CHAPTER XII

COUNTERPROLIFERATION OF WEAPONS OF MASS DESTRUCTION

Counterproliferation of Weapons of Mass Destruction (WMD) includes the military capabilities to combat the proliferation of WMD, including counterforce, passive defense, and consequence management operations, to protect U.S. forces and interests should they confront an adversary armed with weapons of mass destruction. Counterforce operations are those intended to divert, deny, delay, disrupt, or destroy an enemy's capability to develop, manufacture, stockpile, and employ WMD before it can be used against friendly forces. Passive defense actions are the operational capabilities required by joint forces to survive, fight, and win in an NBC-contaminated environment. Consequence management operations are the capabilities to support the rapid and full restoration of services to military and civil authorities.[1]

Section 1 of this chapter, Chemical/Biological Defense, focuses on passive defense and consequence management in scenarios involving chemical and biological threats. Section 2, Counter Weapons of Mass Destruction, focuses on nonproliferation and counterforce against the full spectrum of WMD threats. Other aspects of counterproliferation capabilities, as defined by the Counterproliferation Program Review Committee (Reference 24), are addressed in the Information Superiority (Chapter IV), Air and Missile Defense (Chapter VII), Combating Terrorism (Chapter XIII), and Hard and Deeply Buried Target Defeat (Chapter XV) JWCOs.

Section 1
Chemical/Biological Defense

A. DESCRIPTION

The concept of CB defense provides the framework for developing the operational capabilities required by the joint force to survive, fight, and win in a CB-contaminated battlespace environment. The objective of joint force CB defense is to ensure that U.S. forces can maintain freedom of action during deployment, maneuver, and engagement while providing multilayered CB defenses for U.S. forces and facilities at all levels. This is accomplished by protecting the force and minimizing the effect of CB weapons threat or use on joint force operations. The cornerstone of CB defense is the integrated principles of joint CB defense as delineated in the Joint Service Integration Group (JSIG) Joint NBC Defense Concept (Reference 25). These principles are as follows:

- *Battle management*, which includes providing leaders and forces with an actual and predictive situational awareness of CB threat agent hazards within their battlespace, and supporting implementation of medical and nonmedical countermeasures.
- *Contamination avoidance*, which includes detecting, identifying, locating, and sampling suspected CB agent contamination.
- *Protection (individual and collective)*, which includes providing safe and effective medical and nonmedical protection against chemical and biological hazards.

[1] Active defense, a key component of counterproliferation, is addressed in other chapters of this JWSTP.

- *Restoration capability*, which includes rapid, safe, effective, and nonhazardous restoration of unit operational capabilities using medical and nonmedical countermeasures.

Chemical and biological defense provides the framework for developing the operational capabilities required to survive, fight, and win in a CB-contaminated environment. The user has identified and defined five critical operational capabilities that uniquely align to the principles of CB defense. These critical operational capabilities are outlined in *FY01 Nuclear, Biological and Chemical (NBC) Defense Joint Future Operational Capabilities—JFOC* (Reference 26), published by the JSIG. These principles are battle management, contamination avoidance, individual protection, collective protection, and restoration capability. These capabilities are synergistic and are essential to avoid contamination, to warn and treat the force, and to sustain operational tempo on an asymmetric battlefield. Each critical operational capability is further divided into a subset of more focused and specific key operational capabilities.

The DoD CB Defense Program integrates all medical and nonmedical programs and invests in technologies to address the user's CB defense JFOCs while minimizing any adverse effects on joint force warfighting potential.

B. OPERATIONAL CAPABILITY ELEMENTS

The critical operational capabilities in CB defense are as follows:

- *Battle management*—capabilities to securely access, assimilate, and disseminate medical and nonmedical CB information throughout the joint battlespace; to analyze this CB information; to predict current and future operational impacts of CB agent hazards; and to model and simulate the totality of mission operations within the context of the CB environment.
- *Contamination avoidance*—automated capabilities to detect, locate, identify, quantify, sample, and plot the extent of all suspected CB threat agent hazards; and medical surveillance capabilities.
- *Individual protection*—all medical and nonmedical means taken to protect the warfighter from all battlespace CB agent hazards while maintaining normal operational mission tempo.
- *Collective protection*—capabilities to provide a safe and effective environment to protect medical and nonmedical personnel and equipment from the effects of all CB threat hazard agents while not degrading mission operation performance.
- *Restoration capability*—medical and nonmedical measures required to restore the joint force, units, facilities, and equipment to near-normal operating conditions after being challenged by an CB agent hazard. These measures include nonhazardous decontamination operations, effective supply and sustainment of all CB defense assets, and effective medical diagnostics and post-exposure countermeasures required to allow rapid determination of CB agent exposures and subsequent treatment.

Figure XII–1 illustrates how CB defense affects all aspects of the battlespace, particularly in supporting the four operational concepts contained in the CJCS's *Joint Vision 2020* (Reference 5) and the national One+ Major Theater Wars (1+ MTW) global power projection strategy.

Operational capabilities for CB defense are enhanced by the Defense Technology Objectives (DTOs) included in the JWSTP and DTAP. Technologies supporting these objectives

normally will be refined through the RDT&E process. Advanced Technology Demonstrations (ATDs), Advanced Concept Technology Demonstrations (ACTDs), and other technology demonstrations may be used to accelerate program development.

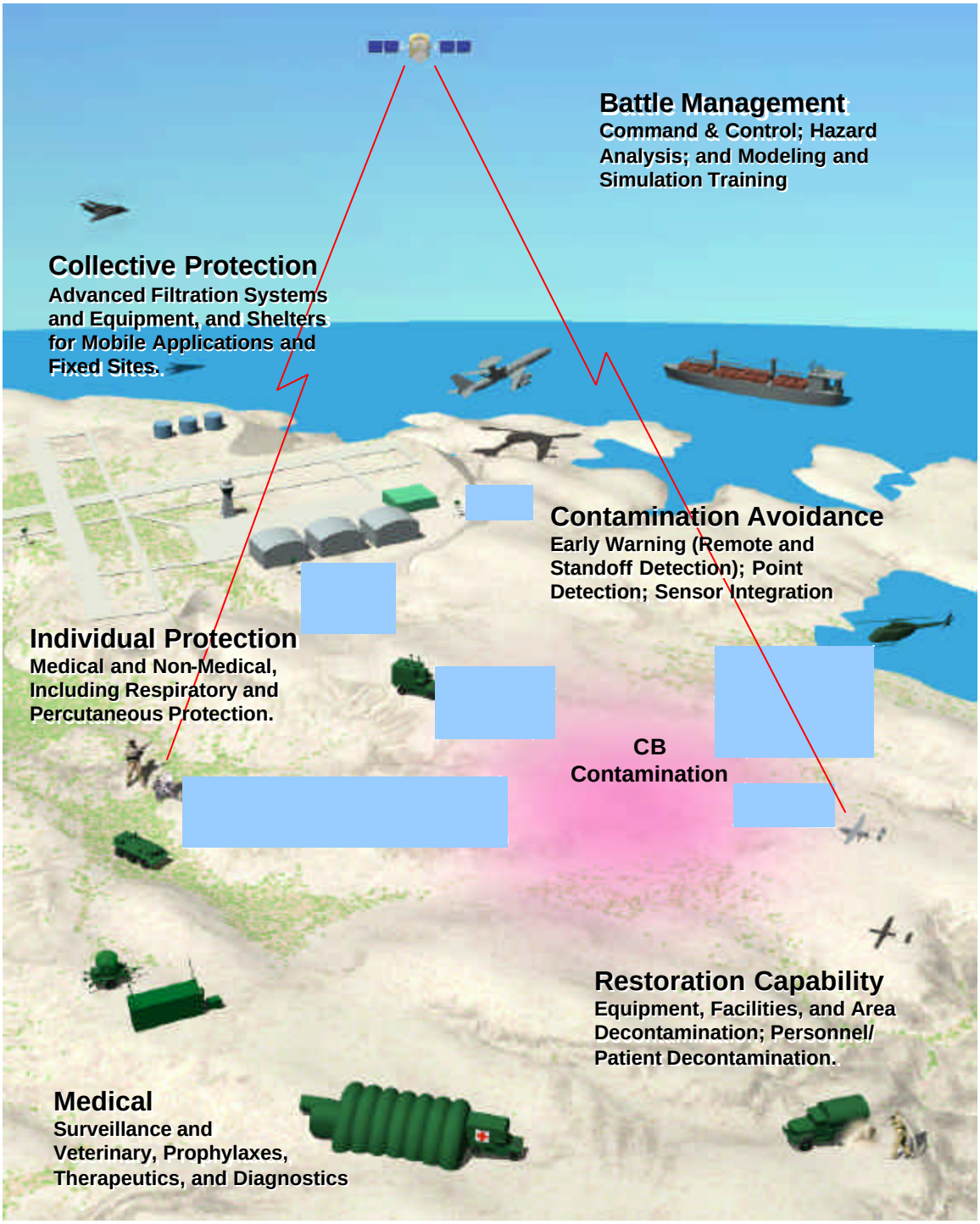

Figure XII–1. Concept—Chemical/Biological Defense

C. FUNCTIONAL CAPABILITIES

Table XII–1 provides an overview of the functional capabilities required to produce the operational capabilities composing Chemical/Biological Defense. Functional capabilities provide the systems, processes, or integration of technologies needed to enable the achievement of the operational capabilities. Specific technologies and research efforts that support the functional capabilities are described in Section D, Current Capabilities, Deficiencies, and Barriers. Achieving the operational capabilities depends on several distinct functional capabilities supported by projects and initiatives within the science and technology base. In addition, functional capabilities are supported by nontechnological activities that are outside the scope of the science and technology base (and this JWSTP), including doctrine, concepts of operations, and tactics, techniques, and procedures.

