



U.S. Department
of Transportation
**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

December 9, 2021

Mr. Peter Shelley
Managing Director
Onepoint4 Ltd.
75 Chevington Green,
Morpeth, Northumberland
NE65 9AX United Kingdom

Reference No. 21-0082

Dear Mr. Shelley:

This letter is in response to your July 29, 2021, email requesting clarification of the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) applicable to Class 1 (explosive) and Division 4.1 (flammable solid) materials and articles using hazardous materials. Specifically, you ask for confirmation that highly energetic substances and associated articles—which are normally classified and approved as Class 1 (explosive) materials—cannot be classified as Division 4.1 (flammable solid) materials without proper testing and subsequent approval by PHMSA.

We have paraphrased and answered your questions as follows:

- Q1. You ask—specific to thermites and thermates and referencing your previous letters of interpretation requests (Ref. Nos. 18-0141 and 20-0015)—whether a company can self-certify a material as Class 4 or otherwise as non-hazardous and subsequently alter the material or make it a component of an article without needing an approval.
- A1. As provided in § 173.22, it is the shipper's responsibility to properly classify and describe a hazardous material. If a material is not specifically listed by name in the hazardous materials table in § 172.101, then selection of a proper shipping name must be made from the general description entries corresponding to the specific hazard class, packing group, and subsidiary hazards of the material. When a material meets the definition and criteria of a hazard class, the shipper must assign an appropriate proper shipping name and UN identification number. While many hazardous material classification determinations are left solely to the shippers based on classification criteria in the HMR, specific provisions for certain hazard classes—such as Class 1 (explosive) materials and certain Class 4 materials—require a government approval.

For example, where the assignment of Division 4.1 (flammable solid) material versus Class 1 (explosive) material is concerned, offerors cannot self-classify the material as a flammable solid if the material also meets the definition of an explosive—as provided in § 173.50—which instead would require approval in accordance with § 173.56. The issuance of an approval indicates that a material—based on data from approved test labs—has been verified as an explosive or not and meets the criteria for inclusion or exclusion from Class 1.

With regard to necessitating a new approval if the material is altered or made a component of an article—as discussed in answer A3 below—any change to an explosive in the formulation, design, or process so as to alter any of the properties of the explosive, and any change to a material that is not an explosive but by the manner in which it was changed may render it now an explosive, would require new examination and a new approval. However, any PHMSA-approved explosives test lab, as described in § 173.56(b) may determine and confirm in writing to our Office that there are no significant differences in hazard characteristics from the material previously approved.

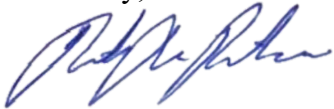
- Q2. You ask whether thermites or thermates must be tested for an approval, even if they are not designed to function by explosion.
- A2. The answer is yes. Because of their energetic properties, thermites and thermates are provisionally considered explosives until PHMSA issues an approval letter specifically excluding the material from Class 1 based on testing conducted by a DOT-approved test laboratory, in accordance with § 173.56.
- Q3. You refer to a report which indicates that energetic properties of certain materials may be manipulated by pressing and shaping of powdered energetic material to control the burning surface area and burn rate (e.g., pressing and shaping into pellets/donuts by pressure, temperature, compression, sintering, etc.). You ask whether these materials—after being tested in one physical form—should be resubmitted for testing and PHMSA approval if they are then intended to be transported in another form or intended to be transported as a component of an article.
- A3. The answer is yes. Under § 173.56(a)(2), any change to an explosive in the formulation, design, or process, so as to alter any of the properties of the explosive would require examination and meet the definition of a “new” explosive unless a PHMSA-approved explosives test lab, as described in § 173.56(b), has determined—and confirmed in writing to our Office—that there are no significant differences in hazard characteristics from the explosive previously approved.
- Q4. You ask—noting that binder(s) may add additional energetic properties to a hazardous material such as a thermite or thermate—whether an energetic material without binder(s) and where binder(s) are subsequently added to the material requires re-testing and re-approval for classification purposes.

