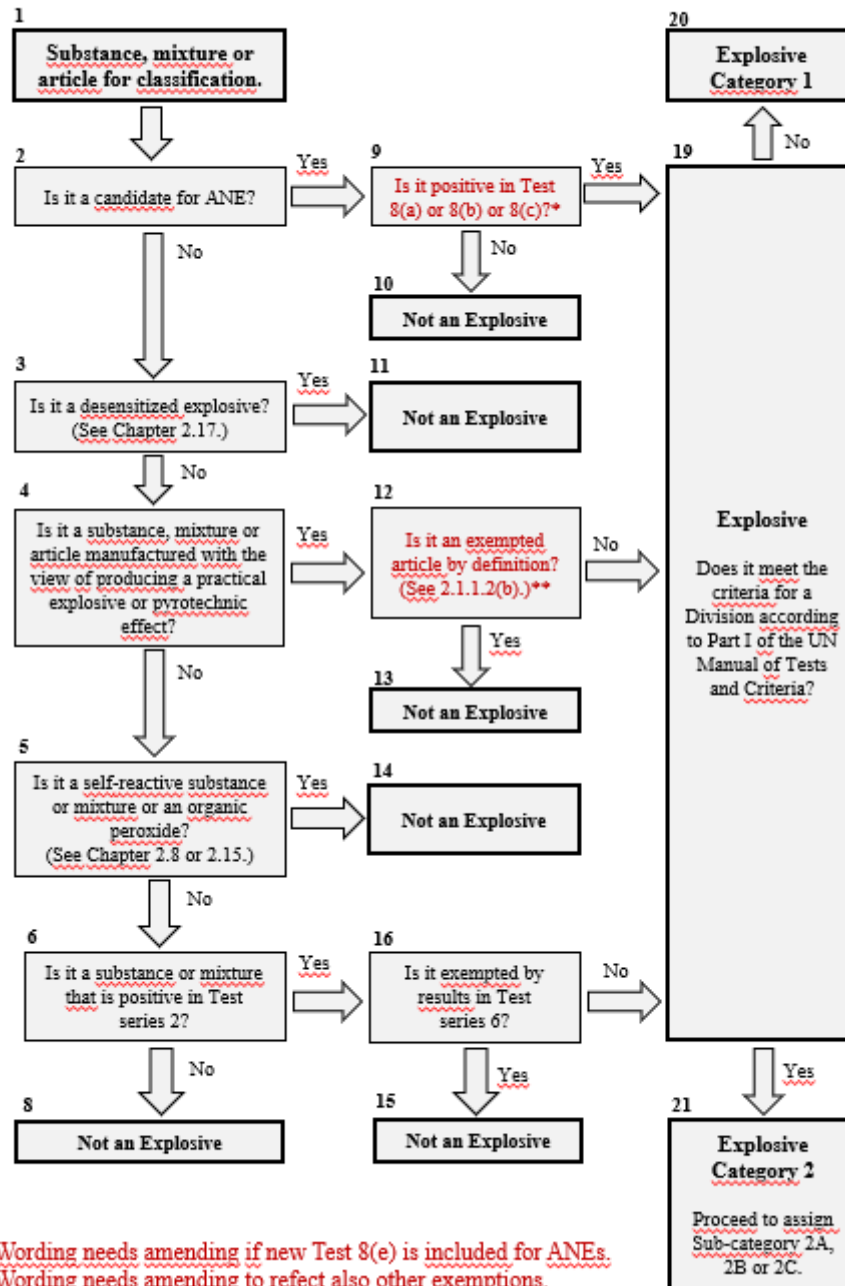
[The following descriptions of the sub-categories may be useful in section 2.1.2 or 2.1.4:

Description of hazard levels	
Low hazard (Sub-Category 2C)	“Low hazard” effects may cause damage to objects and injuries to the body when in immediate proximity and the explosive functions accidentally. Injuries would not normally result in permanent impairment, though more serious injuries or death may occur under unfavorable conditions.
Medium hazard (Sub-Category 2B)	“Medium hazard” effects may cause serious damage to objects including serious harm to the body when nearby and the explosive functions accidentally. Injuries are likely to be of a permanent nature, and may include death under unfavorable conditions.
High hazard (Sub-Category 2A)	“High hazard” effects may cause complete destruction of objects or death when in the vicinity and the explosive functions accidentally.

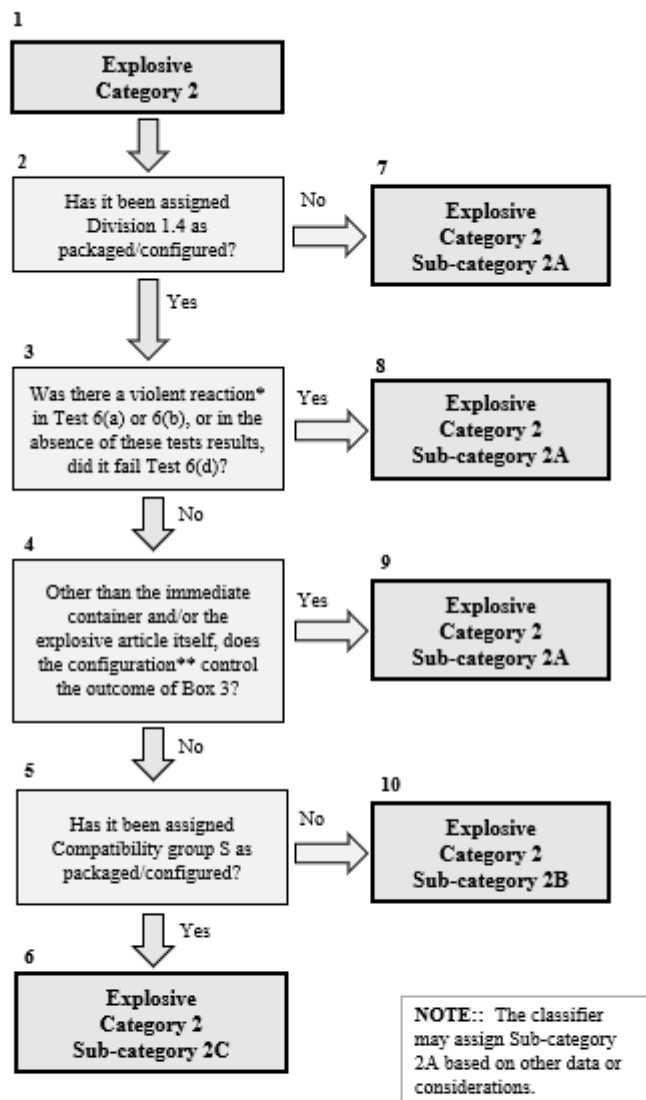
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[The following flow charts are from December 2018 and are included for reference only.
They require updates to match the classification scheme above.

**Proposed criteria for assigning substances, mixtures and articles to the hazard class Explosives
AS AMENDED AT THE ICG/EWG MEETING ON 29 NOVEMBER 2018**



**Proposed criteria for assigning Sub-categories 2A, 2B and 2C within the hazard class Explosives
 AS AMENDED AT THE ICG/EWG MEETING ON 29 NOVEMBER 2018**



* Violent reaction is defined as:

- 1) Significant change of witness plate shape; and/or
- 2) Instantaneous scattering of most of the confining material.

** Configuration means the complete package and explosive as tested according to the UNMTC, including special orientation for cancellation of explosive effects.

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