Table XII–1. Functional Capabilities Needed—Chemical/Biological Defense

Functional Capabilities	Operational Capability Elements				
	Battle Management	Contamination Avoidance	Individual Protection	Collective Protection	Restoration Capability
1. Battle Management Systems (Operations)	●				
2. Battle Management Analysis	●				
3. Modeling and Simulation Training	●				
4. Chemical and Biological Early Warning		●			○
5. Chemical and Biological Point Detection		●			○
6. Sensor Integration		●			
7. Medical Surveillance/Veterinary Support		●			○
8. Medical Prophylaxes			●		
9. Respiration/Percutaneous			●		
10. Mobile Applications				●	
11. Fixed-Site Applications				●	○
12. Medical Diagnostics					●
13. Medical Treatment					●
14. Equipment, Facilities, and Area Decontamination					●
15. Personnel/Patient Decontamination					●

● Strong Support ○ Moderate Support

Battle Management. The critical functional capabilities for battle management are as follows:

- Battle management systems (operations)
- Battle management analysis
- Modeling and simulation training.

Battle Management Systems (Operations). This capability will provide the commander with a secure, real-time, common operational picture of the medical and nonmedical CB environment within the context of total battlespace operations. This capability includes the automatic collection and fusion of medical and nonmedical information from all CB defense assets

throughout the entire battlespace and also includes interfacing with other relevant battlespace information from other command and control nodes, such as meteorological, terrain, intelligence, allied, and civil support information. The end result of this capability is the rapid dissemination and display of operationally meaningful CB defense information throughout the battlespace. All commanders and units at all levels will have the situational awareness to support timely decision making related to joint force protection, restoration of operational tempo, and casualty treatment and care.

Warning and reporting is a critical component of battle management. It serves as the critical link between CB detection and CB protection and provides situational awareness to the commander. Warning and reporting provides the hardware and software to connect point detection and early warning detection systems into the overall command and control architecture. Additionally, it provides modeling and simulation capabilities to enhance hazard forecasting and assessment. Warning and reporting differs from early warning in that it provides no capabilities to detect or identify chemical or biological agents, but rather provides information that has been collected to the commanders and warfighters. The goal of warning and reporting is to provide sufficient, accurate, and timely information to commanders at all levels through early and direct warning capabilities so they may develop options on how to conduct their mission and decide the appropriate protective posture to assume.

The services developed functional capabilities by integrating ongoing hardware and software into the Joint Warning and Reporting Network (JWARN Phase II, DTO CB.02), which was completed in FY99). Technologies will be developed to provide increased management and control functions, as well as to integrate features of the emerging Global Command and Control System (GCCS). The goals of JWARN are to (1) increase warning time by transmitting data digitally rather than by manual and voice means, (2) use improved modeling and simulation capabilities to identify and predict the location and nature of CB hazards on the battlefield, and (3) serve as a commander's decision aide.

Battle Management Analysis. This capability will allow the commander to analyze, evaluate, and predict current and future medical and nonmedical impacts of CB agent hazards and the effect on joint force operations throughout the battlespace. The ability to link virtual environments and simulations with reality-based operations will allow the commander to readily assess several complex CB threat alternatives and to make accurate predictions regarding the spread and impact of the threat on battlespace operations. This capability will support realistic mission planning, decisionmaking activities, and risk assessments in the areas of threat mitigation, contamination avoidance, joint force protective measures, decontamination, and the medical care and treatment of casualties. This overall analysis capability must be based on a validated, verified, and accredited database standardized throughout the CB defense analysis community.

Modeling and Simulation Training. This capability will allow the commander to simulate the battle management requirements of the entire joint force command and control structure within the context of the CB environment. The synergistic effects of the CB environment on operational missions are varied and complex but can be understood and mitigated through realistic individual and collective training experiences available through modeling and simulation capabilities. This training capability will support doctrinal development, military worth of CB defense material, and the effectiveness of the command and control structure of the joint force.

Contamination Avoidance. The critical functional capabilities for contamination avoidance are as follows:

- Chemical and biological early warning
- Chemical and biological point detection
- Sensor integration
- Medical surveillance/veterinary support.

Chemical and Biological Early Warning. This capability will provide commanders at all levels within the joint battlespace the ability to detect the presence of a chemical or biological agent threat at a distance in order to provide adequate warning to at-risk joint force personnel for taking appropriate nonmedical and medical protective measures. There is also a need for an early warning identification capability for specific chemical and biological agent threats to support timely and realistic medical planning activities related to medical pretreatment, treatment, and care that is tailored to the specific threat.

CB early warning incorporates a variety of technological approaches to detect, identify, and track CB agents and provide information to commanders in the hazard area following an attack involving the release of CB agents. Early warning may be implemented using standoff detection technologies. Standoff detection may employ a variety of laser and optical detector technologies (potentially exploiting the full electromagnetic spectrum), with the goal of providing detection at ranges significantly farther than those that can be achieved with currently fielded systems to maximize warning time. Early warning may also be accomplished using point detection systems deployed on remotely controlled platforms (e.g., unmanned aerial vehicles (UAVs)), or point detectors deployed via forward or remote placement (e.g., airdrops, Special Operations Forces (SOF) emplacement). Current technology thrusts for early warning focus on separate systems for chemical and biological detection. The recently completed Laser Standoff Chemical Detection Technology DTO (CB.07) demonstrated a standoff laser integrated chemical vapor and aerosol detection capability for protection of fixed sites, reconnaissance, and other battlefield applications. In the far term, the technological goal is to provide a single system (which may include a multi-technology suite) that can detect multiple CB agents, detect emerging threats, support the warfighter need for a low logistical profile (i.e., small size, minimal power consumption, etc.), and be integrated into an automated command and control architecture.

The near-term approach continues to emphasize separate yet complementary detection technologies, which provide the data for making operational decisions and improved performance over fielded systems. For biological agents, current and near-term technologies seek to identify the presence of higher than normal concentrations of aerosols or particulate matter in the atmosphere. If aerosols or particulates are present, data are examined to determine whether the formation is natural or manmade, and whether the aerosols contain pathogenic biological material. As technologies mature, new systems will be able to detect, identify, and characterize an increasing number of biological agents, more reliably, and from greater distances. Technical barriers associated with developing these technologies include overcoming attenuation of laser energy by atmospheric absorbents, providing algorithms to discriminate between natural atmospheric species and biological agents, and miniaturizing deployable biological and chemical point detectors with needed specificity and sensitivity.

Chemical and Biological Point Detection. A CB point detection capability is needed to determine the presence of CB agents in the immediate area of troops or on individuals or equipment. This capability addresses post-attack situations and supports subsequent planning activities and decisions regarding CB defense reconnaissance; monitoring of suspected exposed personnel, equipment, and terrain; sampling for CB agent hazards; and the CB agent attack confirmation

process. Point detection and identification also supports the medical planning and response activities associated with CB agent attacks.

The overall goal of point detection technology efforts is to develop sensor systems that can rapidly detect the presence of CB agents, identify these agents, and enhance the detection time, sensitivity, selectivity, reliability, and reduced size of CB agent detectors. The program is divided into two parts—biological and chemical. Technologies under consideration in the near and mid term cannot address both of these threats using the same technology. However, a desired goal is to develop a single suite of sensors to detect all potential CB threats. For the interim, CB detectors will detect validated threat agents, and be incorporated as separate modules to more easily allow upgrading as newer technologies emerge. Also, advances in other technology areas, such as the recently completed Microelectromechanical Systems (MEMS) DTO (SE.38), will support the development of improved, smaller point detection technologies.

Point detection systems operate by exploiting emerging technologies such as immunoassays, gene probes, various forms of spectroscopy, and other physical/chemical characterization technologies. Technical problems associated with point detection include (1) developing sensors with sufficient sensitivity and discrimination that can detect, identify, and quantify the presence of biological and chemical hazards in a timely manner without false alarm, (2) continuing development of antibodies and DNA probes to meet the emerging threat, (3) developing concepts to eliminate or reduce the need for consumables (reagents), and (4) developing and integrating C^3I technology to permit rapid, automatic collection, collation, dissemination, and display of CB hazard information to various command levels. Heretofore, the primary S&T focus has been in sensor development. However, increased effort or improved technologies are required to integrate sensor information with other battlefield situation awareness information (geographical, meteorological, intelligence, etc.) to meet warfighter needs.

