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Using the combustion continuum to distinguish between explosive material and explosive article reactions for a unified scale in ordnance disposal categorization

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ABSTRACT

In this paper, we continue our exploration of the *Combustion Continuum*, building upon the foundational concepts and analyses presented in Part One of this two-part series (Alford, Hazael, and Critchley 2024). In the first paper, we introduced the benefit of considering burning, deflagration, and detonation (BDD) as lying on a continuum, defining the transition points from each regime to the next. This second paper builds on that background for a deeper understanding of how it can inform an understanding of how munitions react to explosive ordnance disposal (EOD) techniques designed specifically to prevent detonation of the explosive. We propose that when an explosive material within an explosive article (munition) detonates, the munition is said to high-order, but when the material burns or deflagrates, the munition low-orders. In short, a bomb explodes while the explosive within it detonates and low-orders when it deflagrates. This statement is explored in depth to form a robust justification for this and then propose a new munition reaction scale, based on physical evidence that allows results of EOD interventions to be correctly and consistently categorized.

KEYWORDS

deflagration; detonation; UXO; explosive; high-order; low-order

Introduction

The authors developed Combustion Continuum (Alford, Hazael, and Critchley 2024) for energetic material reactions to provide a clear way of considering the three main forms of combustion, burning, deflagration, and detonation as being different forms of the same basic oxidation processes ranked according to the speed of reaction (Figure 1). Critically, the transition points are clearly defined by the transition from burning to deflagration being the point at which the reaction becomes an explosion identified by the formation of an atmospheric shockwave, which is a transition that had not been so clearly defined in the previous work.

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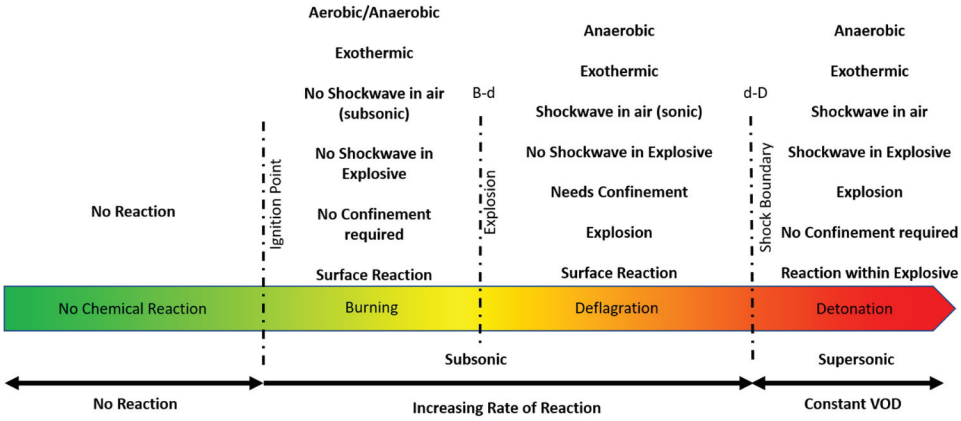


Figure 1. The combustion continuum illustrates the three reaction regimes and defines the characteristics of each (Alford, Hazael, and Critchley 2024).

When applied to the field of explosive articles, the observer will witness both the energetic material reactions described by the Combustion Continuum, but also the mechanical reactions of the casing and other materials that make up the explosive article. When a munition explodes, the detonating explosive forms large volumes of heat, light, and gas, which then cause the munition casing to fragment and fly apart at high speed as the designer would have intended. If, however, the explosive does not detonate, but for some reason deflagrates, the lower detonation velocity, which might be of the order of 10^3 or even 10^4 times slower (Schumacher 1972, secs. 12–4), the result would be expected to be very different. This situation might occur in rare instances of poorly made or designed munition but is more typically encountered when a munition is being deliberately disposed of as part of an Explosive Ordnance Disposal (EOD) action.

Unfortunately, within the EOD community, there has long been a degree of imprecision and confusion in the use of terminology used to describe both explosive and explosive article reactions, in general with little distinction between the two. This paper aims to bring greater clarity to what the various types of reactions are and to provide a clear understanding of how they are related to one another. This is done by developing the Combustion Continuum to show where different explosive article behaviors lie on the continuum.