- A4. The answer is yes. See answer A3.
- Q5. You ask whether PHMSA will consider the use of binders and additives—such as polymers (e.g., Teflon®) and their role in combustion and sensitivity—in future testing of such thermite- or thermate-based substances/products.
- A5. As discussed in answer A3, every separate formulation containing thermite or thermate would need to be considered on its own merit. Any previously classed thermite or thermate material would be considered a new explosive if a change has been made in the formulation, particle size, design, or process, so as to alter any of the properties of the explosive, including the use of binders.
- Q6. You ask whether thermite and thermate compositions—with and without additional binders and additives that contribute to the overall energetic properties of the thermite and thermate compositions—can be transported on civil and commercial aircraft as substances or also contained in articles, without an approval.
- A6. The answer is no. As discussed in answer A2, thermites and thermates are provisionally considered explosives. The conditions for transport by aircraft would be outlined in the final classification approval issued by PHMSA.
- Q7. You ask how distinctions in classifications are made between a Division 4.1 (flammable solid) material (e.g., “UN3178, Flammable solids, n.o.s.”) and a Division 1.4G pyrotechnic material (e.g., “UN0431, Articles, pyrotechnic”) when transported in packagings and when contained in articles.
- A7. Thermites and thermates, including articles containing either thermites or thermates, are provisionally considered explosives (see answer A2). The classification for these hazardous materials is based on tests and the resulting classification recommendation provided by a DOT-approved explosives test laboratory, which will result in a designated classification by PHMSA under § 173.56.
- Q8. Further, you ask about Division 4.1 (flammable solid) materials that have been transported prior to the implementation of PHMSA’s current approval process involving approved explosives test labs. You ask—regarding future shipments—if such energetic materials will be transported as part of an article, whether they will require re-testing by an approved explosives test lab regardless of whether the hazardous material was previously deemed to be a Class 1 (explosive) material or a Division 4.1 (flammable solid) material.
- A8. The answer is yes. See answers A2 and A7.
- Q9. You ask whether a thermite or thermate material that has been classified as a Division 4.1 (flammable solid) material and then is packed into a steel tube and intended to be transported would be considered an article requiring testing by an approved explosives test lab because thermite and thermate both have a practical pyrotechnic effect.

- A9. Thermite or thermate packed in this manner may be considered an article, depending on the function of the steel tube. If the tube lends itself to the function of the product, then it may be classified as an article. If the thermite or thermate was excluded from a Class 1 determination and is subsequently transported as an article it would require re-approval as an explosive. However, if the tube is part of the packaging for purposes of handling and transport of the material and not a component part of an article, it may be considered packaging and does not have to be re-examined.
- Q10. You ask whether a thermite or thermate material packaged in an oilwell cartridge would now fall under Class 1 (explosive) material or be required to undergo testing by an approved explosives testing lab.
- A10. Oil well cartridges are defined explosives in § 173.59. Any article meeting this definition requires examination as an explosive under § 173.56.

I hope this information is helpful. Please contact us if we can be of further assistance.

Sincerely,



Dirk Der Kinderen
Chief, Standards Development Branch
Standards and Rulemaking Division

From: [Foster, Glenn \(PHMSA\)](#)
To: [Dodd, Alice \(PHMSA\)](#); [Hillman, Kenetha CTR \(PHMSA\)](#)
Subject: FW: Interpretation Final Response Letter
Date: Friday, July 30, 2021 1:28:35 PM
Attachments: [Letter to US Director DOT PHMSA FINAL.docx](#)

Alice/Ikeya,

Please have the attached checked in as an Interp and ask the assigned Specialist to expedite a response.

Thanks,
Glenn

From: peter.shelley@onepoint4.co.uk <peter.shelley@onepoint4.co.uk>
Sent: Thursday, July 29, 2021 12:03 PM
To: January, Ikeya CTR (PHMSA) <ikeya.january.ctr@dot.gov>
Cc: Foster, Glenn (PHMSA) <Glenn.Foster@dot.gov>; DerKinderen, Dirk (PHMSA) <Dirk.DerKinderen@dot.gov>; Andrews, Steven (PHMSA) <steven.andrews@dot.gov>; Dodd, Alice (PHMSA) <Alice.Dodd@dot.gov>
Subject: Re: Interpretation Final Response Letter

CAUTION: This email originated from outside of the Department of Transportation (DOT). Do not click on links or open attachments unless you recognize the sender and know the content is safe.

Dear Ikeya,

could you please provide an update on the progress of any replies to the questions sent to the Hazmat Info Center at Infocntr@dot.gov on the 18th August 2020.

I have re-attached the questions to assist you in responding.

Regards,

Peter.