The strategy for the biological detection technology effort is to develop a suite of complementary technologies and systems to ensure that desired capabilities in biological detection are achieved. The Chemical Biological Defense Program sponsors annual field trials for the evaluation of emerging and nondevelopmental technologies. The evaluations provide recommendations that have advanced the development of relevant technologies, returned immature technologies to the laboratory for additional development, or terminated the development of inadequate technologies.

The strategy for chemical detection is similar to that for biological detection. While many current detectors rely on wet chemistry or ion mobility spectrometry, newer technologies are being demonstrated. Technologies for chemical detection are more mature than those for biological detection. Surface acoustic wave (SAW) completed the transition to the Joint Chemical Agent Detector (JCAD) program in FY98. In addition, mass spectrometry is being examined for its potential in providing both chemical and biological detection. An emerging requirement for chemical detection systems is the detection of emerging and nontraditional chemical agents, including toxic industrial chemicals (TICs).

Sensor Integration. An integrated detection capability (early warning and point) of the presence of CB agents will allow a common output interface between the CB agent sensing function and the operator, thus simplifying the operational deployment of the overall CB defense reconnaissance, surveillance, and monitoring functions as well as reducing the logistics associated with the sustainment and maintenance of separate detection functions. The capability should also encompass the ability to interface the CB defense detection architecture with other battlespace sensing capabilities that have operational relevancy to the CB defense mission.

Medical Surveillance/Veterinary Support. A capability is required to conduct medical and environmental surveillance in the theater of operations, in support of ongoing threat assessments and medical decision making and planning. It includes the ability to rapidly identify, report, and document CB agent threats through laboratory analysis in theater, to conduct medical surveillance for health outcomes of operational importance, and to conduct epidemiological analysis of medical events and patterns. This capability provides medical situational awareness and decision support to the commander. Included in this capability are rapid and automated dissemination, recording, and archiving of medical surveillance reports and analyses. The capability will allow the execution of veterinary service support to the food and water safety mission and the environmental surveillance mission in a CB hazard environment. This capability furthers sustainment of the force through the timely performance of inspection, laboratory analysis, and reporting to identify food-borne and water-borne CB threats. It also includes surveillance of indigenous animal populations for diseases of operational importance, and information support to ongoing threat assessments.

Individual Protection. The critical functional capabilities for individual protection are as follows:

- Medical prophylaxes
- Respiration/percutaneous.

Medical Prophylaxes. This capability addresses the need for using FDA-approved pretreatments, vaccinations, or prophylaxes—to guard against, prevent, or mitigate adverse health effects of CB agent threats to operational forces and individuals. This capability will allow joint forces to operate safely under assessed or imminent CB threats or in a CB agent hazard environment.

Respiration/Percutaneous. This capability addresses the need for total individual protection (eye, skin, and respiratory) against the lethal and operationally debilitating effects of all CB agents on joint force personnel and supporting personnel. The capability must be compatible with all battlespace mission operations and with all warfighting equipment and must not degrade normal (non-CB environment) mission performance or operational tempo because of undue physiological/psychological stress effects. This capability will allow the joint force to operate safely, at near-normal levels of effectiveness, while under a CB threat or in a CB agent hazard area.

The goals of individual protection technology efforts are to (1) improve protection against current threats, (2) add protection against future threats, (3) minimize mission degradation by reducing the effects of the use of individual protection on the warfighter's performance, and (4) reduce logistics burden. The key components of individual protection are ocular/respiratory protection and percutaneous protection. Both components support general warfighter requirements such as the Army's Land Warrior Program, as well as specialized applications for SOF. Degradation of individual performance can be reduced through advanced filtration technologies to decrease breathing resistance and use of selectively agent-impermeable membranes and self-detoxifying materials to increase uniform comfort.

Collective Protection. The critical functional capabilities for collective protection are as follows:

- Mobile applications
- Fixed-site applications.

Mobile Applications. This capability will provide the joint forces protection against adverse operational effects of all CB agent hazards while operating in mobile configurations throughout the battlespace. It will provide protection for sensitive equipment against the damaging effects of CB contamination and from the adverse effects due to subsequent decontamination processes. The capability is required to allow joint force personnel (e.g., crew members, operations and planning staff, medical personnel, support personnel, equipment operators) to sustain safe, near-normal operations without being encumbered by individual protective posture while conducting the mission in combat vehicles, aircraft, ships, vans, shelters, field hospitals, field operational tents, and other mission-related mobile enclosures.

Fixed-Site Applications. This capability will provide the joint forces with protection against adverse operational effects of all CB agent hazards while operating in fixed-site configurations throughout the battlespace. It will provide protection for sensitive equipment against the damaging effects of CB contamination and from the adverse effects due to subsequent decontamination processes. Collective protection capability at fixed sites is required to enable joint force personnel (e.g., operations and planning staff, support personnel, medical personnel, equipment operators) to sustain near-normal operations without being encumbered by individual protective posture while conducting the mission in rear-area buildings, command and control centers, logistic nodes, and other fixed medical and nonmedical facilities within aerial ports of embarkation/debarkation (APOEs/APODs) and sea ports of embarkation/debarkation (SPOEs/SPODs). This capability will also provide a safe, toxic-free respite environment for personnel operating for long periods of time in individual protection gear.

The collective protection technology base efforts seek to improve capabilities against current and future threats and reduce the logistics burden normally associated with such equipment. To accomplish this goal, collective protection efforts focus on (1) improvements in single-pass vapor filtration, (2) imbedded filter monitors for residual life indication, (3) reductions in size, weight, power requirements, and potential hazards associated with collective protection filters and filtration systems, (4) improvements in transportable protective shelters, (5) regenerative filtration technologies, and (6) decontaminable, transportable shelter material.

Restoration Capability. The critical functional capabilities for restoration capability are as follows:

- Medical diagnostics
- Medical treatment (post-exposure therapeutics and treatment regimens)
- Equipment, facilities, and area decontamination
- Personnel/patient decontamination.

Medical Diagnostics. This capability addresses an FDA-approved medical diagnostics capability to identify and confirm individual exposure to CB hazards before symptoms develop. This capability will permit prophylaxis or treatments to be started early and enable early return to duty and early restoration of unit operational capabilities.

Medical Treatment. This capability will provide rapid, effective, and safe treatment and mitigation of the health effects of CB agent exposure. Prompt medical treatment will enable early return to duty and restoration of unit operational capabilities.

Equipment, Facilities, and Area Decontamination. This capability addresses the need for neutralizing, destroying, or otherwise mitigating the adverse operational and health effects of all

CB agent hazards on the surfaces of mission-essential joint force equipment (sensitive and non-sensitive), facilities, areas, and main supply routes. This capability must be operationally compatible with mission requirements and performance and must be supportable within the standard sustainment and logistical capabilities of the joint force, at all levels of operations.

Decontamination is the process of removing or neutralizing a surface hazard resulting from a chemical or biological agent attack. The objective of decontamination technology efforts is to develop methods that are effective, are environmentally safe, react with chemical agents or disinfect biological agents, do not impact the operational effectiveness of the surface or equipment being decontaminated, and reduce the logistical impact on operations. Current decontamination materials are caustic and rely heavily on water. However, nonaqueous techniques for critical areas at fixed-site facilities—such as seaports or airports, interiors of sea or air transport vehicles, and sensitive equipment such as electronics and avionics—are receiving increased emphasis in the current DoD decontamination program. The current thrust for decontamination is the Joint Service Sensitive Equipment Decontamination (JSSED) Block 1 program. JSSED Block 1 addresses the need to decontaminate CB agents from sensitive equipment such as avionics, electrical, electronic, optical, and environmental systems. The JSSED Block II/III program emphasizes decontamination of vehicle and aircraft interiors and also addresses the need for "on-the-move" decontamination. The Superior Decontamination System (SDS) program consists of a series of projects that target the replacement of Decontamination Solution 2 (DS2) and STB (HTH) and the development of other decontaminating solutions. The Restoration of Operation (RestOps) ACTD (I.06) will demonstrate integrated mature decontamination technologies to restore operations at a port, airfield, or logistic node that has been attacked with CB weapons. The Contamination Avoidance at Seaports of Debarkation (CASPOD) ACTD (I.07) will demonstrate the before-, during-, and after-attack actions necessary to minimize the effects of a CB attack on force flow and OPTEMPO in support of contingency operations or theater war at OCONUS sea ports in theaters where there is limited U.S. presence, especially during the early and more vulnerable stages of power projection operations.

Personnel/Patient Decontamination. A capability, using FDA-approved pharmacological or non-pharmacological products, is needed to provide a rapid, effective means for partial- or whole-body neutralization and thorough decontamination of personnel/patients contaminated with CB agents that is safe to use on skin and wounds. This will reduce adverse effects on the forces and individuals from CB agents and ensure that rapid medical treatment is made available to exposed patients without spreading the contamination or health hazard to medical facilities and personnel.