The Combustion Continuum for Energetic Materials

The Combustion Continuum (Figure 1) is described in detail in Paper 1 of this series. It divides the chemical combustion reactions into three regimes which lie on an axis of increasing speed of reaction: burning, deflagration, and detonation (BDD).

High-Order Detonation Vs High-Order and Low-Order Detonation Vs Low-Order

Although the normal mode of reaction for munitions is clearly detonation, there are situations, most notably in the field of EOD, where the ability to cause a munition to break apart energetically without causing it to detonate is often seen as highly desirable as it can both render a potentially dangerous munition safe to remove and dispose of while avoiding the significant damage to the surroundings the munition was originally designed to cause (United Nations 2021, 12). This is most correctly described as a low-order event; however, this term is often poorly defined in the literature and the terms deflagration and low-order are often incorrectly used interchangeably. The author's previous work on the combustion continuum shows that deflagration is limited to energetic materials and should not be used to describe dynamic responses of explosive articles.

To make matters still more confusing, low-order *detonation* was historically used to describe both metastable detonation at a low detonation velocity such as that observed in dynamite which has two detonation velocities largely depending on charge diameter (Cook 1958, 51, 184; Johansson and Persson 1970, 51, 148; Leiber 2003, 219) and also for reactions in which military explosives resulting in an unpredictable partial failure to detonate (Cook 1958, 51). This is often used to simply mean a misfire regardless of the cause – for example a broken wire, which is clearly wrong. Similarly, the term high-order *detonation* was originally a synonym for detonation of an explosive (Alam 2007, 172). Clearly, both high-order detonation and low-order detonation are explosive substance reactions but are also distinct from the terms high-order low-order when used in EOD.

For the purposes of this paper, the terms high-order and low-order are used exclusively to describe explosive article reactions and burning, deflagration, and detonation are restricted to energetic and explosive substance reactions.

Understanding the Relationship Between Explosive Substance and Explosive Article Reaction Classes

The *combustion continuum (BDD)* (Figure 1) describes the various reaction classes of energetic substances as lying on a continuous spectrum based on the speed of reaction. With explosive articles, such as munitions which contain explosive substances, the casing surrounding the explosive may affect the explosive reaction, for example by providing the conditions for them to deflagrate rather than simply burn, but the casing may itself undergo different types of mechanical behavior. These differences need to be understood, and a suitable lexicon used to differentiate between explosive substance and explosive article behaviors.

This is particularly important in the field of explosive ordnance disposal (EOD) where it is necessary to be able to predict how a munition will respond to an action taken against a munition. The full detonation of a bomb is often an undesirable result due to the damage that may be caused, and many EOD techniques aim to cause a less energetic breakup of munitions to make them safe.

EOD rarely takes place in a scientifically controlled environment and instrumentation is normally minimal or non-existent. Understanding what has occurred after an EOD action is not always easy but is essential to be able to make an objective comparison between different results to learn and develop meaningful experience that can be used to guide future actions. An evidential method of analysis is needed which requires a clear understanding of the potential types of reaction and what to look for after an EOD action has been taken. Failure to do this can lead to misreporting of results and poor decisions in the future based on incorrect analysis of past work.

Unfortunately, the terminology and understanding of these events is often somewhat vague and misunderstood by operators, leading to a degree of confusion. The terms deflagration, low-order, and low-order deflagration are commonly used interchangeably with no acknowledgment of the difference between explosive substances and explosive articles.

The term *high-order* is generally used to describe full-detonation events, and *low-order* is used where the explosive deflagrates or partially detonates in a munition. It is important to recognize that this should be differentiated from the *combustion continuum (BDD)*, which is restricted to the chemical reactions of explosive substances, and instead describes the entire munition's reaction and not simply the explosive's reaction.

This could be due to the explosive deflagrating or partially detonating and this definition, but the term is often used to describe a misfire which might be caused by a failure in the priming of a charge, much to the confusion of many EOD operators.

In this paper, it is the modern definition relating the terms to munitions that is being used and which will be investigated deeper.

In essence, when the explosive substance in a munition deflagrates, the munition will break apart and the munition will be said to have low-ordered. In the same way, when the explosive in a munition detonates, the munition will have high-ordered.