Peter Shelley

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18th August 2020

Our ref: Technical Note 180820-DOT

Clarification on Class 1/Class 4.1 Energetic Materials and Articles using Energetic Materials

References

1. Questions for the US side of Dangerous Goods Classification and Testing, Technical Note 261018-DOT, 26th October 2018.
2. DoT Response Letter to Reference 1 above 18-0141 dated 9th May 2019.
3. Supplemental Questions for the US Department of Transport, Pipeline and Hazardous Materials Safety Administration. Technical Note 200120-DOT, 20th January 2020.
4. DoT Response Letter to Reference 3 above 20-0015 dated 28th May 2020.
5. Energetic Properties of Thermites, Final Report, DOT Contract #DTPH5616D00001, SwRI® Project # 24178. Prepared for: DOT PHMSA, November 27, 2019 (Rev 1).
6. DOT Letter to Diamondback Industries Inc 17 May 2006,
[0_EX2006050012_2006055032.pdf](#)
7. DOT Letter to Diamondback Industries Inc 27 May 2014 - Deny
[0_EX2013120248_2013120384.pdf](#)
8. US DOT Letter to Diamondback Industries 29 April 2015 - Deny
[0_EX2014060446_2014060989.pdf](#)
9. Fast reaction of Nano-Aluminum: A study on fluorination versus oxidation - Kyle Watson, Aug 2007.

Introduction

First let me thank you once again for your technical competence in responding to my previous requests for information and analysis of the data presented.

Having reviewed the DoT PHMSA responses, Refs 1 to 4, and the DoT PHMSA Ref 5 report, this has inevitably prompted new questions. Which I now pose to you the DoT PHMSA for clarification. In particular I wish to clarify that highly energetic substances and associated articles which are normally classified and approved by DoT PHMSA as Class 1, cannot be classified as Class 4.1 without proper testing and subsequent approval by DoT PHMSA.

Please note: References 5 to 8 were obtained from the DoT PHMSA's website and approvals web page and Reference 9 is publicly available from the internet.

Questions

1. **Background:** I note the Ref 6 letter and Refs 7 and 8 denial letters to Diamondback Industries and have interest in thermites and thermates as described in Refs 1 and 2.

Question: If a thermite or thermate substance were packaged in an oilwell cartridge would this cause the article (i.e. the oilwell cartridge) to fall under Hazard Class 1; or at least require to undergo Class 1 testing by an approved DoT Explosive Test Lab?

2. **Background:** I note the type of materials tested in Ref 5 and that the energetic properties of such materials may be manipulated by pressing and shaping of powdered energetic material into pellets/donuts by pressure, temperature, compression, sintering etc., which controls the burning surface area and burn rate.

Question: If such energetic materials after being tested in one physical form by the DoT PHMSA, an approved DoT Explosive Test Lab/Competent Authority or a company, e.g. as a powder. Should an energetic material be resubmitted for testing and DoT PHMSA approval if it is then transported in another form i.e. pressed pellets or donuts or if the energetic materials are then intended to be used within articles that they are transported in?

Question: If the DoT PHMSA, a Competent Authority or a company tests an energetic material as a powder without a binder(s) and that subsequently a binder(s) is/are added to the material. Noting the binder(s) may themselves add additional energetic properties to the energetic material such as thermite or thermate. Does the resulting energetic material (which now includes one or more binder materials) require re-testing and re-approval for classification by DoT PHMSA?

3. **Background:** As defined by the DoT PHMSA an explosive means any article that is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion. The term includes fireworks, which are pyrotechnic articles. No person may offer a new firework or explosive for transportation unless the substance or article has been classed and approved by the PHMSA. I also note that a definition of a Class 4.1 – for Flammable solids, etc., is that these will burn easily, more so than ordinary combustible materials such as wood and paper. The burning may be fierce and rapid; creating great heat and that some Class 4.1 materials are desensitised explosives, e.g. wetted trinitrotoluene (TNT) which would otherwise be in Class 1.

Question: Should all Class 4.1 energetic materials used by any company have an EX number issued by DoT PHMSA, regardless of whether it's an energetic material recently invented or one that has been in existence for many years (including prior to when the current DoT PHMSA system using approved test labs came into force, which I understand to be in the mid-1990s)? Thus does the energetic material and article, if it were then transported inside an article, require re-testing by a DoT approved Explosive Test Lab regardless of whether deemed by the DoT PHMSA to be a Class 1 explosive or a Class 4.1 energetic material.

4. **Background:** I note that thermite and thermate both have a practical pyrotechnic effect as per Refs 2 and 4. I also note that prior to transportation into and within the U.S., all explosives, including fireworks, must be classed and approved by DoT federal hazardous Materials (hazmat) transportation Law, 49 U.S.C., 5101 et seq., and authorizes DoT to issue classification documents - EX Approvals - in accordance with the procedural

requirements in Part 107 and the hazardous Materials Regulations. All explosives must be in compliance with the HMR, 49 CFR §173.56.

