

# THERMITES UNDER DANGEROUS GOODS LEGISLATION: STATUS OF THE UN DISCUSSIONS AND REGULATORY CHALLENGES

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## 1. Introduction

Experts at the United Nations (UN) are currently discussing how thermites and products containing thermites should be regulated under international dangerous goods and chemicals legislation, particularly under the UN rules for the transport of dangerous goods (ECOSOC Sub-Committee of Experts on the Transport of Dangerous Goods, **UN TDG**) and the Globally Harmonized System (ECOSOC Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals, **UN GHS**).

Thermites are inorganic mixtures of a metal powder and a metal oxide that, once ignited, undergo a highly exothermic redox reaction at very high temperatures of more than 1,000 °C. The term thermate is used where additional components are present, such as oxidizing agents, in order to control the thermite reaction. No distinction is made between thermites and thermates for classification purposes. Accordingly, only the term thermite will be used below. In both cases, the intensity of the redox reaction depends to a significant extent on the interaction of the mixture components and their particle size.

Thermites are widely used in civilian industry, for example for the permanent joining of railway rails, for plugging oil wells, and in the foundry industry as feeders.<sup>1</sup>

According to the current state of knowledge, civilian thermites are generally not classified as dangerous goods. [2], [5], [11], [12], [13]

## 2. The Trigger for the Current Discussion at UN Level

In the UN discussion, the term “thermite” is also used as a blanket term for thermites and thermates. The term therefore covers very different substances and applications – ranging

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<sup>1</sup> A feeder serves as a volume reservoir to compensate for volume shrinkage during the solidification of the casting when metal parts are cast. During the casting process, the interior cavity of the feeder is filled with molten metal. This initiates an exothermic reaction, and the feeder wall, heated by this exothermic reaction, keeps the molten metal inside the feeder liquid, ensuring that the casting is continuously fed with the incoming molten metal.

from traditional welding mixtures to cutting devices, oil-well plugging devices and devices for humanitarian mine clearance.

In practice, thermites are therefore classified differently depending on their formulation and application: rarely as Class 1 (explosives), in some cases as Class 4.1 (flammable solids), but in most cases as non-regulated articles for transport purposes under dangerous goods legislation. The classification of thermites is generally based on a formal assessment in accordance with the UN Manual of Tests and Criteria (**MTC**). Every classification or exemption must always be supported by appropriate documentation issued by an accredited testing laboratory and/or the competent authority. [2], [5], [12], [13]

At the end of 2024, experts from the United Kingdom drew attention to alleged inconsistencies in the global classification of thermites. Manufacturers and applicants are said frequently to have classified certain thermite-containing products merely as Class 4.1 substances or as non-regulated goods WITHOUT testing, based on analogies, although the function and effect of these products could also be assessed as having a pyrotechnic or explosive effect. The UK paper mentions, among other things, initiators, percussion caps, incendiary devices, rocket initiators, offshore plugging devices and cutting devices capable of severing pipelines almost instantaneously [2].

The experts from the United Kingdom therefore define thermites and thermite-containing articles in general terms as mixtures of a fuel and an oxidizer whose practical effect is based on a self-sustaining exothermic reaction involving heat and/or gas, and initiated the establishment of a working group to clarify the following fundamental questions:

- whether thermites in general should be regarded as explosive or pyrotechnic substances,
- whether thermite-containing articles should in principle be regarded as explosive articles,
- whether separate UN numbers for industrial thermites (e.g. railway thermites) would be useful.

The core of the UK objection was therefore not a finished solution, but a substantiated warning not to exempt thermites from Class 1 or Class 4.1 prematurely on the basis of formulation-based analogies. The UK experts likewise expressly acknowledge that industrially used thermites for civilian applications have to date been transported safely, without any known safety-related incidents.

When classifying a product as a potential Class 1 explosive, its intended use is decisive. If a product is developed with a view to achieving a practical explosive or pyrotechnic effect, exclusion from Class 1 is not possible, whereas products manufactured for another purpose may be exempted on the basis of exclusion rules and tests.

In addition to **Appendix 6** of the UN Manual of Tests and Criteria, the relevant provisions are **Test Series 1** (question: “Does the test article have explosive properties?”) and **Test Series 2** (question: “Is the test article too insensitive for inclusion in Class 1?”). If either test series produces a negative result, a test article that was not developed with a view to achieving a practical explosive or pyrotechnic effect must be exempted from Class 1, because either it does not possess explosive properties or it is too insensitive. It should be noted, as a general principle, that other hazards outside Class 1 may nevertheless result in transport labelling under the regulations – for example flammable properties (Class 4.1). [2], [12], [13]

The concerns raised by our UK colleagues are expressly supported: thermite mixtures and thermite-containing articles must not be exempted or classified without testing in accordance with the UN Manual of Tests and Criteria (MTC). This is established practice in industry and, a priori, the prerequisite for the safe transport and handling of thermites and corresponding articles under the regulations.

### **3. Previous Findings of the UN Working Group**

The working group at UN level currently comprises representatives of international authorities, industry, academia, trade associations and users. The working group has established that thermites are not a homogeneous group of substances. By their nature and composition, some specific mixtures meet the definition of a pyrotechnic or explosive substance, whereas other known thermites do not.