Unfortunately, among EOD operators, the distinction between the explosive and munition reactions is generally lost. The terms *deflagration* and *low-order* are commonly used interchangeably and even combined as "low-order deflagration", and *detonation* and *high-order* are similarly used as synonyms or combined as in "high-order detonation."

When the explosive in a munition detonates, the munition breaks up into small, high-velocity fragments as described by the model developed by

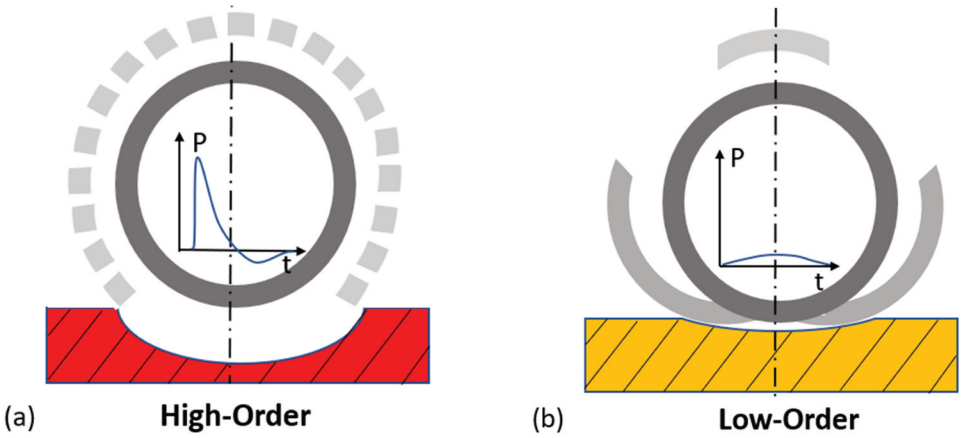


Figure 2. High-order events can result from munitions functioning as designed or because of some other stimuli. The dark gray shows the munition casing prior to functioning and the light gray the fragmented casing. Note the crater formed. (b) Low-order events can be much more variable in their final state, but the munition casing is shown to remain in much larger pieces (fig. 5). Adapted from held M (Lee 1998).

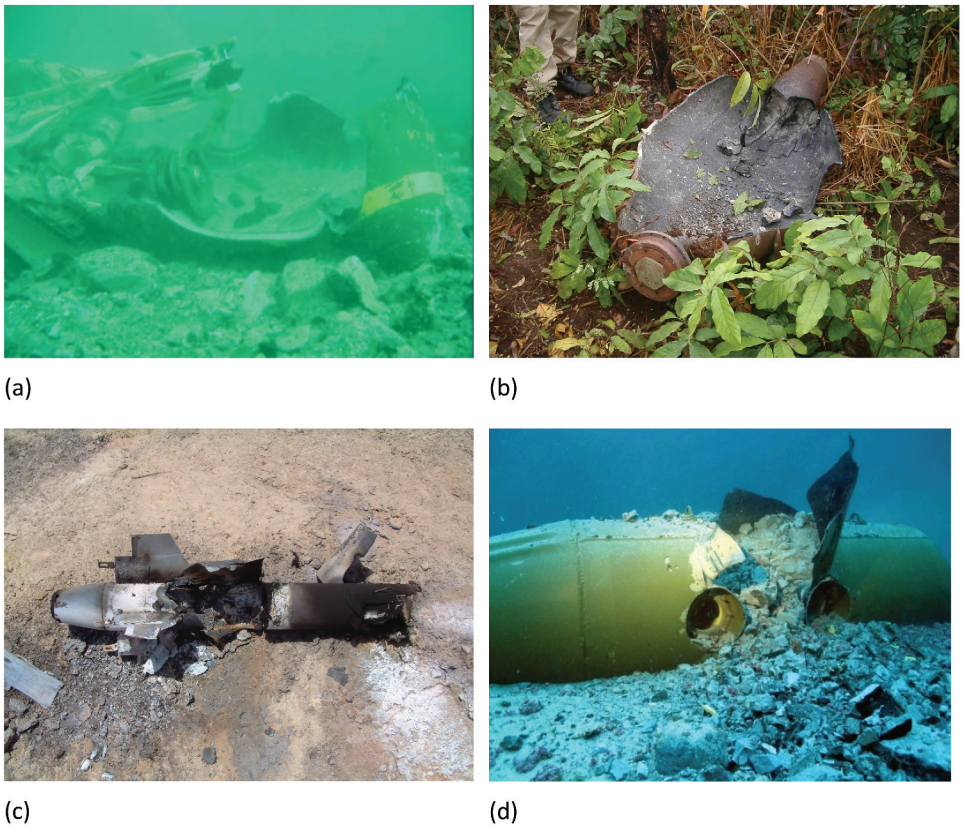
R. W. Gurney in the early 1940s (Cooper 1996, chap. 27) (Figure 2a). This is generally what the munition was designed to do and is known in EOD as a *high-order* event. Logically, it is most correct to say that the explosive detonated and the munition high-ordered.