D. CURRENT CAPABILITIES, DEFICIENCIES, AND BARRIERS

To achieve the operational and functional capabilities described above, a variety of technology development initiatives are planned or underway. Table XII–2 presents the key technologies being pursued to overcome current operational limitations in the functional capabilities that compose CB Defense. DTOs are listed identifying where they address the limitations and technology development efforts; however, not all identified limitations are being addressed by DTOs.

Table XII–2. Functional Capabilities and Related Limitations, Technologies, and DTOs—Chemical/Biological Defense

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Battle Management			
1. Battle Management Systems (Operations)	Limited automated collection and fusion of NBC defense asset information (medical and nonmedical) and relevant non-NBC defense assets	Sensor network command post Joint Simulation Federation Multispectral data processing Distributed array processing	I.06, 07
	Not interfaced with C4ISR and civil support warning and reporting networks	RF communication network Joint Tactical Information Distribution System (JTIDS) Other reachback technologies	
2. Battle Management Analysis	Limited set of medical/nonmedical analytical and planning tools available to the commander in support of mission operations	Artificial Intelligence (AI) and advanced data processing Integrated Target Planning Tool Set (ITPTS)	I.06, 07
	Commander's inability to accurately evaluate, in real time, the actual and predictive impact of NBC weapons on mission operations	Computer mapping with rapid, near-real-time updates: • STAFFS • VLSTRACK • CBW-CFX • Joint Effects Model (JEM)	
3. Modeling and Simulation Training	Limited capability to simulate the NBC environment, integrated with total joint force operations, in support of training and doctrine development	Validated models for combat simulations and transport and diffusion: • VLSTRACK • Joint Effects Model • Joint Operational Effects Federation • ADVEDS • MIDAS-AT • CBW-CFX • STAFFS • CWNAVSIM	IS.11
	Limited capability to simulate command and control functions to respond to simulated NBC agent contamination events	Unified architecture that integrates computer mapping, hazard assessments, and real-time planning	
Operational Capability Element: Contamination Avoidance			
4. Chemical and Biological Early Warning	Aerosol cloud detection only; no true identification of biological agents or materials. Inability to identify biological agent hazards at operationally effective distances	Remotely employable technologies (e.g., remote sensing) Ultraviolet and laser induced fluorescence CO_2 LIDAR Differential scattering/differential absorption of light (DISC/DIAL)	I.06, 07; CB.35
	Limited capability to detect chemical agent aerosols and vapors at operationally effective distances	8-µm laser technology DISC/DIAL Frequency Agile Laser (FAL) LIDAR Next-generation CO_2 LIDAR (e.g., Warning and Identification LIDAR Detector for Countering Agent Threats) Infrared sensors	CB.19

Table XII–2. Functional Capabilities and Related Limitations, Technologies, and DTOs—Chemical/Biological Defense (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Contamination Avoidance (continued)			
5. Chemical and Biological Point Detection	Lack of ability to identify chemical or biological agents by specific chemical agent type and by biological species and strain	Py-GC-IMS Flash GC/MS Bio MS Mini GC-GC Small CAD (integrates IMS, SAW sensors) Microfluidics Force diffusion assay Polymer technologies (e.g., electroactive, non-specific doped, etc.) Aerogel characterization/development Up-converting phosphors Gene probe sensors Biodiffractive grating sensors Multiarray and single-particle detection technologies Cell/tissue activity detection technology Molecular recognition technologies (e.g., DNA sequencing)	L.07, 12; CB.38, 39, 41
	Lack of capability to rapidly, effectively, and accurately detect and identify surface contamination	Time-of-Flight Mass Spec (TOF MS) Surface Enhanced Raman Scattering Next-generation CO_2 LIDAR (e.g., Warning and Identification LIDAR Detector for Countering Agent Threats (WILDCAT)) Biocontaminant Detection/ID strategies (e.g., culture quantitation and quantitative PCR analysis, ABI Prism 7700 Sequence Detection System (APS))	L.07
	Logistical burden posed by current CB detection and identification systems due to size, weight, and power requirements	Process and materials engineering, thermal management, component integration, fluidics management, and other new engineering concepts Microelectromechanical systems	L.07, 12
6. Sensor Integration	Limited integration of multiple CB agent sensing capabilities	Automatic radio relay Sensor network command post Artificial intelligence and neural network technologies	
	Limited interface of CB detection capabilities with other battlespace sensing capabilities that have relevance to contamination avoidance	Artificial intelligence and neural network technologies	

Table XII–2. Functional Capabilities and Related Limitations, Technologies, and DTOs—Chemical/Biological Defense (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Contamination Avoidance (continued)			
7. Medical Surveillance/ Veterinary Support	No mobile in-theater capability to identify all CB agents in clinical specimens	Rapid and automated dissemination, recording and archiving of medical surveillance reports and analyses Rapid handheld screening assays and immunoassays Specimen processing/gene amplification	CB.26, 38
	Limitations for biological sample preparation and screening, including preparation time, separation of environmental background from sample, and standardization of reagents	Microfluidics Force diffusion assay Multiarray detection Biomarker ionization PCR Optical fiber simultaneous orthogonal detection MALDI TOF Bacterial endospore detector DARPA automated rare event detection Force amplified biosensor Gene probe detection Bio MS ESI/MS Nondestructive evaluation technologies	CB.38
	Limited rapid, forward, and identification capability and analysis of contaminants in food and water supplies	FTIR-ATR Molecular imprinted polymer Biodetection immuno-tickets Pyrolysis-GC-IMS Surface-Enhanced Raman Spectroscopy Automated colorimetric test kit	CB.37
Operational Capability Element: Individual Protection			
8. Medical Prophylaxes	Limited protection against bacterial agent hazards	Vaccine research and development efforts (e.g., recombinant plague vaccine, anthrax vaccine (next-generation anthrax (NGA), tularemia vaccine, brucella vaccines) Antibacterial prophylaxes Immunomodulators Novel genomic, molecular genetics, molecular phylogeny, and CpG DNA approaches	CB.25, 31, 33, 34
	Limited protection against viral agent hazards	Vaccine research and development efforts (e.g., smallpox vaccine, multivalent equine encephalitis vaccine, filovirus vaccine) Antiviral prophylaxes Immunoprophylaxes Novel genomic, molecular genetics, molecular phylogeny, and CpG DNA approaches	CB.24

Table XII–2. Functional Capabilities and Related Limitations, Technologies, and DTOs—Chemical/Biological Defense (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Individual Protection (continued)			
8. Medical Prophylaxes (continued)	Limited protection against toxin hazards	Vaccine research and development efforts (e.g., staphylococcal enterotoxin(s) vaccine, ricin vaccine, botulinum vaccine, recombinant vaccine technologies) Passive immunoprophylaxes Active site-directed inhibitors Receptor antagonists Novel genomic, molecular genetics, and molecular phylogeny approaches	CB.25
	Limited protection against chemical agent hazards	Chemical agent pretreatments (e.g., reactive/catalytic scavengers, NA pyridostigmine pretreatment, chemical agent prophylactic, cyanide pretreatment)	CB.28, 30
	Limited protection against multiple chemical and biological agents using one medical action (nonspecific protection) or a series of pretreatments	Vaccine research and development efforts (e.g., multiagent vaccine against biological threat agents, naked DNA vaccines, replicon vaccines, recombinant protein-based vaccines) Antivesicant treatments Small molecule antibiotics and protein inhibitors Novel bioengineering, genomics, molecular genetics, molecular phylogeny, and CpG DNA approaches Advanced anticonvulsant Active topical skin protectant (polymers, enzymes, organic compounds, inorganic compounds)	CB.24, 25, 27, 28, 29, 30, 31, 33, 34
	Limited capability to deliver medical prophylaxes safely and quickly	Novel vaccine delivery approaches (e.g., parenterally administered vaccines, needle-less and intranasal/inhalation vaccine antigen delivery, transdermal, or oral immunization strategies, such as peptide delivery system) Novel genomic, molecular genetics, and molecular phylogeny approaches	CB.25, 32
9. Respiration/Percutaneous	Limited mission duration because of current protection capability imposed physiological and psychological stress	Engineered permeable materials for clothing Permeable sorptive materials for clothing Microclimate cooling technologies Dual-function materials for both vapor and particulate removal Advanced aerosol separation technologies	CB.08, 29, 36, 45
	Cumbersome interface between current capability and other individuals and mission equipment	Integrated closure technologies Integrated ensemble concepts Advanced communication technologies Novel mask concepts Active topical skin protectants	CB.08, 45

