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MEMORANDUM FOR ASSISTANT DEPUTY UNDER SECRETARY OF DEFENSE
(ENVIRONMENT, SAFETY AND OCCUPATIONAL HEALTH)

SUBJECT: Report of the Defense Science Board Task Force on Unexploded Ordnance,
November 2003—DoD Response

At OSD's request, the Operational and Environmental Executive Steering Committee for Munitions (OEESCM) prepared a DoD response (enclosed) to recommendations contained in the November 2003 report of the Defense Science Board Task Force on Unexploded Ordnance (UXO).

Between September 2002 and May 2003, the DSB Task Force on UXO met to address whether advanced technology could (a) reduce munitions response and range maintenance costs; and (b) minimize the environmental impact of future live-fire military munitions training. The Task Force recommended that DoD: (a) Institute a national area assessment of munitions response areas; (b) Increase the research and development effort on UXO instrument technology, green munitions, and munitions constituent (MC) phenomenology; (c) Institute a management and contractual structure that can capitalize new technology instruments; (d) Assess live-fire practices on operational ranges with the goal of reducing the UXO and related MC problems; and (e) Establish a full life-cycle cost (LCC) protocol for military munitions that includes cleanup and demilitarization.

In general, the DoD response agrees with the Task Force that technology may reduce costs and minimize environmental impacts; but indicates that translating the Task Force's broad recommendations into actionable plans is neither simple nor direct. The DoD response concurs with the broad goals the Task Force outlined, but differs with the means to reach some of the goals. While the DoD response focuses on the specific recommendations of the Task Force, it also addresses other issues the Task Force raised, either directly or indirectly, in its report.

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Enclosure

**Operational and Environmental Executive Steering Committee for Munitions (OEESCM)
Munitions Response Subcommittee (MRSC)
Response to Defense Science Board UXO Task Force's Recommendations
(Report of the Defense Science Board on Unexploded Ordnance, November 2003)**

Executive Summary

Between September 2002 and May 2003, the Defense Science Board (DSB) Task Force on Unexploded Ordnance (UXO)¹ (Task Force) met to address two questions:

- Can advanced technology reduce munitions response² and range maintenance costs?
- Can advanced technology minimize the environmental impact of future live-fire military munitions training?

The Task Force concluded that technology could reduce costs and minimize environmental impacts and offered five recommendations for improving the Department of Defense (DoD)'s UXO-related programs. The Task Force's recommendations identified changes in funding and approach to address DoD's UXO-related obligations; and recognized that, to preserve its operational ranges, DoD must address the cumulative effects of UXO and munitions constituents (MC)³.

The Task Force recommended that DoD:

- Institute a national area assessment of munitions response areas.
- Increase the research and development (R&D) effort on UXO instrument technology, green munitions, and MC phenomenology.
- Institute a management and contractual structure that can capitalize new technology instruments.
- Assess live-fire practices on operational ranges with the goal of reducing the UXO and related MC problems.
- Establish a full life-cycle cost (LCC) protocol for military munitions that includes cleanup and demilitarization.

The Office of the Secretary of Defense (OSD) tasked the OEESCM's Munitions Response Subcommittee (MRSC) to develop a recommended DoD position on the Task Force's recommendations. The MRSC agrees, with the Task Force, that technology may reduce costs and minimize environmental impacts; but it believes that translating the Task Force's broad recommendations into actionable plans is neither simple nor direct.

The MRSC concurs with the broad goals the Task Force outlined, but differs with the means to reach some of the goals. The first three Task Force recommendations call for significant increases in UXO-related funding. These increases approximate \$250M per year for the next 5 years and \$200M per year for the out years—a doubling of current levels. The MRSC agrees that the recommended increases in funding would allow significant progress in technology development, site assessment, and UXO cleanup and are justified. However, given current funding and mission requirements, the MRSC recognizes that these funding increases may not occur. Nevertheless, DoD can pursue many of the recommendations at current funding levels, or at funding levels reduced from that which the Task Force recommended.

The MRSC also examined the Task Force's recommendations in view of DoD's current funding levels to identify steps DoD could reasonably take to achieve the goals the Task Force recommended. The MRSC believes DoD should:

- Develop an area assessment process that DoD Components can implement on a limited scale. Initiate discussions within the Munitions Response Committee (MRC) to establish parameters for a flexible, UXO assessment (i.e., footprint reduction) process. The parameters must identify how to distinguish clean parcels⁴ from potential munitions response sites (MRS)⁵, thereby, reducing the total acreage suspected or known to be encumbered by UXO and/or DMM—the UXO footprint. The Task Force's discussion about a national area assessment focused on the use of a small number of contractors to conduct a nationwide assessment of MRA. The MRSC's approach focuses on establishing a mutually agreed upon⁶ process and criteria for distinguishing clean parcels from potential MRS. The MRSC's approach recognizes that the DoD Components are best able to determine their specific needs and program constraints and leaves contracting decisions to them.
- Pursue additional R&D funding in the Task Force recommended areas (e.g., UXO technologies, green munitions, MC phenomenology), with added emphasis on quickly transitioning technology improvements from the laboratory to the field. Barring the availability of additional funding, DoD should continue its current plans and funding levels in these areas. Regardless of the course that DoD takes, it should increase the involvement of environmental regulators and safety officials in technology development, validation and acceptance.
- Increase Military Munitions Response Program (MMRP) funding levels, and provide incremental funding to encourage innovation, increase investment by existing firms, and entice new companies to enter the field. The Task Force's discussion focused on using a small number of large contracts, which would serve to enable those firms awarded such contracts to make capital investments in new equipment, so that emerging technologies would transition to the field faster. The MRSC believes that total program funding rather than the number of contracts is a core issue. DoD should establish policy, incentives and contract selection criteria to encourage the use of advanced technology. Incremental funding could encourage industry to invest in advanced technology by allowing investments to be spread across several years or to larger projects. Use of incremental funding would require changes in DoD contracting rules.
- Continue to assess how DoD can best maintain readiness, while reducing the creation of additional UXO and decreasing the deposit of MC on operational ranges. Among other things, the Task Force recommended DoD increase its use of simulators, use electronically scored ranges, focus on the development and use of green munitions, and implement range clearance policy. The MRSC agrees with the recommendation to assess how additional UXO and MC can be decreased. While, the MRSC agrees that an increased use of simulators and electronically scored ranges can reduce creation of UXO and the deposit of MC, it does not agree that DoD should increase such use solely for these purposes. DoD believes that live-fire training directly translates into Force survivability on the battlefield; and while simulators and electronically scored ranges enhance individual proficiency, they do not provide the realism necessary to successfully engage an enemy in a combat situation. The MRSC recommends DoD continue its efforts to develop empirical data about the effects of munitions use, particularly on operational ranges.
- Develop a protocol to capture the LCC of munitions, to include their demilitarization and cleanup; define "green munitions;" and establish a process to attain visibility of the Services' efforts to (1) develop and field green munitions; and (2) reduce the LCC of munitions management. DoD should also develop systems engineering tools that project total ownership costs based on pertinent parameters so that design optimization can occur during tradeoff analyses in acquisition.

