Future Considerations for Chemical Weapons Demilitarization

Executive Summary

August 2024

DEFENSE SCIENCE BOARD

DEFENSE SCIENCE BOARD

OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301–3140

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

SUBJECT: Defense Science Board (DSB) Report on Future Considerations for Chemical Weapons Demilitarization

I am pleased to forward the final annotated briefing of the DSB study on *Future Considerations for Chemical Weapons Demilitarization*, conducted on behalf of the DSB by the Permanent Subcommittee on Threat Reduction. This study was undertaken because of increased chemical weapon (CW) production and use worldwide, as well as activities to dispose of certain agents in areas abroad and under the domestic U.S. Chemical Demilitarization Program. Concerns persist that the Department will return to a low level of activity relative to activities targeting biological and nuclear weapons now that these projects are complete, losing expertise and capabilities necessary to disable, destroy, or demilitarize (D3) CW agents that will be costly and time-consuming to reestablish when needed.

To preserve these assets for use in future conflicts as well as to support allies and partners seeking to divest themselves of such stockpiles, the study makes two central recommendations.

- First, the Department should ensure the maintenance of a chemical weapon D3 program that develops and sustains scalable technologies and expertise for fielding at relevant timescales; develops and demonstrates capabilities to address anticipated threats; and ensures periodic field testing and operational exercises to demonstrate readiness and message U.S. commitment to eliminating CW.
- Second, the Department should undertake a comprehensive "Chemical Weapons Deterrence and Defense Posture Review" akin to what has been done for nuclear forces, missile defense, and biodefense. This review should span the nonproliferation, counterproliferation, and chemical defense mission space and lead the development of an implementation plan built upon the priorities and gaps identified.

The findings, observations, and recommendations were presented to the full DSB, received through discussion and deliberation, and were approved unanimously. I fully endorse all the study's recommendations and urge their careful consideration and adoption.

Eric D. Evans

Dr. Eric D. Evans
Chair, Defense Science Board

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OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301–3140

MEMORANDUM FOR THE CHAIR, DEFENSE SCIENCE BOARD

SUBJECT: Report of the Defense Science Board (DSB) Permanent Subcommittee on Threat Reduction Study on Future Considerations for Chemical Weapons Demilitarization

Attached is the final report of the DSB Permanent Subcommittee on Threat Reduction on *Future Considerations for Chemical Weapons Demilitarization*. The Subcommittee was tasked by the Defense Science Board with studying potential methods and technologies for demilitarization of chemical weapons (CW), agents, or precursors under different scenarios. Specific questions in the Terms of Reference included:

- Consider a range of potential scenarios that might require demilitarization of chemical weapons (CW), agents, and/or precursors
  - On compressed timescales
  - Domestic and international scenarios, peacetime to wartime
- Assess basic capabilities best kept on "warm" or "hot" standby
  - Include estimates of minimum resources and expertise needed to support development, testing, training and fielding
- Evaluate existing and on-the-horizon technologies

The study examined the U.S. Chemical Demilitarization Program in addition to actions in Russia, Syria, and elsewhere to dispose of CW stockpiles, often in challenging environments. The study concluded that in spite of the successful completion of the U.S. program, maintaining a baseline of capabilities and expertise for CW disablement/destruction/demilitarization (D3) is an essential element for deterring the use of, and defending against, the current and future threat of chemical weapons. This conclusion is based on a careful assessment of various intelligence and open source reporting, as well as the technical advances in the chemical sciences for synthesis of new chemicals and new synthesis pathways. In addition, the revolution in operational deployment of precision platforms such as UAVs is increasing interest in, and impact of, CW. In that context, not only is a D3 program important, but a more comprehensive end-to-end strategy and its implementation for countering CW is needed. The study therefore recommends that DoD undertake and act upon a Chemical Weapons Deterrence and Defense posture review, analogous to what it has already done for both nuclear and biological threats.

These and other findings are listed within the study's final product, as well as detailed recommendations for implementing a future-oriented program to disable, destroy, and demilitarize (D3) CW and agents.

Dr. Miriam John
Co-chair

Dr. Vincent Tang
Co-chair

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Executive Summary

In September 2023, the Under Secretary of Defense for Research and Engineering (USD(R&E)) tasked the Defense Science Board through its Permanent Subcommittee on Threat Reduction to study a range of potential "surprises" that might require demilitarization of chemical weapons (CW), agents, or precursors, especially on a compressed timescale, as well as what capabilities are critical for prompt response at varying levels of risk and confidence. Potential scenarios under this tasking span domestic and international areas of operation across the full spectrum of peacekeeping and conflict.