If, however, the explosive deflagrates, the munition contains gas products until the internal pressure becomes too great for the casing material to withstand than the munition breaks apart. As the deflagration does not impart significant brisance to the munition casing as brisance is directly related to the VOD (Kramarczyk et al. 2022), it breaks up far less violently and tends to simply split apart or break into a few, large pieces that are traveling at relatively low velocities (Figure 3b). This is what is known as a *low-order* event.

Interpreting the Physical Evidence

As with any scientific experiment, reliably and consistently capturing the results is essential when carrying out EOD operations, but considering that such work is carried out under field-conditions, both on land and underwater, the use of pressure sensors and high-speed cameras, which might normally be used to record data, is virtually unheard of despite the fact that the gross difference between a munition high-ordering or low-ordering would be easy to measure. This is quite different from mining and demolition activities, where it is standard practice to measure air over-pressure/noise from blasts and to compare readings with predictive models.

For these reasons, the most reliable source of data is physical, case fragment size, crater size, damage to surroundings are all useful; however, in the normal



(a) (b)

(c) (d)

Figure 3. (a) Typical low-order of a Mk20 bomb underwater (b) low-order of mk 81 bomb in air, (c) low-order and burn of rocket motor and warhead (d) partial low-order on a thin-skinned mine showing premature bursting due to weak casing. Photos (a–c) Alford Technologies Ltd (d) image courtesy of Royal Norwegian Navy.

course of many EOD operations, significant protective works can be put in place partially obscuring or burying some or all of this data.

Reporting the noise level of explosions without measurement and solely relying on the observer's recollections can be highly subjective and is often an unreliable indicator (Schlaefer, Schlehofer, and Schüz 2009). Unless the listener is familiar with the noise from a bomb of a particular size functioning at a specific distance, it can be hard to tell with any degree of certainty even though the peak overpressure and damaged caused by a bomb detonating are very much greater than that of a low-order.

Robinson et al. measured a series of high-orders and low-orders of historical sea mines underwater (Robinson et al. 2020). They found that the peak sound pressure from high-orders was typically 20 dB higher than that from equivalent low-order events. It was found that the noise levels were almost entirely related to the amount of explosive that detonated and deflagrating explosive contributed almost nothing to the noise measurements. It is believed that the

peak pressures from low-order events was caused by the small (50–250 g) explosive charges used to trigger the low-order rather than the subsequent low-order explosion from the munitions bursting (Lepper et al. 2024).

In the commercial underwater UXO clearance industry, efforts are being made to mandate pressure measurements to police work, and this does provide useful data (National Physical Laboratory et al. 2020; Lepper et al. 2022; Robinson et al. 2022). This would not be required to reliably gain a clear understanding of what has occurred if careful and informed examination of the physical evidence is carried out and documented (Figure 3).

Several attempts have been made to allow operators to assess results (MOD 2007); however, these scales were not created with a clear understanding of the *combustion continuum (BDD)* and the clear distinction between explosive substance reactions and munition responses, so they naturally tend to be somewhat jumbled in their hierarchy (Table 2) rather than a progressive scale going from least violent to most violent, making it confusing to use (MOD 2007, 364).

No satisfactory definitions have been found in the literature, so the authors propose the following definition for high-order:

> A munition is said to high-order when the explosive fill detonates causing it to function largely as originally designed.