Table XII–2. Functional Capabilities and Related Limitations, Technologies, and DTOS—Chemical/Biological Defense (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Individual Protection (continued)			
9. Respiration/Percutaneous (continued)	Limited scope of protection (e.g., toxic industrial materials, fourth-generation agents, etc.)	Advanced vapor separation Advanced facepiece materials Material finishes and treatments	CB.08, 29, 36, 45
	Limited capability for predicting when protection will no longer be provided	Passive indicator technologies (e.g., colorimetric indicator reagents/films)	CB.36
Operational Capability Element: Collective Protection			
10. Mobile Applications	Limited capability to provide permanent collective protection for future fielded mobile applications	Regenerative vapor and particulate filtration processes (e.g., pressure-swing adsorption/temperature-swing adsorption, catalytic oxidation, advanced particulate filtration materials) Novel adsorbent technologies (e.g., carbon nanotubes, metal oxide nanoparticles, surface modified carbon, reactive impregnated carbon, novel structured carbons, layered adsorbents.) Oxygen generating and carbon dioxide scrubbing systems	I.06, CB.08
	Logistical burden posed by current CB collective protection systems due to operations and maintenance, size, weight, and power requirements	Improved materials to increase protection and to reduce costs, weight, vdume and logistics burden Self-decontaminating materials Pressurized, flexible composite structures utilizing highly oriented hybrid fiber combinations (e.g., inflatable airbeams, composite frames, tensegrity structures)	
	Lack of integration of the protection capability with other mobile support functions	Advanced airlock and contaminant removal technologies Optimized closures and hermetic seals	
11. Fixed-Site Applications	Limited capability to provide temporary collective protection for fixed-site structures	Regenerative vapor and particulate filtration processes (e.g., pressure-swing adsorption/temperature-swing adsorption, catalytic oxidation, advanced particulate filtration materials) Novel adsorbent technologies (e.g., carbon nanotubes, metal oxide nanoparticles, surface modified carbon, reactive impregnated carbon, novel structured carbons, layered adsorbents)	I.06; CB.08, 40
	Limited capability to provide permanent collective protection for fixed sites at the theater and strategic level of operations	Infrastructure modification concepts (e.g., real-time, active control of HVAC airflow patterns, or full-time, passive, highly efficient filtration—in addition to whatever other modifications might be appropriate—such as real-time neutralization of the aerosolized agent, or networked surveillance systems)	

Table XII–2. Functional Capabilities and Limitations, Technologies, and DTOs—Chemical/Biological Defense (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Restoration Capability			
12. Medical Diagnostics	Lack of deployable rapid diagnostics for all CB effects in humans	Mini-PCR Fluorescent probe chemistry Rapid portable nucleic acid analysis for medical diagnosis Rapid portable immunoassay techniques for medical diagnosis GC/MS Cholinesterase field screening kit (Next-generation Test-Mate) Colorimetric assay Cholinesterase-microtiter plate method Microsonication technology Cellular or tissue activity detectors (e.g., detectors utilizing cellomics) Specimen processing/reagent preparation for field use	CB.26, 38
	Limited capability for conducting validated and reliable medical risk assessments	Advanced chemical warfare agent for forward and forensic diagnostic capability	
13. Medical Treatment	Lack of ability to deliver continuous medical care to casualties in CB protective gear	Vesicant and respiratory agent therapy (e.g., aerosolized atropine)	CB.27
	Limited capability to treat and remediate all CB effects in humans	Chemical therapeutics (e.g., NA Antidote Kit, Multichambered Autoinjector, convulsant antidote for nerve agent) Gene therapy Immunotherapy Antibacterial therapeutics (e.g., bacterial lytic enzymes, FtsZ—broad-spectrum, complex biosignatures, MMARRS, novel broad spectrum antibiotics, genetic metabolic pathogen, broad-spectrum antibodies, thioaptamers, nanoparticles, target pathogen DNA, antigenomic countermeasures, transcriptional/translation inhibitors) Antiviral therapeutics (e.g., novel viral blocking, stock drug subunits, universal path protection, second-generation vaccines, genome-based agents, pokeweed (PaP), combinatorial technology, antigenomic countermeasures, prodrug development, countermeasures for viral induced effects) Antitoxin therapeutics (e.g., toxin neutralization, target replacement, respiratory/mucosal countermeasures, neutralization of toxin-induced effects, superantigen toxin inhibitors)	

Table XII–2. Functional Capabilities and Related Limitations, Technologies, and DTOs—Chemical/Biological Defense (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Restoration Capability (continued)			
14. Equipment, Facilities, and Area Decontamination	Current decontaminants cause adverse effects to physical, optical, electronic, or mechanical properties of the items being decontaminated and are not environmentally friendly	CB survivability technology Supercritical fluidics Decontamination coating technologies Thermal desorption methodology Enzyme- and catalyst-based decontamination Gas phase decontamination Decontamination green Chemical matrix strategies Novel approaches using non-ozone-depleting solvents, plasma, oxidation catalysts, peroxy-carboxylic acid (peracids), novel surfactants and microemulsions, dioxiranes, nanoparticles, etc.	I.06; CB.09, 44
	Heavy dependence on large quantities of water, decontamination materials, and personnel resources	Gas phase decontaminants Destructive adsorption Organic chemical matrix strategies	
	Limited capability for large area CB decontamination	Enzyme- and catalyst-based decontamination Oxidative formulations	
15. Personnel/Patient Decontamination	Lack of forward-area capability to decontamination internal and external CB contamination of casualties	Enzymatic decontamination Antimicrobial nanoemulsions Skin/wound decontamination	I.06; CB.09, 29
	Limited ability to rapidly remove or neutralize all internal and external contamination on casualties	Improved personal decontamination	

E. TECHNOLOGY PLAN

Technology demonstrations and joint field trials provide a means for the rapid field testing of technical options to solve operational needs. These demonstrations support the CB Defense JWCO. Table XII–3 illustrates how these demonstrations and supporting technologies are structured to support the JWCO. The DTOs supporting the operational capability elements are shown in Figure XII–2. Each DTO is described in *Defense Technology Objectives for the Joint Warfighter Science and Technology Plan and the Defense Technology Area Plan* (Reference 4). Relationships among DTOs are plotted in the technology roadmap, Figure XII–3. Figure XII–4 provides a notional path for the contribution of each DTO toward the overall CB Defense goals of the JWCO.

Following is a brief description of the current JWSTP CB Defense DTOs:

- *I.06, Restoration of Operations ACTD,* will demonstrate those mitigating actions taken before, during, and after a chemical or biological attack to protect against and immediately react to the consequences of a CB attack. These actions aim to restore operating tempo in mission execution and the movement of individuals and materiel to support

combat operations at a fixed site. The ultimate payoff will be the improved ability of fixed sites worldwide to better prepare for and recover from CB attacks.

- *I.07, Contamination Avoidance at Seaports of Debarkation (CASPOD) ACTD*, will demonstrate the before-, during-, and after-attack actions necessary to minimize the effects of a CB attack on force flow and OPTEMPO in support of contingency operations or theater war at OCONUS sea ports in theaters where there is limited U.S. presence, especially during the early and more vulnerable stages of power projection operations. Potential payoff includes providing the in-theater ability to protect against, immediately react to, and minimize the impact of a CB attack at sea ports, thereby maintaining the critical flow of forces and materiel into any theater worldwide.

F. SUMMARY

Science and technology efforts in CB Defense provide the basis for significant future advances in protecting U.S. forces from the CB threat and address the highest priority of this JWCO. These efforts support capabilities identified by the joint services in a prioritized list of joint future operational capabilities for chemical and biological defense. Warning and reporting is key to detection efforts because it integrates detection systems into the digital battlefield and provides commanders with information to accurately visualize the battlefield and assess warfighting options. Achieving these objectives will ensure that the warfighter is equipped with state-of-the-art capabilities that correct the deficiencies encountered during Operation Desert Storm and that prepare the warfighters for future threats.