The MRSC also recommends that:

- DoD develop and implement policy and process that encourages the rapid transition of new or advanced technology to field use in munitions responses and operational range clearance activities.
- DoD develop a plan for investment in fuze and fuze-related technology to ensure munitions system reliability policy goals are met and to reduce UXO through improving fuze and munitions reliability.
- OSD designate an organization to be responsible for funding and coordinating efforts in the area of human toxicology of MC.

Introduction

Between September 2002 and May 2003, the Defense Science Board (DSB) Task Force on Unexploded Ordnance (UXO) (Task Force) met to address whether advance technology:

- May reduce munitions response and operational range maintenance costs.
- Could minimize the environmental impact of future live-fire military munitions training.

The Task Force recognized that the UXO problem is complex, with specific challenges. These include:

- The massive scale of the UXO problem (e.g., the number of sites, the total acreage potentially encumbered by UXO or DMM--the UXO footprint). (See enclosure.)
- The lack of reliable data on munitions response sites (MRS).
- The variety of physical characteristics at munitions response areas (MRA)⁷ (e.g., geology, munitions types).
- The technology challenges (e.g., achieving a high probability of detection, while keeping the false alarm rates low) involved.
- The lack of accepted health standards for many munitions constituents (MC).
- Variety and number of stakeholders.

The Task Force recognizes that developing and fielding advanced technology and changing the way DoD uses and manages operational ranges may help reduce DoD's UXO-related liabilities. DoD estimates that its munitions-related liabilities⁸ for closure of its operational ranges to be between \$16B and \$165B. For other than operational ranges (e.g., former ranges, demilitarization sites), DoD estimates its MMRP liabilities to be between \$8B and \$35B⁹. Meanwhile, UXO funding levels are about \$0.225B per year. As the Task Force points out, the DoD will never complete the job, without a number of changes that include increases in funding and changes in DoD's approach to the UXO problem.

The Task Force believed to preserve its operational ranges, DoD must address the cumulative effects of UXO and MC. The Task Force recognized that with increased development and use of property (e.g., former ranges) on which UXO is known or suspected to exist, public concern about the hazards potentially present on these properties and even about the management of operational ranges will only increase.

The MRSC agrees with the Task Force, that technology may reduce DoD's liabilities and minimize environmental impacts; but it believes that translating the Task Force's broad recommendations into actionable plans is neither simple nor direct.

Task Force Recommendation 1: Institute a national area assessment of the identified 10 million acres.

The MRSC concurs that a large-scale assessment process for reducing the UXO footprint would be advantageous. Such a process would provide two critical benefits:

- Significantly reduce the total acreage suspected or known to contain UXO and/or discarded military munitions (DMM)¹⁰. (See enclosure.)
- Provide critical data to improve the management of the remaining acreage.

The MRSC believes that an appropriate UXO footprint reduction process that establishes broad criteria to efficiently assess and reduce the total acreage currently suspected to be within the UXO footprint is required. Although the footprint reduction process differs from the Task Force's recommendation, the MRSC believes that it will achieve the same goal. A UXO footprint reduction process is likely to include wide area assessment (WAA) technology as an important element. The MRSC believes that airborne technology,

which may not be a suitable approach for all MRA or MRS, should be applicable for a significant portion (see enclosure). The Environmental Security Technology Certification Program (ESTCP)'s fiscal year (FY) 05 WAA demonstration is the first step in developing this process. ESTCP's demonstration should provide the testing required for planning a full-scale UXO footprint reduction process.

In 2001, DoD established the MMRP to get better visibility of the resources required to address the safety, health, and environmental issues presented by UXO, DMM, and MC. DoD's first step was to identify, through a comprehensive inventory, all potential Defense Sites¹¹ (referred to as MRA and MRS) that would require a military munitions response. Most likely, UXO and DMM encumber only a fraction of the total acreage DoD identified in its MRS Inventory. The MRSC agrees with the Task Force that quickly determining or more closely approximating the actual acreage for which a military munitions response is required might enable the reuse of any acreage mutually agreed upon as "clean parcels." Implementation of a footprint reduction process would also allow DoD to better estimate its potential liabilities, under the MMRP and to plan required munitions responses.

The MRSC concurs with the Task Force that any assessment used to reduce the UXO footprint must follow the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and have acceptance by environmental regulators and safety officials. The MRSC recognizes that ruling out the presence of UXO and/or DMM would not necessarily mean that an area was available for unrestricted use because other environmental contamination (e.g., heavy metals, petroleum) may exist.