Question: If a Class 4.1 thermite or thermate substance was packed into a steel tube (a tool) and transported in this nature, would this subsequently be considered an article and no longer simply a substance, and the article require testing by a DoT PHMSA approved Explosive Test Lab given thermite and thermate both have a practical pyrotechnic effect?

5. **Background:** Energetic materials such as those in Ref 5 are often much more energetic than high explosives (e.g. TNT), sometimes up to a factor of two, three or more depending on the composition, particle sizes, shape, structure, porosity, density, flame front propagation etc.; Thermite and thermate additives such as polymers (e.g. PTFE/Teflon® (76% fluorine by weight, the other 24% being carbon)), polyester etc., are often not merely 'binders' as they provide additional oxidisers to the thermite/thermate composition and enhance the energetic properties of the base thermite/thermate composition i.e. the overall energetic composition is much more energetic than the base thermite/thermate composition. In addition they generate large volumes of gas on decomposition and during the various highly exothermic chemical reactions that take place. Ref. 9 for instance is just one of many publically available documents that describes the science and highly energetic properties of such thermite-based/thermate-based compositions.

Question: Should the 'fierce burning' of a thermite or thermate substance (potentially determined as Class 4.1) which is then packaged and transported in a pressure producing vented steel tube, which produces an 'extremely rapid release of gas and heat', be tested for approval as a Class 1 explosive article by an approved DoT PHMSA Explosive Test Lab? Even if not designed to function by explosion and regardless of the classification and EX number DoT PHMSA ultimately assigns?

6. **Background:** It is clear that some companies would prefer the classification of a Class 4.1 (or even non-hazardous) for their materials and products as opposed to for instance a Class 1.4. If a company did not choose Class 1 testing of a thermite or thermate powder composition (with or without the binder and/or additives), but instead chose a Class 4.1 burning train test. Is there a possibility that the gas produced by the burning composition escapes to atmosphere and pushes some of the powder mixture out of the way thereby disrupting the test? However if the same composition were tested under Class 1 with confinement, the test would show pressure build up from gas production and the effects from the flame front. Furthermore sensitivities of the final thermite or thermate composition as transported and used may not have been tested e.g. spark test, electrostatic test, drop test etc.

Question: From Refs 2 and 4, do thermite and thermate substances and containing articles, have to undergo Class 1 testing and procedures and submission to the DoT PHMSA for approval? Can the DoT PHMSA please also assure that there are no gaps in the assessment process i.e. the interface between assessments of different hazard classes is robust and that a company cannot self-certify a substance as Class 4 (or even non-

hazardous) and alter it or package it in an article and then not re-submit to DoT PHMSA for approval?

7. **Background:** Ref 5 seems to have been written solely from the stand point of historical powdered or granulated forms of thermite type compositions and in no way approaches any testing of the type of compositions listed in the second letter to the US DoT, Ref. 3. The stated objective of the report was "The testing may help form a technical basis for regulation or exemption of certain thermite formulation families". I particularly note that the report states, when discussing auto-ignition temperatures that, "Based on the limited data set, the explosiveness of these Thermites appears strongly related to two parameters. Additional testing is required to further investigate this relationship." In the case of Teflon[®], the report states "These have common application in aircraft flares (pyrotechnic effect) and are generally included in Class 1 by definition". Ref 9 is an example of the publicly available research going into the energetic properties of such highly energetic compositions.

Question: In addition to the chemical formulae contained in Ref 5, will the DoT PHMSA consider the use of binders and additives such as polymers e.g. Teflon[®], in their future testing of such 'thermite' (or thermate) based substances and products as are currently on the market and their role in combustion and sensitivity?

8. **Question:** Can the DoT PHMSA please clarify how the differences in assessments are made between the designated Flammable Solids UN3178/UN1325 classified as 4.1, versus a Pyrotechnic Substance UN0431/UN0432 classes 1.4G/1.4S as substances and when contained in articles?
9. **Question:** Finally can the DoT PHMSA please confirm if thermite and thermate compositions, with and without additional binders and additives that contribute to the overall energetic properties of the thermite and thermate compositions, which produce a practical pyrotechnic effect. Can be transported on civil and commercial aircraft as substances and also contained articles, without DoT PHMSA approval and an EX number from DoT PHMSA?

Yours sincerely,



Mr P Shelley BEng (Hons), MISEE, MIEExpE

Managing Director
Onepoint4 Ltd