Table XII–3. Demonstration Support—Chemical/Biological Defense

Demonstration	Operational Capability Element					Service/ Agency	DTO	Type of Demonstration	
	Battle Management	Contamination Avoidance	Individual Protection	Collective Protection	Restoration Capability			ACTD	ATD
Restoration of Operations ACTD	○	○	○	○	●	Joint	I.06	X	
Contamination Avoidance at SPODs ACTD	○	○	○	○	●	Joint	I.07	X	
Terrorist Chemical/Biological Countermeasures		○				Joint	L.07		
Force Medical Protection/Dosimeter ACTD			○			Joint	L.12	X	
On-Scene Weather Sensing and Prediction Capability	○					Joint	BE.04		
High-Resolution Meteorological Nowcasting for CB Hazard Prediction	○					DTRA, Joint	BE.10		
Advanced Adsorbents for Protection Applications			●	●		Joint	CB.08		
Enzymatic Decontamination					●	Joint	CB.09		
Chemical Imaging Sensor		●				Joint	CB.19		
Biological Sample Preparation System for Biological Identification		●				Joint	CB.20		
Medical Countermeasures for Encephalitis Viruses			●			Joint	CB.24		
Multiagent Vaccines for Biological Threat Agents			●			Joint	CB.25		
Common Diagnostic Systems for Biological Threats and Endemic Infectious Diseases			○		●	Joint	CB.26		
Therapeutics Based on Common Mechanisms of Pathogenesis					●	DARPA	CB.27		
Chemical Agent Prophylaxes II			●			Joint	CB.28		
Active Topical Skin Protectant			●			Joint	CB.29		
Medical Countermeasures for Vesicant Agents II			●			Joint	CB.30		
Medical Countermeasures for *Brucellae*			●			Joint	CB.31		
Needle-less Delivery Methods for Recombinant Protein Vaccines			●			Joint	CB.32		
Recombinant Protective Antigen Anthrax Vaccine Candidate			●			Joint	CB.33		
Recombinant Plague Vaccine Candidate			●			Joint	CB.34		
Standoff Biological Aerosol Detection		●				Joint	CB.35		
Universal End-of-Service-Life Indicator for NBC Mask Filters			●			Joint	CB.36		
Chemical/Biological Agent Water Monitor		●			●	Joint	CB.37		
Activity-Based Detection and Diagnostics		○			●	DARPA	CB.38		
Chemical/Biological Warfare Agent Screening and Analysis					○	DTRA	CB.39		
Immune Building Program			●	●		DARPA	CB.40		
Biological Warfare Defense Sensor Program		●				DARPA	CB.41		
Environmental Fate of Agents					●	Joint	CB.42		
Chemical and Biological Warfare Effects on Operations	○	○			●	Joint	CB.43		
Oxidative Decontamination Formulation					●	Joint	CB.44		
Self-Detoxifying Materials for Chemical/Biological Protective Clothing			●		○	Joint	CB.45		
Simulation Information Technologies	○					Joint	IS.11		
Cleanup of Contaminants					○	Joint	MP.18.06		
Prediction and Mitigation of Collateral Hazards	○	○				DTRA	NT.04		