The MRSC concurs with the Task Force that the potential costs of any UXO footprint reduction effort may be high. The MRSC notes that the approach the Task Force recommends emphasizes identifying clean parcels before addressing high-risk parcels. This may equate to a subtle shift in DoD's current approach of focusing on MRS presenting the highest relative risk first. The MRSC recommends DoD implement a UXO footprint reduction process that balances relative risks against the benefit of identifying clean parcels for unrestricted use. The use of the recently developed Munitions Response Site Prioritization Protocol (MRSP), which assigns each MRS a relative priority based on risk, but allows sequencing decisions based on other factors, will help DoD maintain this balance.

Recommended Action: DoD should implement a UXO footprint reduction process. Although this can be done immediately, with the concurrence of the appropriate environmental regulators and safety officials, on a MRS by MRS basis, DoD should initiate discussions with the Munitions Response Committee (MRC)¹² to establish criteria, acceptable nationwide, for such a process. This process must:

- Identify the minimum information necessary to distinguish clean parcels from potential MRS.
- Determine acceptable risk based on reasonable exposure scenarios.
- Be flexible enough to accommodate a variety of site-specific conditions (e.g., different types of munitions, topography).
- Establish a method to identify appropriate and acceptable assessment technologies that anticipates insertion of new technology and methods.
- Be based on a transparent decisions-making process that would allow reasonable individuals to make the same decision independently.

Rationale: DoD's recent MRS Inventory identified a UXO footprint of approximately 16.5 million acres, not including operational ranges. The successful development of a footprint reduction process will require significant advance planning and extensive coordination with environmental regulators and safety officials, and stakeholders. To identify and accept a parcel as clean, environmental regulators and safety officials will require a high level of confidence in the technologies used and the data gathered. As such, DoD should work with the MRC to attain mutual agreement on an assessment process.

The FY 05 Appropriation provided ESTCP with \$5M to demonstrate the ability of emerging technology to perform WAA and reduce costs. These funds along with leveraged DoD Component resources offer DoD an opportunity to test various approaches to such assessments prior to initiating any large-scale effort.

The Task Force identified an initial national area assessment as key to DoD getting ahead of the UXO problem and developing a sensible, coherent cleanup program. The MRSC concurs with this goal but believes the focus should be on developing a UXO footprint reduction process rather than a national area assessment program. The MRSC believes that:

A Preliminary Assessment (PA), which is required by and key to the CERCLA process and includes a detailed historical records review, is the most viable approach for the initial stages of any UXO footprint reduction process. The review of available records (e.g., historic records and aerial photographs) and the site reconnaissance are the first step to reducing the UXO footprint by identifying MRS (discrete areas), within an MRA. Indicators of munitions-related activities and of potential MRS within an MRA include, for munitions and explosives of concern (MEC)¹³, UXO, munition debris, range-related debris and, for MC, soil stains, discolored sediments. A typical MRA, which is normally a conservative identification of acreage on which MEC "could" be present, would be the entire acreage of a former installation or range. A typical MRS would be only a portion of the entire acreage (e.g., only the impact area, specific target areas, firing points or sites used for open detonation of unserviceable munitions).

When there is insufficient definitive historical information to identify all MRS, or where there is a belief that undocumented MRS exist, other methods (e.g., statistically based sampling) may be used to identify potential MRS. The collaborative development of a conceptual site model (CSM), which considers all available information (e.g., type of military activities conducted, munition used) will help ensure all potential MRS are considered in the design of a munitions response.

Use of advanced technology (e.g., WAA, discrimination software) offers the technical planning team an opportunity to refine MRS boundaries and further reduce the UXO footprint as well as obtain a better characterization of the areas requiring remediation. A suite of tools (e.g., WAA, digital geophysical mapping, site reconnaissance, statistically based sampling) to support the data quality objectives and other factors, as mutually agreed upon, may allow the total UXO footprint to be reduced and provide critical data to improve the management of the remaining acreage.

Task Force Recommendation 2: Increase the R&D effort on UXO instrument technology, green munitions, and munitions constituents phenomenology to a level of \$80M per year. (The Task Force recommended an increase of \$20M per year for UXO remediation technology R&D and \$20M per year for green munitions and munitions constituents related R&D.)

The MRSC agrees that increased R&D funding could result in significant return on investment in:

- UXO technology. This is particularly true for technology that allows for reduction in the false alarm rate, while it maintains a high probability of detection.
- Green Munitions. The development of green munitions has the potential to reduce the environmental impact of military munitions use and the level of cleanup required for operational ranges closed in the future.
- MC Phenomenology. Development of empirical data on MC fate and transport is needed to model and address the potential environmental effects of MC.
- Toxicological data. Review of existing toxicological data and new research into compounds of military interest offers opportunities to evaluate better the actual and potential health effects of MC.

Since the Task Force issued its report, DoD increased the Strategic Environmental Research and Development Program's (SERDP) funding in UXO-remediation technology by \$4 M in FY 06 and \$5M per year, starting in FY 07. Additionally, DoD plans to increase ESTCP funding for UXO-remediation technology by approximately \$5M per year, starting in FY 08. Increased funding is still needed to support DoD's green munitions efforts and for MC-related R&D efforts.

Recommended Action: DoD should:

- Continue to pursue additional R&D funding in the Task Force recommended areas (e.g., UXO technologies; green munitions to include fuze technology; MC phenomenology), with added emphasis on quickly transitioning technology improvements from the laboratory to the field.
- Better define *green munitions* and attain visibility of the Services' efforts to develop and field green munitions.
- Designate an organization to be responsible for funding and coordinating efforts in the area of human toxicology of MC and other environmental contaminants.
- Work with the MRC and the Interstate Technology Regulatory Council (ITRC) to establish a process that allows rapid transition of new technology to field use.
- Provide opportunities for the demonstration of innovative technologies during planned or on-going munitions responses.