Correct Identification and Understanding the Mechanism of Low-Order Events

If the explosive fill of a munition can be caused to deflagrate, the result is typically a low-order and, as found by Lepper et al., is much lower energy events than high-orders, typically by an order of magnitude. As can be seen in Figure 3, the final condition of the munition can vary widely between shots, ranging from cases opening like a butterfly to breaking up into a small number of large pieces.

Understanding why this is the case requires an appreciation of the failure mechanism of munition cases.

As the explosive deflagrates, the pressure within the munition casing increases as the combustion gases are formed. Even without DDT, the pressure within a vessel can be raised by combustion or deflagration to pressures in excess of 1 kbar in under 100 microseconds (Jackson and Hill 2007) which is enough to exceed the limits of most munitions, causing them to rupture (Figure 3b) with the majority of the casing remaining in large pieces and possibly leaving a small crater. This is the typical failure mechanism linked to low-order events.

The moment at which the munition casing fails depends on many factors such as the speed of deflagration, type of explosive, metallurgy, and

construction of the munition and weak points in the casing. Unlike the VOD of an explosive, which remains constant once it has achieved a steady state, deflagration occurs over a range of reaction speeds that are dependent on external factors, so the degree to which the munition will break apart is likely to vary with the rate of pressure increase and the strength of the casing. The authors have observed that munitions that have a high steel-to-explosive ratio tend to react more violently than those that have lower hoop strength. For example, it has been found that US made 155 mm projectiles, which are generally shorter and stubbier than the British equivalent, typically break up into smaller pieces having undergone more violent low-orders (Figure 4).

Similarly, thin-skinned rockets and sea mines tend to undergo less complete breakup than air-dropped bombs.

In general, it seems that the higher the pressure required to burst the munition casing, the more violent the explosion will be. This will manifest itself in producing smaller bomb fragments and higher overpressure at a given distance but will always be an order of magnitude lower than would be achieved from a detonation event (Robinson et al. 2020).

Note that while it is common to describe the more violent results as *violent deflagrations*, this is imprecise, and the correct term should be violent low-



Figure 4. (A-b) typical low-order of a British 155 mm projectile (c–d) a violent low-order of an American 155 mm projectile resulting in smaller fragments photos Alford Technologies Ltd.

orders as there is no way to tell by looking at the physical remains if the deflagration of the explosive substance was more violent.

The human perception of noise is not a reliable way to compare explosions and those who lack experience of explosions will often report relatively small explosions to be large explosions. For this reason, it is often the final condition of the munition that is the best and only indication of the sort of reaction that has occurred and how violent the event was. Operators must therefore be able to "read" the evidence from the remains of a munition after an event. This is significant when selecting tools and methods of disposal.

Existing definitions of low-order generally tend to have one or more inconsistencies. For example, the UK MOD Joint Services Publication for EOD, JSP 364 (MOD 2007), describes a low-order as a "*detonation at a velocity well below the maximum stable velocity of detonation for a system*." Similarly, Akhavan classifies a low-order as a confined reaction in which the rate of deflagration has reached a value of 1000–1800 m/s (Akhavan 2004, 52).

This is equating low-order to an energetic material reaction level which was a historical application of the term which has now fallen out of current use.

There are several low-order techniques (LOTs) in use, with different levels of success when measured as a percentage of low-orders achieved. The most common methods of triggering a low-order are to cause deflagration of the explosive within the munition, either by imparting shock into the explosive (using an explosive charge or projectile) or by explosively injecting a burning material into it. Both shock and ignition can cause the explosive to deflagrate, rapidly generating a large volume of gas which pressurizes the munition casing, which eventually fails catastrophically, normally in conjunction with a fireball and an "explosion."

Alternative methods might be developed that do not require ignition (for example, pressurizing the munition), so low-order results are not a function of the means of triggering, merely the end state.

As with high-order, the term low-order has been poorly defined in literature, and the authors propose the following as a new definition:

> A munition is said to low-order when the explosive fill deflagrates, rapidly pressurising the munition to the point at which munition casing bursts and breaks apart less energetically than when detonating.

Existing and Proposed New Definitions for Relevant EOD Terms

The following definitions are drawn from the preceding discussions. They represent the relevant terms needed for EOD applications when considering low-order techniques.