● Strong Support ○ Moderate Support

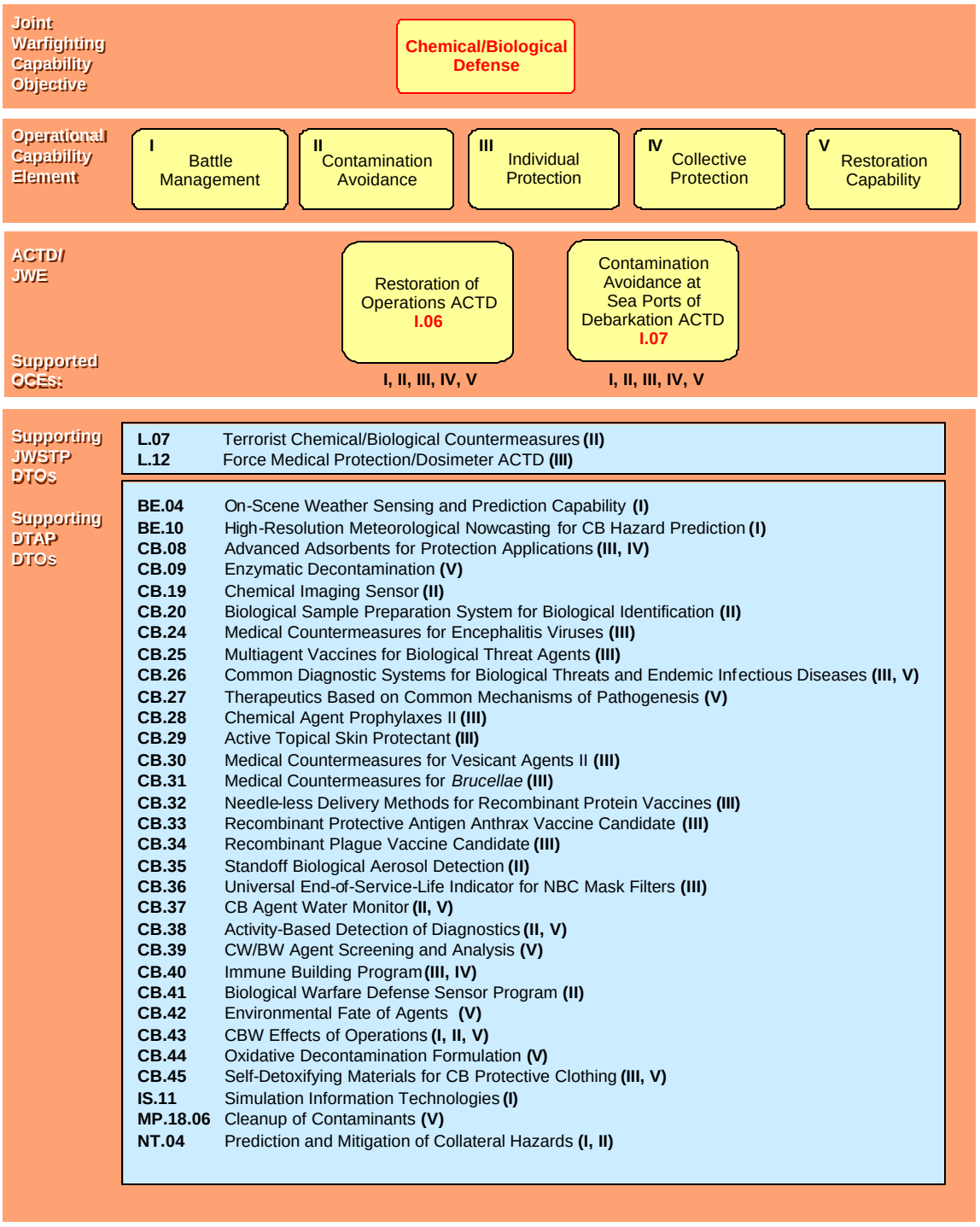

Figure XII–2. Technology to Capability—Chemical/Biological Defense

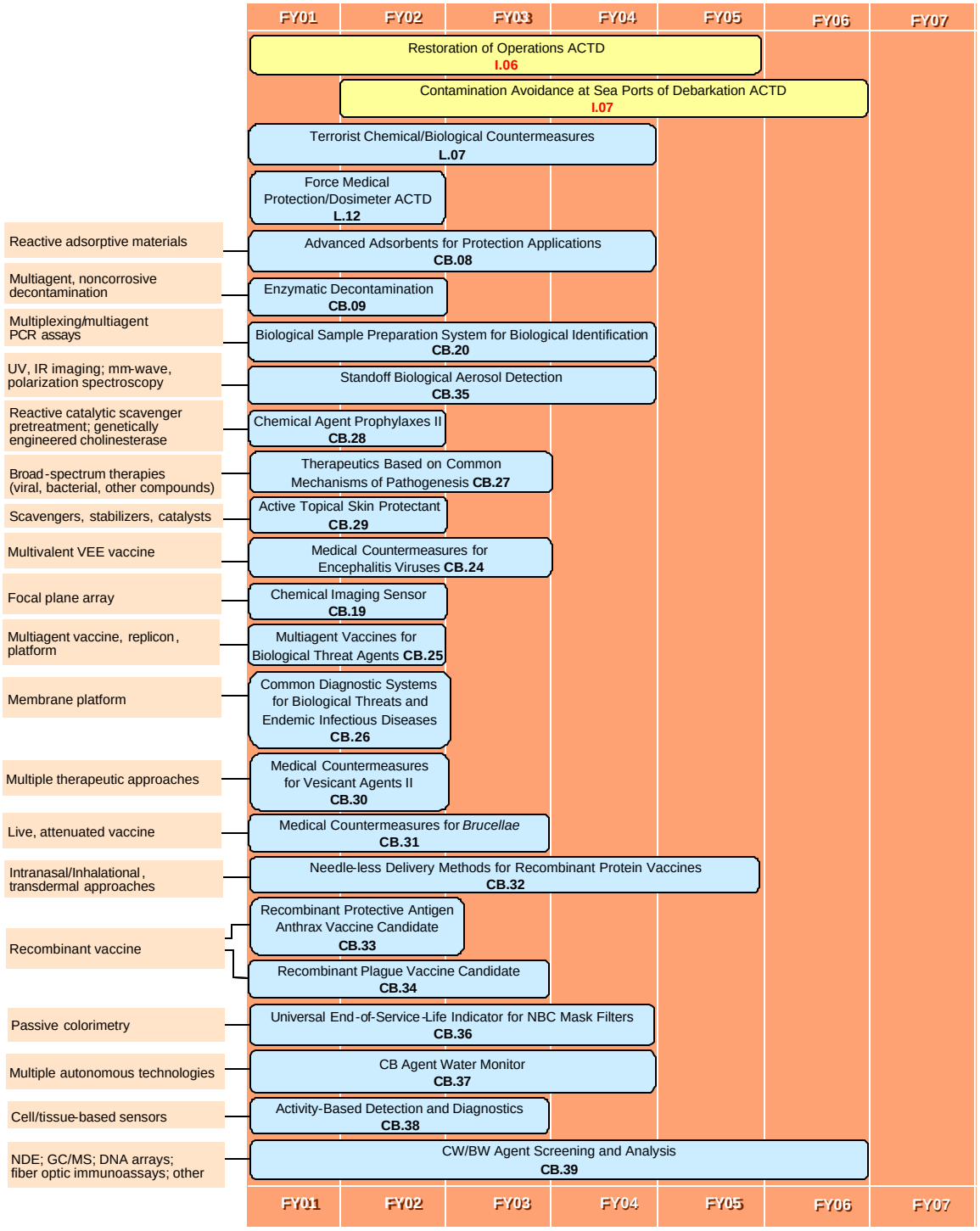

Figure XII–3. Roadmap—Chemical/Biological Defense

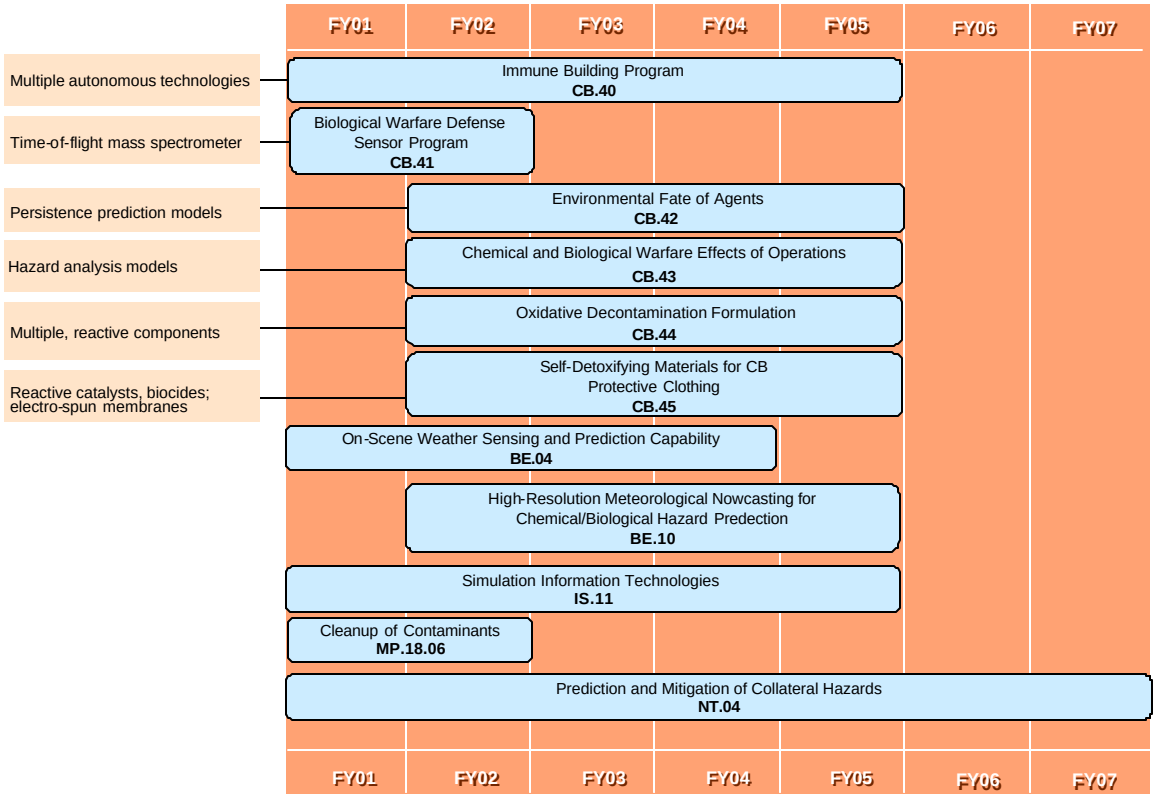

Figure XII–3. Roadmap—Chemical/Biological Defense (continued)

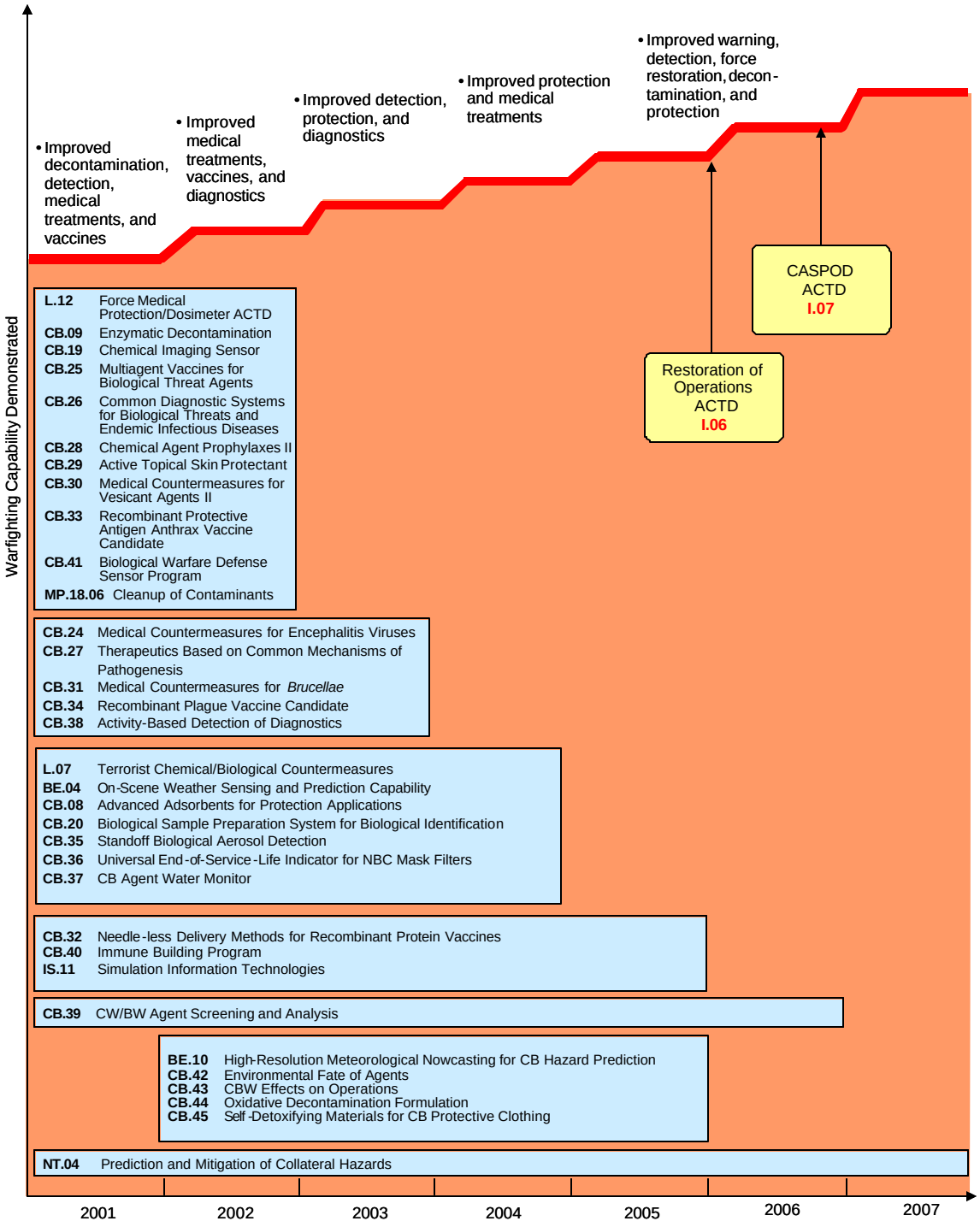

Figure XII–4. Progress—Chemical/Biological Defense

Section 2
Counter Weapons of Mass Destruction

A. DESCRIPTION

Counter Weapons of Mass Destruction (CWMD) provides the CINCs with counterforce capabilities to hold NBC targets at risk while minimizing collateral effects. The DoD CWMD program addresses end-to-end processes from planning to employment to combat assessment. It enables the military forces to intelligently and effectively target NBC facilities and provides appropriate weapons to eliminate the threat. Finally, it includes the capability to perform combat assessment and standoff detection of any NBC contamination released during the attack. These capabilities directly contribute in the near, mid, and far term to the Joint Vision 2020 capabilities of precision engagement, information superiority, and full-dimension protection, and indirectly support dominant maneuver.

B. OPERATIONAL CAPABILITY ELEMENTS

CWMD focuses on the counterforce dimension of counterproliferation and military support to nonproliferation.[2] Figure XII–5 shows the position of counterforce and military support to nonproliferation within counterproliferation programs and activities.