Rationale: DoD is already addressing many of the issues the Task Force raised, with funding targeted to the most promising. The use of any increased funding provided must have clearly defined goals, and should be applied to either new studies (e.g., toxicology), funding more ambitious studies (e.g., large scale demonstrations), supporting studies that will allow rapid transition of technology to the field, and developing decision making tools. Such efforts should be harmonized with other DoD efforts (e.g., development of high performance energetics, insensitive munitions (IM), green munitions, and reliable fuzes).

- UXO Instrument Technology. The MRSC believes, along with a continued focus on detection and discrimination technology, that DoD funding decisions and policy development should focus on rapid technology insertion. The use of new technology is dependent on the transition and insertion process. The 2005 Program Objective Memorandum (POM) included funding for technology transition. Early regulatory involvement is a recurring theme in all UXO discussions.

To realize the promise new or improved UXO technology offers, DoD must continue to be proactive in soliciting input from environmental regulators and safety officials, industry, and stakeholders during the development phase. Any additional increased funding should focus on rapidly transitioning technology that is nearing maturity to the field.

The ESTCP conducts technology demonstrations on test sites. Current funding does not allow for large demonstrations on an actual MRS. The DoD Components' operational tempo and mission requirements often make it difficult for the ESTCP to conduct more extensive testing of new technology on operational ranges. The insertion of new technologies at uncontrolled sites (e.g., an MRS), with input from the environmental regulatory community, is a needed step in transitioning technology from R&D to industry practice. The DoD will need to provide policy to support the RDT&E community's demonstration of new technology during a munitions response at an actual MRS.

- Green Munitions. The Task Force recommended an increase in R&D of green munitions. The Task Force indicated its belief that improving fuze reliability was a key to addressing the overall UXO problem. [An ongoing DSB Task Force study of munitions system reliability, which will address range safety and operations, and battlefield UXO danger to friendly troops and civilians, is also focusing on fuze reliability because of the role fuzes play in the creation of UXO.]

Historically, DoD performed green munitions evaluations using a qualitative, rather than a quantitative, process. DoD does not have a clear definition of what constitutes a green munition. Although DoD has been evaluating green munitions for an extended period, the focus remains on munitions constituents, and there is a lack of evaluation of the end use effects. Although DoD's 5000 directive series and guidance contains requirements for green products and evaluations, DoD's Green Procurement Strategy and ESOH's munitions-related policy has focused on production processes, handling and disposal processes, and support services and products, rather than on development or use of alternative munitions constituents. The green product evaluation is generally left to the developer, with little oversight of the developer's assessment at milestone decisions.

DoD's recent emphasis on IM provides an example of the need to understand the interrelationships between different aspects of DoD's munitions programs better. IM are military munitions that are not likely to detonate when subjected to unplanned stimuli (e.g., bullet impact, fuel fire). General-purpose bombs with RDX-based fills (instead of TNT-based tritonal explosive fills) are an IM-improvement; however, RDX, as an MC, has come under intense environmental scrutiny in the past several years due to its potential adverse health effects.

Software that evaluates MC against 71 federal and state environmental, health and safety regulations is available to DoD, but largely remains unused. The software and its integrated modules perform environmental impact assessments, but cannot identify green munitions. Additional tools are being developed to accelerate the expansion of green munitions by providing a means, early in the design and development stages, to identify MC that are the least environmentally friendly and offer potential replacements. This will provide quantitative assessments at the item, component, part and chemical level. The intention is to improve future compliance, and reduce cleanup and demilitarization costs.

- MC Phenomenology. The Task Force recommended increasing research in the area of MC phenomenology. Under current and developing DoD policy and per the Defense Planning Guidance for Fiscal Years 2004 - 2009, DoD Components are required to determine whether a release or substantial threat of a release of MC of concern from an operational range or range complex to an off-range area poses an unacceptable risk to human health or the environment. Required operational range assessments will contribute to DoD's understanding of MC fate and transport mechanisms. As part of these assessments, qualitative and quantitative models will use existing data to analyze the most probable migration pathways through environmental media (e.g., percolation through soil to groundwater, dissolution in groundwater and surface water, and/or erosion).

By better understanding the MC phenomenology and potential effects munitions-related, activities (e.g., use, production, demilitarization) have on human health and the environment, DoD may be able to ensure it designs military munitions not only to defeat enemy forces, but also to reduce the potential long-term effects on human health and the environment. This understanding will help DoD ensure the long-term sustainability of operational ranges and reduce the potential (unknown) cost of closing or cleaning up operational ranges on their closure.

- Human Toxicology. Understanding the full range of MC phenomenology requires that potential toxicological effects of MC be addressed. Along with other data, environmental regulators and safety officials establish cleanup standards based on toxicology studies that may not meet current quality standards. The application of inadequate toxicological data to risk assessments can result in overly conservative remediation and cleanup standards nationwide.

In the past:

- DoD has made only limited investment in evaluating the underlying toxicological effects of MC. Historically, short-term efforts to understand MC toxicology have been ineffective at influencing cleanup standards. Maintaining a sustained effort to understand these effects is the key to influencing such standards. However, changing standards that have historically been based on policy decisions driven by public perceptions rather than science is difficult.
- Several federal offices have contracted with universities and others to perform toxicity studies. In many cases, improperly scoped studies were conducted, and frequently the work was not of sufficient quality for use in modern risk assessment. In short, there has been insufficient coordination in the area of toxicology, and central leadership is needed to ensure application of appropriate skills in planning, evaluation and scoping such study efforts.