Combined Combustion Continuum (BDD) and Explosive Article (Munition) Reaction Levels

Combining the munition reaction information with Figure 1 produces a graphic that clearly shows how the two types of reaction are related (Figure 5) that provides both a scientific understanding of what is occurring as well as clues that allow an operator to quickly assess and confirm what sort of EOD result has been obtained.

To further help the user to understand the definitions and to help identify the result based on the evidence found after an EOD intervention, the following graphic (Figure 5) has been developed. This graphically illustrates the spectral nature of the different reactions, showing how they are related and what evidence a user should look for when making an identification.

When reporting EOD actions and reactions that have taken place, Figure 5 allows operators to quickly assess and categorize the results. Just as the explosive reactions lie on a continuum that varies with the speed of reaction, the munition reactions in the combustion and deflagration categories both fit on their own scales of "violence of reaction." As was illustrated above in Figures 3 and 4, the result of a low-order event can vary widely from shot to shot depending on many different factors.

It is therefore useful to be able to further categorize results to give a qualitative understanding of the type of result achieved. During the literature review several different scales were found, one from the NATO Policy for

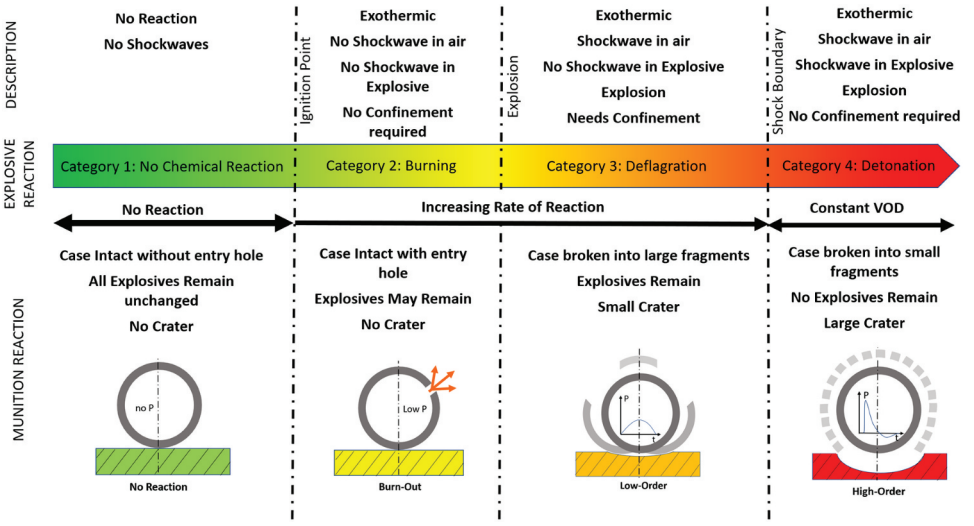


Figure 5. Proposed combined combustion continuum (BDD) and Explosive Reaction Levels Graphic. Dark gray shows munition casing in the original state and light gray indicates the condition post-intervention. Existing Reaction scales for categorising munition reactions.

Insensitive Munitions Assessment (AOP-39) (2018, p. I–2) and two from the UK's EOD Publication (Killip 2014; Lee 1998, 327; MOD 2007). All are in broad agreement with each other but each with their own features.

The NATO AOP-39 has IM Response Descriptors for munitions that are designed for subject matter experts rather than operators and are designed to provide a detailed means of identifying and categorizing results from insensitive munitions tests. The basis of these descriptors are six fundamental "types" of results: Type I – Detonation, Type II – Partial Detonation, Type III – Explosion, Type IV(f) – Deflagration, Type IV (p) – Propulsion, Type V – Burn and Type VI – No Reaction. It is worth noting that this scale covers both energetic materials and munitions without distinction between them.

The UK Ministry of Defence (MOD) Joint Services Publication (JSP) 364 - Joint Service Explosive Ordnance Disposal (EOD) Manual (Table 2) (MOD 2007) has a similar set of categories to the NATO document but has different terms used to describe results.