The Subcommittee consists of subject matter experts with decades of knowledge and hands-on experience in all aspects of weapons of mass destruction (WMD) – research and development, testing and evaluation, policy, planning, acquisition, and operations. Some had direct experience in chemical demilitarization, chemical weapons defense and medical countermeasures, cooperative threat reduction, and related policy and treaty development. To inform deliberations, members received briefings from DoD stakeholder organizations and other experts in the field across a series of meetings, resulting in a final set of findings and recommendations for DoD leadership.

Context

The U.S. expenditure of tens of billions of dollars to demilitarize its CW and agents has left many with the impression that the nation has done its part in reducing the threat. Arguing to continue to invest in Disable/Destroy/Demilitarize (D3) capabilities, especially since the U.S. has not experienced any CW attack of significance, is difficult because awareness of the growing threat is limited.

Chemical Weapons Threat

Norms against the use of CW emerged in the aftermath of World War I and World War II. These norms were encoded with the adoption of the Chemical Weapons Convention in the 1990s but they have been steadily eroding over the two decades since the treaty went into force. Syria and Russia have been at the forefront of violations, most egregiously via attacks on civilians. Despite widespread acknowledgment of their transgressions, the U.S. response has largely been through diplomatic channels—with mixed results depending on the effectiveness of sanctions imposed and the degree to which they can be enforced.

Principal areas of concern include the following:

- Large stockpiles continue to exist in numerous countries, and although they continue to degrade, many remain functional. The degradation, however, is making these weapons more dangerous to destroy.
- Norms that made pariahs of actors using CW, especially on civilians, are breaking down. It appears that the long-standing notion of CW as “a poor man’s nuke” is taking hold, especially in the context of limited and manageable sanctions on perpetrators by non-CW states. While considered tactical in warfighting effect on the battlefield, the strategic effect of CW use to generate widespread fear should not be underestimated.
- New and non-traditional agents, innovative delivery operations, and new technologies, are combining to paint a worrisome-or-worse picture of current and future threats. Of particular concern is the targeting accuracy afforded by unmanned aerial vehicles that mitigate the historic aerosol dispersion techniques delivered either by airborne spraying or by burst munitions.

Chemical Weapons: Past, Present and Future

With this threat picture in mind, the study reviews the U.S. Chemical Demilitarization program and included in its analysis a range of past international events involving chemical weapons use and/or demilitarization, including the most recent confirmation of Russian CW use in Ukraine. Future scenarios that might require demilitarization of CW, agents, and/or precursors were also analyzed. These scenarios considered events occurring on compressed timescales, operating in environments that spanned cooperation to hostility, and varying in scale from a small cache of munitions to major stockpiles of munitions and bulk agent. Each scenario was informed by evaluations of existing and on-the-horizon technologies and capabilities. Members of the Defense Science Board also spoke with experts within the Department of Defense to assess what basic capabilities could be developed and kept on "warm" or "hot" standby, including estimates of minimum resources and expertise needed to support development, testing, training, and fielding.

Forward-Looking Strategy for CW Deterrence and Defense

The Defense Science Board recognizes that its primary focus on D3 limited its ability to make judgments as to what level of resourcing should support its continuation without taking a similar deep dive into all components of a more comprehensive CW deterrence and defense strategy—something that does not yet fully exist as it does for other WMD modalities. In the absence of an updated strategy, the study applies the latest CWMD strategy framework to the CW topic to determine how well a D3 capability might contribute. In effect, the Defense Science Board undertook the first steps of a posture review in order to convince itself of the value of a D3 program. In addition to what the Department has developed in its CWMD strategy from 2005 to 2023, the study takes into account previous DSB studies and demonstrates the significant role that D3 can play in numerous aspects of implementing a CW deterrence and defense strategy.

Recommendations Summary

To ensure a D3 capability remains viable in DoD, as well as to support broader U.S. needs, the report makes the following principal recommendations.

The **Under Secretary of Defense for Acquisition and Sustainment (USD(A&S))** should ensure the maintenance of a CW D3 program.

- ASD(NCB/TRAC) should be resourced for the five year, approximately $20 million plan for RDT&E that will ensure the relevant D3 capabilities are available to deploy in a timely manner to address future chemical weapons threats.
    - Depending on the technology and scale called for in a given scenario, this would involve readiness levels of days to a year.
- In addition, **the Army should continue to fund its baseline program** to develop more advanced scalable technologies and maintain expertise that can be fielded on a timescale relevant to future threat environments.
    - This should include periodic field testing and operational exercises to demonstrate readiness and message U.S. commitment to eliminating CW.

The **Secretary of Defense** should direct the **Under Secretary of Defense for Policy** to undertake a comprehensive "Chemical Weapons Deterrence and Defense Posture Review" akin to what has been done for biodefense and nuclear forces.