The Environmental Protection Agency (EPA) applies uncertainty factors when calculating toxicity values (e.g., reference dose values and cancer slope factors) used in risk assessment. If the studies supporting these values are substandard, as many older ones are, the result is larger uncertainty factors and cleanup standards lowered to levels that are overly conservative (well beyond those required to protect against health risks). EPA allows significant reduction from the customary factor or, in some cases, eliminated altogether, if the regulated community agrees to conduct additional toxicity studies. To ensure the lowest appropriate uncertainty factors are used in determining toxicity values and in setting cleanup standards, DoD must conduct the recommended toxicity testing. Updating MC-toxicity data using the latest techniques can reduce the normal ten-fold uncertainty factor to three or even to one. Current procedures encourage investigators to use both traditional biochemical studies and newer genomic and proteomic technologies in the conduct of studies to clarify the mode of toxic action. Such mechanistic data can significantly reduce uncertainty factors.

As an example, the regulatory community currently uses a 4,000-fold (combined) uncertainty factor for the risk assessment value for RDX (2 ppb) in drinking water. This means that the drinking water exposure is 4,000 times lower than the no effect level (NOAEL) observed in the toxicology study that supports this value. Although an uncertainty of this magnitude is not warranted, DoD could do little in the past to affect this value. DoD now has the ability to conduct the toxicological studies and provide scientific justification for reducing the uncertainty related to health effects. The MRSC believes it is in DoD's best interest to invest in toxicological testing. Additional funding for such tests will accelerate DoD's understanding of MC toxicology and has the potential to help ensure realistic cleanup standards are applied thus reducing cleanup costs.

Task Force Recommendation 3: Institute a management and contractual structure that can capitalize new technology instruments.

The Task Force stated that:

- Deployment of technology is the key to saving billions in remediation/cleanup costs.
- Larger industrial firms are necessary to migrate to a “wholesale” operation. DoD must encourage participation of larger industrial firms.

The MRSC believes that the timely transition of technology to field use is one of the best ways to reduce the costs associated with the cleanup of MRS. The keys to technology insertion are:

- Increasing program funding and size.
- Consolidating like work (e.g., the cleanup of all or a regional portion of former small arms ranges).
- Involving environmental regulators and safety officials early and continuously in technology development and in the site-specific design of munitions responses. The MRSC believes this will improve the probability of successfully transitioning technology from R&D to field use.
- Implementing policy and processes that encourage the rapid transition of advanced technology to field use in both munitions responses and operational range clearance activities.
- Deferring the cleanup of the most challenging MRS, for which current technology is not suitable, until appropriate technology is available, or using such MRS to prove out technology in R&D.

The Task Force based its recommendation on the premise that (1) available and appropriate advanced technology is not reaching the field, and (2) only larger firms are willing and able to invest in advanced technology. The MRSC believe that these basic assumptions require further examination. It appears that funding levels and contractual disincentives, rather than business size, are the actual barriers to technology insertion.

Recommended Action. DoD should:

- Seek MMRP funding at the levels recommended by the Task Force.
- Provide incentives that encourage the use of advanced technologies
- Clarify and provide greater policy support for the use of the best available technology.
- Review and change, as necessary, contracting methods (e.g., incremental funding, consolidation of like work) to allow contractors to plan return on technology investments.

Rationale: Discussions with industry representatives and within DoD indicate that:

- Contract capacity and individual contract size are presently sufficient to support fielding of advanced technology. Advancements in current technology have not been so expensive as to prevent their use, particularly when the contractor can realize a reasonable return on investment.
- Funding levels for contracts is a major barrier. A small market and uncertain funding discourages investment, and reduces the probability that additional companies will enter the munitions response field. Increased funding would have the greatest impact on the use of advanced technologies by encouraging innovation, lead to increased investment by existing firms, and entice additional companies to enter the field.

The MRSC believes barriers to technology insertion include:

- The overall size of the MMRP budget and contracting rules that force execution to be programmed in small piece-meal efforts that do not support the use of advanced technology.
- Limited regulatory involvement in technology development leads to a perception that advanced technology is unproven, and its use carries with it a regulatory-acceptance risk.
- The current contracting approach and selection process appears to favor older technology, providing little incentive for use of advanced technology.
- The potential need to address MRS that, although suitable for technology demonstrations, are either not funded or considered of lower risk than other MRS.
- Limited funding and opportunities for large-scale demonstrations of advanced technologies during actual munitions response hampers a more rapid transition of technology from R&D to use.

Munitions response contracting has evolved over the last few years from contracts that used 'method specifications' on a cost reimbursable basis to alternate, innovative contracting mechanisms. As DoD and contractors developed a better understanding of the munitions response process and potential risks, alternate contract mechanisms (e.g., firm fixed price contracts, performance-based contracts) became viable. This understanding also allowed insurance companies to begin to offer contractors environmental insurance for munitions responses to MEC. As a result, contractors have greater flexibility in technology selection and their munitions response design, and are better able to determine their potential costs.

Small companies have demonstrated that they are willing to make considerable investments (e.g., digital geophysical mapping, or DGM), when the technology is proven, accepted by both DoD and environmental regulators and safety officials, cost effective and provides for a reasonable return on investment. A difficulty for all businesses is assuring a reasonable return on investment. Incremental funding and consolidation of like work could encourage industry investment in advanced technology by spreading them across several years or larger projects.

Fielding of advanced technologies is subject to a number of differing pressures. Most project managers, installations, and contractors are risk averse. Inserting advanced technology into a cost driven-contracting environment is difficult, potentially more complex, and may increase costs over the short term to save costs over the life of the project. In addition, the end user may not recognize the value of the improved product (e.g., availability of a digital record) at the added cost, and the company's improved performance may not be recognized in a cost-driven selection process. Additionally, evaluation criteria for contracts, which generally focus on lowest cost, often do not recognize the added value provided by the use of advanced technology such as DGM. Clearly, the current competitive process does not provide an incentive for rapidly transitioning advanced technology to the field. Performance statements and standards that clearly define cleanup objectives and encourage the use of advanced technologies are necessary to overcome resistance to its use.