This is not a publicly available document, but the authors have been given permission by the MOD to reproduce Table 2 from the publication (Offord 2023). The main scale divides reactions into five types; No Chemical Reaction, Burn, Deflagration, Violent Deflagration, and Detonation, which are based on the explosive reaction level rather than the munition reaction. Reaction codes are given to each level of reaction based on the category the fall under.

The fault in this approach is that when subdivided further, categories such as burn to detonation (Code B4) falls under burning results when it is a partial detonation.

The second MOD scale from the same document is a more subjective but simpler scale (Table 3) that is based on the operator's view of the munition's reaction and is very subjective. It appears to be for use when operators are unable to determine the results in accordance with the first scale. Confusingly, the reaction code letter used do not correspond with the letters used in Table 2 even though they are from the same document.

None of these scales recognize the fundamental difference between explosive reactions and munition reactions, which the authors believe are key to categorizing results, instead grouping results according to the initial reaction type, so if a munition burns to detonation, it is classed as a type of burn rather than a partial detonation.

Proposed Scale for Munition Reactions

The proposed reaction scale is based on the definitions in Table 1 and grades all the reaction levels by the munition reaction as this is what the operator can most readily observe by examining the results. They are

Table 1. Summary of relevant EOD definitions.

Term	Definition
Explosive Ordnance (EO)	*All munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. Note(s): The English preferred term refers to explosive munitions collectively. Example(s): bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket, and small-arms munitions; all mines, torpedoes and depth charges, demolition charges; pyrotechnics; clusters and dispensers; cartridge and propellant-actuated devices; electro explosive devices; improvised explosive devices and all similar or related items or components explosive in nature*. (NATO Standardization Office 2021)
High-Order	*A munition is said to high-order when the explosive fill detonates causing it to function largely as originally designed. (Alford et al, Proposed 2025)*
High-Order Detonation	*A detonation is a shock wave with a rapid exothermic chemical reaction occurring just behind the shock front. In a given explosive sample, the wave speed is constant; the shock velocity does not speed up or slow down after the material has been initiated*. (Cooper 1996)
Low-Order	*A munition is said to low-order when the explosive fill deflagrates, rapidly pressurising the munition to the point at which munition casing bursts and breaks apart less energetically than when detonating. (Alford et al, Proposed 2025)*
Low-Order Detonation	*Detonation at the lower detonation velocity of explosives that have two metastable detonation velocities depending on the charge diameter. (Alford et al, Proposed 2025)*
Munition	*A complete device charged with explosives, propellants, pyrotechnics, initiating composition or chemical, biological, radiological, or nuclear material, for use in military operations, including demolitions*. (NATO Standardization Office 2021)

Table 2. UK MOD's main reaction scale from JSP 364 (MOD 2007).

	Reaction code definitions	
RESULTS	Code	Definition
No Chemical Reaction	A1	Case not Penetrated
	A2	Case Penetrated
	A3	Mechanical Breakup
Burn	B1	Burn Not Sustained
	B2	Burn Sustained to Burnout
	B3	Burn to Deflagration
	B4	Burn to Detonation
Deflagration	C1	Deflagration not sustained < 15% of fill consumed
	C2	Deflagration 15–50% of fill consumed
	C3	Deflagration > 50% of fill consumed
Violent Deflagration	D1	Violent Deflagration
	D2	Transition to Detonation
Detonation	E	Full munition detonation

Table 3. The alternative reaction codes in JSP 364 (MOD 2007).

ALTERNATIVE REACTION CODES	
REACTION CODE A:	No reaction
REACTION CODE B:	From the EOD Operator's perspective, reaction is less than expected the weapon partially open but a major portion of fill remains
REACTION CODE C:	From the EOD Operator's perspective, reaction idea, weapon open, remnants in the vicinity of original weapon location, no fill remaining
REACTION CODE D:	Reaction more violent than desired, fragments up to several hundred metres. Majority of fill consumed during deflagration.

scaled in order of violence and include both general descriptions of typical results and what specifically should have occurred. It also includes the reaction code from JSP 364 as a cross-reference to the existing scale.

Table 4. Proposed combined EOD reaction scale.