- The review should span across the nonproliferation, counterproliferation, and chemical defense mission space.

- The **Commander of United States Special Operations Command**, as the CWMD Coordinating Authority, should immediately start to collect the baseline information to inform the posture review in conjunction with the Joint Staff through a CWMD-CW Functional Campaign Plan review.
- **USD(A&S)** through the **Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs (ASD(NCB))** should lead the development of an implementation plan built upon the priorities and gaps identified in the review.

Conclusion

Expertise developed through recent activities to dispose of CW domestically and abroad, as well as the technologies obtained for this purpose, will degrade or be lost entirely if not appropriately resourced. Although these may not appear imminently needed, worldwide trends suggest that CW threats will not just persist moving forward but will become more serious with time. The cost for sustaining a baseline capability is modest and would avoid being forced to redevelop D3 capabilities in times of conflict or disaster in which lives could be at stake.

Appendix A. Terms of Reference

RESEARCH
AND ENGINEERING

THE UNDER SECRETARY OF DEFENSE
3030 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

MEMORANDUM FOR CHAIR, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference – Defense Science Board Permanent Subcommittee on Threat Reduction Study on Future Considerations for Chemical Weapons Demilitarization

At Congressional direction in 1986, DoD began the safe demilitarization and destruction of its chemical weapons stockpile and bulk agent stores. Through numerous technical and political challenges, the program is nearing its end with the last of bulk agent destroyed on July 7, 2023. Questions are now being asked as to what – if any – demilitarization capabilities and expertise developed through the substantial investment that has been made over these last four decades should be sustained and at what level.

More worrisome is some analog to the "Cape Ray," when Syria agreed to surrender its sarin precursor stocks to avoid international military intervention in its civil war. The U.S. assumed the operational lead to remove and neutralize the chemicals under a tight timeline. The research and development base of the U.S. demilitarization program allowed for rapid construction and testing of a viable technical option, and its integration onto the Cape Ray, a military cargo ship. From start to finish, the operation was completed in about a year. Should such an event present itself again after the demilitarization program is completed, it is doubtful that the response could be as swift and/or effective if all knowledge, expertise, and equipment are no longer supported.

The Defense Science Board (DSB), working through its Permanent Subcommittee on Threat Reduction, is directed to conduct a study to consider a range of potential "surprises" that might require demilitarization of chemical weapons, agents, or precursors, especially on a compressed timescale, as well as what "hot" or "warm" capabilities are the critical few for being able to respond – and at what level. Options for various levels of capability to mitigate risk and provide confidence should be considered. Scenarios should assess potential needs spanning domestic and international areas of operation during peacetime to wartime, including humanitarian assistance and disaster relief operations. The study should evaluate existing and on-the-horizon technologies and capabilities with considerations for the resources and workforce required to maintain these capabilities. If other matters material to the study topic are discovered in the subcommittee's fact finding, those matters should be addressed as well.

The Permanent Subcommittee findings, observations, and recommendations will be presented to the full DSB for its thorough, open discussion, and deliberation at a properly noticed and public meeting, unless it must be closed pursuant to one or more of the exemptions found in subsection 552b(c) of title 5, United States Code (U.S.C.). The DSB will provide its findings and recommendations to the Under Secretary of Defense for Research and Engineering as the Sponsor of the DSB. The nominal start date of the study period for this ToR will be within 30 days of when this terms of reference (ToR) is signed. In no event will the duration of the study exceed 12 months from the start date.

In support of this ToR and the work conducted in response to it, the DSB and the Permanent Subcommittee have my full support to meet with Department leaders. The DSB staff, on behalf of

the DSB and the Permanent Subcommittee, may request the Office of the Secretary of Defense and DoD Component Heads to timely furnish any requested information, assistance, or access to personnel to the DSB or the Permanent Subcommittee. All requests shall be consistent with applicable laws; applicable security classifications; DoD Instruction 5105.04, "Department of Defense Federal Advisory Committee Management Program"; and this ToR. As special government employee members of a DoD federal advisory committee, the DSB and the Permanent Subcommittee members will not be given any access to DoD networks, to include DoD email systems.

Once material is provided to the DSB and the Permanent Subcommittee, it becomes a permanent part of the DSB's records. All data and information provided is subject to public inspection unless the originating Component office properly marks the data or information with the appropriate classification and Freedom of Information Act exemption categories before the data or information is released to the DSB and the Permanent Subcommittee. The DSB has physical storage capability and electronic storage and communications capability on both unclassified and classified networks to support receipt of material up to the TS/SCI level.