The Task Force recommended that DoD centralize its MMRP program management structure and execution, believing that doing so would allow larger contracts and make the MMRP more attractive to larger businesses. By implication, this would make larger companies more willing and able to apply innovative technology. In the past, DoD has centralized its MMRP management under FUDS with the USACE (see Table 1), without the effect indicated. However, as DoD better defines and expands its munitions response efforts, consolidation of like work could, with increased funding, have the indicated result. The Task Force's contention that more effective contract bundling will result in much bigger contracts; thereby, bring very large contractors "to the bidding table," with the ability to apply new and cheaper technologies is overstated. The MMRP's current and projected budgets will most likely not allow DoD to realize the kind of benefit the Task Force believed possible. Given the reality of current funding levels and requirements, it is unlikely MMRP funding will dramatically increase.

The MRSC agrees with the Task Force that consolidation of like work (e.g., all former small arms ranges or all MRS in particular state or county) would allow a given contractor to develop the most efficient munitions response approach, to include technical aspects, regulatory interface and required public outreach. The FUDS program allows consolidation of projects when appropriate, and when both funds and suitable MRS are available, but current funding levels and practices limit effective consolidation. The consolidation of like work may allow all concerned (e.g., DoD, the regulatory community, and the contractor) to gain efficiencies in scale. Although there may be significant contractual and budgetary limitations, the MRSC believes that like work should be consolidated to the maximum extent possible. Doing so is one method of moving from “retail” to “wholesale” acquisition, while still effectively using the existing contractor base.

The MRSC believes it is critical for DoD and environmental regulators and safety officials to establish performance metrics for munitions responses. Early, sustained collaboration that attains mutual agreement will minimize conflicts that can adversely effect technology transition. A focus on attaining mutual agreement on Data Quality Objectives (DQO), data documentation, project closeout objectives, and technology used to meet those objectives is necessary.

Task Force Recommendation 4: Conduct an assessment of live-fire practices on operational ranges with the goal of reducing the UXO and related munitions constituents problems.

Although the MRSC and Task Force recognize that live-fire training and testing are critical to force readiness, both acknowledge the importance of minimizing both the creation of UXO and additional deposits of MC that pose a potential risk to human health and the environment. An in-depth evaluation of DoD’s progress in addressing these concerns and of how DoD can best reduce the potential for creating additional UXO or depositing more MC is necessary. This evaluation must assess the:

- Effectiveness of the Services’ policies for operational range clearance.
- Use of “green” or “greener” military munitions.
- Use of less hazardous munitions (e.g., practice and/or training munitions) during training
- Potential to expand the use of simulators and simulations.
- Costs and/or benefits of improved munitions reliability and accuracy.

A draft DoDI 3200.X, Operational Range Clearance, establishes policy, assigns responsibilities and prescribes procedures for determining the degree and frequency of operational range clearance activities required to support safe and sustainable range operations and management. The impact of this policy has not been evaluated. Periodic clearance of UXO, munitions debris,¹⁴ and range-related debris¹⁵ may help to reduce the potential for MC to accumulate on and subsequently migrate off operational ranges.

The Services attempt to use simulators and simulations, to the maximum extent feasible, to develop command, battle staff and crew skills. As simulation technology advances, the Services expect to be able to expand their use of simulators and simulations. The key to any such expansion is the Services ability to maintain operational readiness.

Given the critical role of live-fire exercises, DoD will continue to seek viable methods to reduce the creation of additional UXO and to minimize the deposit of potentially harmful MC on operational ranges. To do this, DoD must continue to develop its understanding of the fate, transport and effect (FTE) of military munitions use, increase military munitions reliability, continue its use of less hazardous MC, and continue its efforts to both develop green munitions and improve simulation technology.

Recommended Action. DoD should continue:

- To assess how it can best maintain readiness, while not creating additional UXO or depositing more MC on operational ranges.
- The collection of data on the FTE of using military munitions on operational ranges.

Rationale: The Task Force accepted the fact that live-fire training and testing were important to military readiness and needs to continue. It also recognized that the use of a large number of military munitions in such testing and training might be out of synchronization with growing concerns about UXO and emerging concerns about the effects of MC on human health and the environment. The Task Forces believed that the most obvious way to reduce the creation of additional UXO and prevent the deposit of more MC on operational ranges is to reduce live-fire training and testing. However, it recognized there were limits to DoD's ability to both do this and maintain readiness. The Task Force recommended the Services assess their live-fire practices and specifically consider an increased use of realistic simulators and inert munitions.

Live-fire training is a cornerstone for maintaining Force readiness. The Services use simulators and simulations to enable live-fire training and believe such training imperative to "training soldiers as they fight." This doctrinal training approach is required not only for success in military operations, but also for survivability on the battlefield. Because training under realistic conditions maintains military readiness, simulations and simulators may never become a substitute for all live-fire training. However, the use of specialized training weapons and/or inert munitions on sophisticated and electronically scored operational ranges is helping to provide necessary training, while reducing the generation of additional UXO or the deposit of additional MC on operational ranges.

The Services establish training requirements based on doctrinal standards that are continuously updated from lessons learned in battle (e.g., Operation Iraqi Freedom and Enduring Freedom) and threat assessments. Additionally, each of the Services has implemented a sustainable range management program to ensure the sustainability of operational ranges now and into the future.

As the Task Force pointed out, properly functioning and reliable military munitions will reduce the potential for the creation of additional UXO, and may reduce the quantity of MC deposited on operational ranges. Studies have shown that the detonation of a properly functioning munition, with a Composition B fill, deposit less than 0.002% of its fill, while the same munition with a partially function (a low order detonation) may deposit a high percentage of its original fill. Military munitions that completely fail to function on use (referred to as UXO or duds) and low order detonations also pose a potential explosive hazard. Low order detonations appear to be the greatest contributor to releases of MC (estimated as 50 percent or more) to the environment¹⁶. Increasing munitions reliability will prevent the creation of additional UXO and minimize the deposit of more MC on operational.