Reaction category	Reaction code	Munition reaction	General description of result	Explosive reaction	Evidence	AOP-39 reactions	JSP 364 code
1	1A	No Reaction	All explosive remains, no crater, no shock wave	No chemical reaction	Case not penetrated, explosive intact	Type VI	A1
	1B	No Reaction			Case penetrated, explosive intact	Type VI	A2
	1C	Disruption			Mechanical breakup, explosive intact	Type VI	A3
2	2A	Partial Burn-Out	Slow combustion, munition case vented but not burst, no crater	Burn	Partial combustion, some/most explosive remaining., some paint burnt	Type V	B2
	2B	Complete Burn-Out			Full combustion, no explosive remaining, all paint burnt	Type V	B2
	2C	Burn to Low-Order	Slow combustion followed by explosion, possibly due to booster cook-off, munition case partially burst, no crater		Slow combustion transitioning to deflagration, some explosive may remain	Type V	B3
3	3A	Partial Low-Order	Explosion, explosive remaining, munition case split possibly broken into large fragments, little or no cratering, no detonation, no shockwave	Deflagration	Deflagration not sustained < 15% of explosive consumed	Type IV	C1
	3B	Low-Order			Deflagration consumed 15%-50% of explosive	Type IV	C2
	3C				Deflagration consumed >-50% of explosive	Type III	C3
	3D	Violent Low-Order			Deflagration, significant case breakup, some explosive may remain	Type III	D1
4	4A	Partial Detonation	Violent explosion, case fragmented into medium/small sized fragments, major cratering, detonation, shockwave, no explosive remaining	Detonation	Burn to detonation, no explosive remaining, less violent than full detonation	Type II	B4
	4B				Deflagration to Detonation Transition (DDT), no explosive remaining, less violent than full detonation	Type II	D2
	4C	High-Order			Immediate, full detonation	Type I	E

Conclusions and Recommendations

Energetic materials and more specifically *explosive substances* may burn, deflagrate, or detonate, while *explosive articles* such as munitions may low-order or high-order.

Existing definitions for key terms used in EOD have been loose and open to interpretation. This paper has examined the various definitions available and analyzed the actual phenomena to come up with a series of definitions that are mutually consistent and clearly defined with observable parameters that allow operators to consistently identify and categorize results without requiring personal opinions and experience.

- It is recommended that EOD activities clearly distinguish between explosive reactions (chemical) and munition reactions (mechanical).
- The *Combined Combustion Continuum (BDD) and Explosive Reaction Levels Graphic* (Figure 5) be adopted as an aide-memoire by EOD operators for identification of EOD results.
- The proposed reaction scale in Table 4 be used by operators to describe the EOD results.
- It is recommended that the following new definitions are adopted into the existing lexicons:

Deflagration	*Deflagration is an exothermic chemical reaction of a confined pyrotechnic, explosive or propellant, proceeding at a rate below the velocity of detonation of the material, the gas products of which produce an atmospheric shock wave as it explodes*. (Alford, Hazael, and Critchley 2024)
High-Order	*A munition is said to high-order when the explosive fill detonates causing it to function largely as originally designed.*
Low-Order	*A munition is said to low-order when the explosive fill deflagrates, rapidly pressurising the munition to the point at which munition casing bursts and breaks apart less energetically than when detonating.*

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The sections released are:
Deflagration: JSP 364 Pt 2 Vol 1 Page 375, Para 3 lines 1,2,3
DTT: JSP 364 Pt2 Vol 1 Page 375, Para 3 lines 3,4 •
Reaction Codes: JSP 364 Pt 2 Vol 1 Pages 401 and 402

Ethical Statement

I, Roland Alford, consciously assure that for the manuscript Application of the Combustion Continuum to Explosive Ordnance Disposal the following is fulfilled:

1. This material is the authors' own original work, which has not been previously published elsewhere.

2. The paper is not currently being considered for publication elsewhere.

3. The paper reflects the authors' own research and analysis in a truthful and complete manner.

4. The paper properly credits the meaningful contributions of coauthors and co-researchers.

5. The results are appropriately placed in the context of prior and existing research.

6. All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.

7. All authors have been personally and actively involved in substantial work leading to the paper and will take public responsibility for its content.

The violation of the Ethical Statement rules may result in severe consequences.

I agree with the above statements and declare that this submission follows the policies of the journal as outlined in the Guide for Authors and in the Ethical Statement.

Disclosure Statement

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