The DSB and the Permanent Subcommittee will operate in conformity with and pursuant to the DSB charter; chapter 10 of title 5, U.S.C.; subsection 552b(c) of title 5, U.S.C.; and other applicable federal statutes, regulations, and policy. Individual DSB and Permanent Subcommittee members and the Permanent Subcommittee as a whole do not have the authority to make decisions or provide recommendations on behalf of the DSB nor report directly to any Federal representative. The members of the Permanent Subcommittee and the DSB are subject to certain Federal ethics laws, including section 208 of title 18, U.S.C., governing conflicts of interest and the Standards of Ethical Conduct regulations in 5 Code of Federal Regulations, Part 2635.

Heidi Shyu

Appendix B. DSB Membership

Dr. Eric Evans, Chair

Mr. Michael Appelbaum

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Dr. DJ Patil

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Dr. Alfred Spector

Dr. Vincent Tang

Dr. Dorota Temple

Dr. Jan Tighe

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Ms. Mandy Vaughn

Dr. Dinesh Verma

Dr. Steven Walker

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Appendix C. Study Membership

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Dr. Vincent Tang

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Dr. Arup Chakraborty
Dr. Melissa Choi
Dr. Anne Fischer
Dr. Deborah Frincke
Mr. Jim Gosler
VADM Bob Harward (Ret)
AMB Ron Lehman
Dr. Gerry Parker
Dr. Jim Tegnelia
Maj Gen Robert Wheeler (Ret)
Dr. George Whitesides
Dr. Heather Williams

Government Advisor
Mr. Kris Perkins (ODASD/TRAC))

DSB Secretariat
Ms. Elizabeth Kowalski, Designated Federal Officer
Dr. Troy Techau, Alternate Designated Federal Officer
Mr. Sean Hagerty, Alternate Designated Federal Officer

SAIC Study Support
Mr. Robert Kolterman
Ms. Alexandria Hayman

Appendix D. Briefings Received

Meeting 1 (6-7 November 2023)

Chemical and Biological Weapons Elimination (CBWE): Overview
Office of the Deputy Assistant Secretary of Defense for Threat Reduction and Arms Control (DASD(TRAC))

CBWE: Case Studies: United Nations Special Commission Mission in Iraq, Syria, and Panama
U.S. Army Combat Capabilities Development Command (DEVCOM), Chemical Biological Center (CBC), Chemical Biological Applications and Risk Reduction (CBARR)

CBWE: Assess: Materiel Readiness Assessment, Current Technologies, and Technology Development Efforts
ODASD(TRAC) & DEVCOM CBC/CBARR

CBWE: Engagements: U.S. and International Stakeholder Engagements, Activities, and Outputs
ODASD(TRAC)

Chemical Warfare Threats from State Actors
ODASD(TRAC) and Central Intelligence Agency/Weapons and Counterproliferation Mission Center (CIA/WCPMC)

CBWE Oversight/Funding: PBR25 Outcomes and Buy-down Risk Requirements
ODASD(TRAC)

Meeting 3 (10-11 January 2024)

U.S. Special Operations Command (USSOCOM) J10 Perspective
USSOCOM J10 CWMD

U.S. Army Nuclear and Countering Weapons of Mass Destruction Agency (USANCA) Command Brief
USANCA

CBWE: "Warm Stand-by" Technologies
ODASD(TRAC)

CBWE: Overview of KRAKEN Series
ODASD(TRAC)

Defense Threat Reduction Agency (DTRA) Security and Elimination Department Perspective
Cooperative Threat Reduction Directorate, DTRA

Meeting 4 (6-7 February 2024)

Discussion with Chemical/Biological Physical Research, Development, and Acquisition Directorate of ODASD/Chemical and Biological Defense (ODASD(CBD)
ODASD(CBD)

Meeting 5 (12-13 March 2024)

National Counterterrorism Center (NCTC) Perspective
NCTC

Chemical Warfare (CW) Agent Elimination
Subcommittee Member

National Ground Intelligence Center (NGIC) Perspective – World-Wide CW Threat
NGIC

Appendix E. Acronym List

CBARR	Chemical Biological Applications and Risk Reduction
CBC	Chemical Biological Center
CBWE	Chemical and Biological Weapons Elimination
CIA	Central Intelligence Agency
DEVCOM	U.S. Army Combat Capabilities Development Command
DoD	Department of Defense
DSB	Defense Science Board
DTRA	Defense Threat Reduction Agency
NCTC	National Counterterrorism Center
ODASD(CBD)	Office of the Deputy Assistant Secretary of Defense for Chemical and Biological Defense
ODASD(TRAC)	Office of the Deputy Assistant Secretary of Defense for Threat Reduction and Arms Control
USANCA	U.S. Army Nuclear and Countering Weapons of Mass Destruction Agency
USSOCOM	United States Special Operations Command
WCPMC	Weapons and Counterproliferation Mission Center


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