While reducing MC deposition is an important goal, DoD must also assess the impact of the MC that are released. DODD 4715.11 and the Defense Planning Guidance for Fiscal Years 2004 - 2009 require that the Services assess potential hazards from off-range migration of MC and begin remediation by FY08. Recently, DoD released DoDI 4715.11 for coordination. This instruction establishes a process for assessing and monitoring operational ranges. The resulting assessments will provide a better understanding of the effects of munitions use on operational ranges and help establish procedures to predict, control, and mitigate potential threats from MC to human health and the environment.

In April 2004, the DSB established a Task Force on Military Munitions System Reliability. DoD directed this Task Force to:

- Assess failure rates in combat use with particular emphasis on submunitions.
- Review ongoing efforts to reduce the UXO, and evaluate ways to improve or accelerate them.
- Identify other feasible measures to reduce the UXO threat to friendly forces and noncombatants. These measures can include:
 - Improving military munitions fuze system reliability (e.g., secondary pyrotechnic fuzing or self-neutralization)
 - Changing practices and/or procedures (including training) to minimize failures.
 - Making technical modifications to munitions to facilitate the location and safe disposal of UXO.

Task Force Recommendation 5: Establish a full life cycle cost protocol for munitions that includes cleanup and demilitarization.

DoD should do the following:

- Consider disposal costs during acquisition as part of ownership cost.
- Raise consciousness of acquisition and firing communities to the UXO problem.
- Search for ways for OSD to encourage green munitions acceptance and use.

DoD has required management of Life-Cycle Costs (LCC)¹⁷ for military munitions, to include demilitarization and cleanup, since 1998. LCC from concept through disposal are identified for all systems including military munitions. DoD includes demilitarization and cleanup in total ownership cost (TOC) computations for each proposed system's Cost Position. It is necessary to ensure these program manager-identified costs are also included in the supporting commodity command's budget. The program manager identifies and manages the costs associated with the LCC during development, initial production, and fielding. The commodity command identifies and manages these costs during full-rate production, operations and support. This split in ownership and responsibility has resulted in LCC not being explicitly programmed as required. The Services recognize the problem and are attempting to resolve it.

The lack of a clear definition of "green" effect DoD's ability to develop green munitions. Encouraging the use and acceptance of a green munition with identical performance characteristics is not of concern. However, the use of green or greener materials often requires program managers to weigh changes in munitions performance against environmental benefits. The best choice, which is often unclear, is often at the program manager's discretion and is subject to milestone decision authority oversight.

Recommended Actions: DoD should:

- Resolve the problems associated with split ownership and responsibility for LCC. In doing so, DoD should earmark the program manager-identified costs that a supporting or commodity command controls for execution.
- Define "green munitions" and attain visibility of the Services' efforts.

Rationale: DoDI 4120.24, DoDD 5000.1 and DoDI 5000.1 clearly state DoD's goal of reducing TOC. DoD Manual 5000.4-M specifies that LCC include not only acquisition program direct costs, but also the indirect costs attributable to the acquisition program (i.e., costs that would not occur, if the program did not exist). In a November 13, 1998 memorandum, the Under Secretary of Defense (Acquisition & Technology), provided the DoD acquisition community a clear understanding of what is meant by TOC, in its broadest context, and a definition of Defense Systems TOC. This memorandum states:

"DoD TOC is the sum of all financial resources necessary to organize, equip, sustain, and operate military forces sufficient to meet national goals in compliance with all laws, all policies applicable to DoD, all standards in effect for readiness, safety, and quality of life; and all other official measures of performance for DoD and its components. DoD TOC is comprised of costs to research, develop, acquire, own, operate, and dispose of weapon and support systems, other equipment, and real property; the costs to recruit, retain, separate, and otherwise support military and civilian personnel; and all other costs of business operations of the DoD."

DoD Manual 5000.4-M clearly requires identification, where practical and cost effective, of the major drivers of TOC for military munitions. The Services' implementing guidance accounts for TOC. As an example, the Army's May 2002 Cost Analysis Manual, Chapter 6, specifically addresses environmental quality costing. Cost elements include demilitarization, disposal, and cleanup of Army systems, to include military munitions. The Services' supporting commodity commands are now responsible for budgeting the costs associated with demilitarization, disposal, and cleanup. This process, which has only been in place since 1998, does not address the costs associated with legacy items.

The Services develop and validate military munitions against a specific operational need identified during the requirements generation process. The DoD identifies these requirements in specific capabilities documents. The Army, as Single Manager for Conventional Munitions, uses the capabilities document to qualify the end items. It is important that environmental quality considerations are included in the capabilities documents for new munitions, if those impacts are to be minimized or eliminated.

Enclosure
Scale of the UXO Problem

Based on the MRS inventory data in OSD Restoration Management Information System (RMIS), the MRSC estimates that the UXO footprint, which does not include the acreage of operational ranges, approximates 16 million acres. Current WAA technology (e.g., low flying aircraft or towed array) is suitable for accessing about 40 percent of this acreage (see Table 1).

The majority (approximately 93 percent) of the identified acreage is landmass, with formerly used Defense Sites (FUDS¹⁸) making up about 85 percent of the total acreage. Approximately seven percent is water acreage, for which development of WAA technology may be the most logical and least costly approach to identifying MRS. The acreage of each MRS is an important consideration (see Table 2).

- Approximately 32 percent of MRS that require assessment are less than 50 acres in size.
- The 9 largest MRS comprise over 33 percent of the total acreage, with the largest 32 making up nearly 66 percent.

Consideration of MRS size is important in developing performance metrics for the program. If the metric used was the number of response complete sites, a large percentage of the total sites would be completed. Existing technologies will generally be adequate to support cleanup of the smaller MRS.