At the same time, it is undisputed that blanket Class 1 regulation of traditional industrial thermites would be disproportionate, especially since such blanket regulation would threaten the economically and logistically viable basis on which many manufacturers and users operate. Given the complexity of the subject, the working group currently has no common understanding of what a suitable definition of “thermites” might look like or, where applicable, whether such a definition would be helpful for the current discussion. [5], [6]

### **4. The So-Called “Test-Based Proposal” by the Sporting Arms and Ammunition Manufacturers’ Institute (SAAMI)**

At the 66th session of the UN TDG Sub-Committee, SAAMI presented a fully formulated regulatory proposal that essentially contrasts two approaches:

- **a definition-based approach with exemptions, and**
- **a test-based, tiered approach.**

The SAAMI representative emphasizes that classification should be scientifically and quantitatively substantiated and based on existing UN tests, referring in this context to an extensive research study by Safety Management Service Inc. (SMS) from 2023, commissioned by the U.S. Department of Transportation’s Pipeline and Hazardous Materials Safety Administration (PHMSA). [4], [6], [11]

The SAAMI experts take the view that established test methods, in particular Test Series 1 and 2, are unsuitable for the classification of thermites, implicitly alleging that the thermite industry and its users manufacture, handle and place on the market unlabelled explosives. This is asserted without at the same time providing robust evidence that the established testing scheme fails for thermites.

Instead, the general inclusion of thermites in Class 1 is proposed which requires extensive additional testing methods that have so far been used only for intrinsic explosives. Their blanket application could produce false-positive results. This would bypass the established test series used for the initial assessment of potential explosives.

This would be unprecedented and would have significant consequences for industry, since the approach appears capable of being extended to other groups of substances, potentially allowing established standards to be undermined at will. [4], [6], [11], [12], [13]

## 5. The German Experts' Fundamental Methodological Position

The German experts point out that the focus of the discussion has shifted from an initially theoretical definition of thermites, intended to improve the inclusion and delineation of pyrotechnic articles or explosives, to a new testing philosophy within the established Manual of Tests and Criteria (MTC).

At the same time, Germany questions the technical basis for the conclusions drawn to date in the SMS report. The German paper submitted to the 68th UN TDG session points out that, although the SMS thermite report contains valuable data on selected thermite formulations, all test results for commercially available thermites in the study would confirm an exemption from Class 1 under Test Series 1 and 2 [9]. By contrast, artificially produced mixtures were tested positive which, in the authors' current understanding, have no relevance under transport legislation. [9], [11], [12], [13]

The German experts point out that two approaches have emerged in the course of the discussion – without coordination or commissioning:

- a definition-based approach under which all thermites are to be regarded as Class 1 explosives on the basis of an assumed pyrotechnic nature,
- an approach departing from the existing testing scheme, with outcomes ranging from Class 1, Class 4.1 and Class 9 through to a possible exemption as “not dangerous goods”.

It should be noted that, under the current regulations governing the transport of dangerous goods, pyrotechnic articles cannot be reclassified out of Class 1.

Germany points out that key technical conclusions are based too heavily on individual studies and test results that are, in some cases, not sufficiently transparent from a methodological perspective. The central point of the German argument is that, before the UN system is adapted or special outcomes leading out of Class 1 are created under new testing schemes, it must be ensured that the underlying tests for thermites are standardized, scientifically traceable, reproducible and economically viable. The German delegation expressly calls for transparent, reproducible, standardized and internationally harmonized test methods.

*The established Test Series 1 and 2 for exclusion from Class 1 (explosives) must not be bypassed without compelling reasons and robust scientific justification, thereby allowing individual initiatives to circumvent proven test methods and schemes. [9], [12], [13].*

**VCI and the authors clearly support the German position and request support from industry.**

## 6. Conclusion: Consensus, Disagreement and Key Regulatory Issues

Despite all differences, the experts share several points of agreement:

- **There is broad agreement that thermites are not a homogeneous group of substances.**
- **There is likewise broad agreement that the regulatory treatment to date is insufficiently clear and not always consistent.**

In the authors' view, the disagreement at expert level currently concerns the approaches and test methods by which thermites can be classified safely or exempted from the dangerous goods transport or GHS regulations:

The United Kingdom began by raising the issue from a precautionary perspective: thermites and thermite-containing articles should not be treated too quickly as falling outside Class 1, explosives, especially since more recent market developments appear to give cause for concern. As the discussion progressed, a politically pragmatic hybrid solution began to emerge: thermites should in principle be regulated appropriately and on a risk basis, while far-reaching exemptions should remain possible for certain industrial or humanitarian applications under clearly defined conditions.

SAAMI, by contrast, is pursuing a test-based approach with its own testing philosophy: in principle, thermites are to be tested as intentionally manufactured Class 1 explosives. A general initial test and, where applicable, exemption as explosives within the meaning of Test Series 1 or 2 is dispensed with – without any evidence to date that these tests are unsuitable for thermites or feeders. This is arguably the most critical point in the ongoing discussion, as it could result in **all thermites having to be retested and potentially reclassified**.

The implications and harm for, among others, railway operations, the automotive industry, the casting and steel industries, and the thermite industry as a whole have not yet been fully analysed or quantified; further implications under German explosives legislation also remain unaddressed.

The German delegation focuses less on the fundamental identification of the problem than on the robustness of the current technical evidence base and the methodological approach at UN level; at the same time, Germany warns against premature regulatory amendments and against abandoning established test series without robust scientific evidence.

## **7. DEMANDS OF VCI AND THE AUTHORS**

- We expect and support an objective and scientifically grounded discussion, without casting **general suspicion** on an important industrial sector and its applications regarding possible misclassification!
- We reject the proposed **test-based approach and SAAMI's own testing philosophy** given the current state of data!
- We **demand no arbitrary deviation from existing and proven testing methods** without scientific evidence that they are unsuitable!
- We expressly request support for the **German position**!

### Disclaimer

*The opinions and interpretations of regulations and their safety assessments presented in this position paper are based on the authors' best knowledge and belief and may not fully reflect the views or understanding of all authorities, experts and representatives of trade associations at international level.*

## 8. References

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Alle UNECE documents are available free of charge at <https://unece.org/info/events/unece-meetings-and-events/transport>

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