Table 1
MRS Acreage

Area ¹ Program	Total Acres Requiring Assessment ²	Water Acres Requiring Assessment ³	Land Acres Requiring Assessment	Land Acres Potentially Suitable for WAA ⁴
FUDS	13,888,255	859,744	13,028,512	5,527,761
DERA	2,458,806	216,876	2,241,930	228,429
USAF	239,673	2,575	237,098	52,162
USA	2,147,390	196,048	1,951,342	176,267
USN	71,744	18,253	53,491	0
BRAC	58,897	630	58,268	6,542
USAF	0	0	0	0
USA	45,455	0	45,455	6,542
USN	13,442	630	12,812	0
TOTALS	16,405,959	1,077,249	15,328,710	5,762,732

¹. Based on Mar 05 RMIS data.

². Total MRS acreage, excluding RAC codes 7 and 8.

³. All acreage with a RMIS topography code for water (07).

⁴. Although MRS of smaller sizes may be suitable for assessments that would mirror WAA, the MRSC only considered MRS of greater than 500 acres as suitable for WAA. The MRSC considered all water acreage suitable and only the following suitable for WAA:

- Acres assigned topography codes of flat (01) and of gently rolling (03)
- Acres with vegetation types of barren (01), heavy grasses with many shrubs (02), low grasses and few shrubs (04), and shrubs and some trees (05) are considered suitable for WAA.

Table 2
Number and Size of MRS Requiring Assessment

MRS Size in Acres	Land Area		Water Area	
	Number of MRS	Acres Requiring Assessment	Number of MRS	Acres Requiring Assessment
Under 50	483	5,618	18	154
50- <100	80	5,698	5	361
100- <500	179	43,632	8	1,729
500- <1000	349	238,909	15	9,778
1,000- <10,000	283	890,307	15	46,415
10,000 and greater	134	14,144,547	14	1,018,813
Total	1,508	15,328,710	75	1,077,249

Based on data in the OSD RMIS as of Mar 05.

Some MRS contain both land and water acres.

¹ **Unexploded Ordnance (UXO).** Military munitions that (A) have been primed, fuzed, armed, or otherwise prepared for action; (B) have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and (C) remain unexploded either by malfunction, design, or any other cause. (10 U.S.C. 101(e)(5))

² **Munitions Response.** Response actions, including investigation, removal actions and remedial actions to address the explosives safety, human health, or environmental risks presented by UXO, DMM, or MC, or to support a determination that no removal or remedial action is required.

³ **Munitions Constituents.** Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. 2710).

⁴ Declaring an area a "clean parcel" in one state required that it be:

- Outside of any anomaly clusters identified by instrument sweeps, and there is no other historical or technical data, which indicates the presence of UXO;
- In an anomaly cluster, but the cluster is not munitions related;
- Cleared to a depth consistent with intended land use, or the Parties agree that it has been adequately addressed during previous munitions response efforts; or
- In an anomaly cluster, but based on results of subsurface investigations, no UXO were identified, and there is no evidence to suggest that UXO exists beyond the depth of investigation.

⁵ **Munitions Response Site.** A discrete location within an MRA that is known to require a munitions response.

⁶ **Mutual Agreement.** A meeting of the minds on a specific subject, and a manifestation of intent of the parties (DoD and environmental regulators and safety officials) to do or refrain from doing some specific act or acts. Inherent in any mutual agreement or collaborative process are the acknowledgement of each member's role in the process and their differing views of their authorities. The mutual agreement process provides a means of resolving differences without denying the parties an opportunity to exercise their respective authorities should mutual agreement fail to be achieved.

⁷ **Munitions Response Area.** Any area on a defense site that is known or suspected to contain UXO, DMM, or MC. Examples include former ranges and munitions burial areas. A munitions response area is comprised of one or more munitions response sites.

⁸ The cost associated with the cleanup of unexploded ordnance, discarded military munitions and munitions constituents.

⁹ The development of a range of costs was a one-time Congressional requirement of Section 313 of 10 USC 2710 and reported in the FY02 Defense Environmental Restoration Program (DERP) Report to Congress.

¹⁰ **Discarded Military Munitions (DMM).** Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include unexploded ordnance, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of, consistent with applicable environmental laws and regulations. (10 U.S.C. 2710(e)(2))

¹¹ **Defense Sites**. Locations that are or were owned by, leased to, or otherwise possessed or used by the Department of Defense. The term does not include any operational range, operating storage or manufacturing facility, or facility that is used for or was permitted for the treatment or disposal of military munitions.

¹² The Munitions Response Committee (MRC) is a chartered committee that operates within the framework of Federal, Tribal, and State authorities, to coordinate, identify, and synchronize efforts among the Department of Defense (DoD), the U.S. Environmental Protection Agency (USEPA), American Indians and Alaska Natives, the Federal Land Managers, and the States to ensure munitions responses for locations on other than operational ranges are conducted in a manner that protects public health and the environment while allowing the DoD to fulfill its mission.

¹³ **Munitions and Explosives of Concern (MEC)**. This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (A) Unexploded ordnance (UXO), as defined in 10 U.S.C. 101(e)(5); (B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710(e)(2); or (C) Munitions constituents (e.g., TNT, RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

¹⁴ **Munitions Debris**. Remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.

¹⁵ **Range-Related Debris**. Debris, other than munitions debris, collected from operational ranges or from former ranges (e.g., targets, military munitions packaging and crating material).

¹⁶ Taylor, et al., in press. Underground UXO: Are they a significant source of explosives in soil compared to low- and high-order detonations?

¹⁷ In a November 13, 1998 memorandum, Dr. Gansler, Under Secretary of Defense (Acquisition & Technology), established that TOC and LCC are equivalent.

¹⁸ **Formerly Used Defense Sites (FUDS)**. FUDS are defined as real property that was under the jurisdiction of the Secretary and owned by, leased by, or otherwise possessed by the US and those real properties where accountability rested with DoD but where the activities at the property were conducted by contractors that were transferred from DoD control prior to 17 Oct 86.