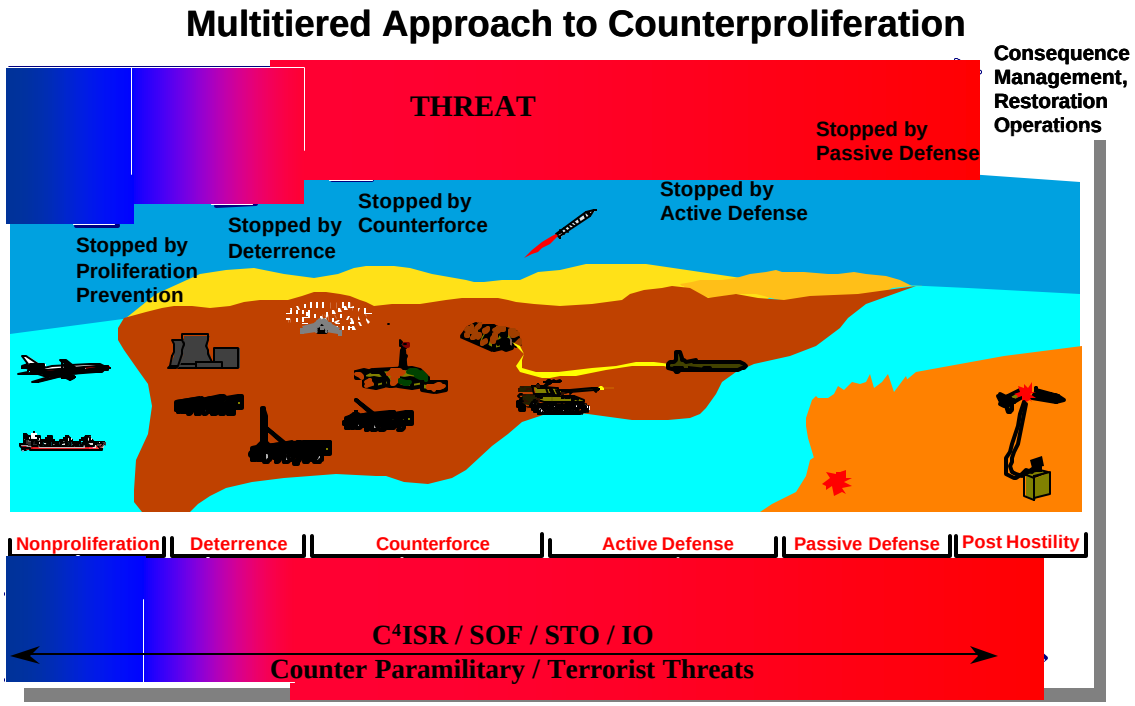

Figure XII–5. Concept—Counter Weapons of Mass Destruction

[2] Most of this section focuses on S&T programs directed at counterforce requirements. Nonproliferation receives less emphasis for two reasons: first, this is a Joint *Warfighting* Science and Technology Plan. Nonproliferation missions do not normally involve use of military force. Denial and interdiction operations are normally conducted in the context of counterproliferation activities. Second, much of the national nonproliferation effort is accomplished by agencies other than DoD, such as the Departments of State, Commerce, and Justice.

The improved CWMD capabilities presented in this section have primary relevance for scenarios involving WMD-capable adversaries; in such situations, adversaries might employ the threat or use of WMD as an asymmetric counter to offset the United States' conventional superiority.[3] They are also relevant for scenarios involving terrorist or unconventional threats (e.g., the August 1998 cruise missile attack of a WMD-related facility in Sudan).

With regard to strategic goals during contingencies or conflicts involving WMD-capable adversaries,[4] CWMD development and demonstration efforts support the objectives of disincentivizing WMD use and denying sanctuary to WMD weapons and associated C^3. To deploy and employ such capabilities credibly and effectively, it is necessary for forces and systems to be able to withstand WMD threats or attacks from adversaries; this makes survivability, as provided by both active and passive defenses, imperative.

Critical operational capability elements (OCEs) for CWMD involve:

- Timely target identification and characterization
- Prompt planning and execution of attacks
- Target defeat with minimal collateral hazards
- Combat and collateral hazard assessment.

Timely Target Identification and Characterization. Target identification and characterization are points on a continuum of information acquisition activities in support of counterproliferation. Identification occurs when NBC-related activities or capabilities are observed with enough specificity to support initial planning. Development of a counterforce target might involve determination that a specific facility is involved in production of NBC weapon materials or that NBC weapons are located at a specific site.

Characterization involves development of a more detailed description of the identified target. For counterforce planning of conventional weapons use against NBC target facilities, detailed descriptions of the target are needed to allow weaponeers to select weapons, delivery means, and aimpoints in a timely fashion. Detailed target characterizations are also required to support planning to minimize collateral hazards that might result from a conventional attack where NBC hazards originate from the targets. In an attack using conventional weapons, the primary hazards may be due to the NBC materials being attacked (e.g., a conventional bomb attack may result in dispersion of NBC material, potentially over a large area).

One challenge is to promptly and accurately locate both NBC production facilities and NBC weapons, to include weapons and delivery systems that have already been deployed. The Iraqi NBC programs illustrated how difficult target identification and characterization of NBC weapons and facilities can be. Since its defeat in the Gulf War, Iraq has undergone onsite inspections (OSI) directed at these objectives. Even after several years of OSI conducted by competent inspectors, the full scope of Iraq's programs did not come to light until August 1995, when Saddam Hussein's son in law defected and provided the West significant new information. These

[3] These scenarios are developed in the Nuclear Technology area (Chapter XI) of the *Defense Technology Area Plan* (Reference 3).

[4] These strategic goals are presented in the Nuclear Technology area (Chapter XI) of the *Defense Technology Area Plan* (Reference 3).

disclosures included an intensive 1990 program that attempted to develop a nuclear weapon using nuclear fuel supposedly protected by international safeguards, manufacture of advanced chemical weapons, and a large-scale biological weapon program (Reference 27).

For counterforce operations, three distinct sets of NBC targets each present different challenges. These differences impact target identification and characterization, the effectiveness of conventional munitions for defeat of the target, and the collateral hazards that might be associated with attacks. The primary NBC target sets addressed in counterforce planning (Table XII–4) involve:

- Fixed-facility targets located on the surface or shallow buried
- Deeply buried or otherwise hardened facilities
- Mobile targets (e.g., surface-to-surface missile launchers).

Table XII–4. Target Sets

Fixed, On the Ground, or Shallow Buried Targets	Fixed, Deeply Buried, or Otherwise Hardened Targets	Mobile Targets
Target Identification and Characterization Issues		
In principle, the easiest set to identify. For extensive facilities, accomplishing the detailed characterization needed to identify specific NBC target nodes within the facility may be difficult. Some targets in this set were not correctly identified or characterized during the Gulf War.	Target identification and (particularly) characterization of facility targets and specific NBC-mission-related subelements are more difficult.	Camouflage, concealment, and deception (CCD) make it difficult to detect deployed missile launchers and, in some instances, deployed launchers. As explained in the Information Superiority JWCO (Chapter IV) and demonstrated during the Gulf War, deployed mobile missiles are very difficult to locate and track.
Susceptibility to Defense Using Current Conventional Weapons		
Most targets can be defeated, in whole or part, using current weapons.	Some targets cannot be physically defeated using current conventional weapons; functional disruption (attacks that prevent operations from being accomplished) is the only practical targeting objective if conventional weapons are employed.	If promptly and accurately detected and target tracking is sustained for the period required, these targets can be defeated using current weapons.
Target-Induced Collateral Hazards		
Collateral hazards can be significant and widespread.	Collateral hazards may be significant; however, in some situations, the same target characteristics that impede defeat (e.g., deep burial) will also confine collateral hazards.	Local area collateral hazards may result; hazard magnitude depends on target characteristics and environmental conditions.

Military objectives, functional capability requirements, and shortfalls in capabilities vary across these three target sets. Target identification and characterization of collateral effects requirements vary from very short ranges (e.g., to support SOF) to considerable distances for some potential target elements.

Analogous operational capabilities are needed to support military support to nonproliferation (e.g., identification and characterization of the most important elements in a proliferant state's attempt to develop or acquire NBC weapons). Targets of interest for military support to nonproliferation include capabilities for the production or use of NBC weapons plus the weapons themselves and supporting systems that are critical for their use. Many of the key technological capabilities required for development of biological, chemical, radiological, and (to a lesser extent) nuclear weapons are inherently dual-use and broadly distributed. Arms control measures

may inhibit, but are unlikely to completely prevent, transformation of such proliferation potential into weapons.

The challenges involved in defeating mobile missile launcher targets were demonstrated during the Gulf War. A large number of aircraft sorties were directed at these targets, but Coalition aircraft were not successful in locating and destroying Scuds prior to launch (Reference 28). While this effort may have impacted Scud launcher operations by inducing the Iraqis to conduct fewer operations, a disproportionate number of Coalition aircraft were diverted from more militarily significant missions to deal with this threat.

DoD R&D programs that develop, validate, and transfer technologies for effective monitoring and verification of arms control treaties and agreements involve the use of identification and characterization capabilities in support of military support to nonproliferation objectives. Information collection is directed against potential treaty/agreement violations involving NBC and related military capabilities. Current programs provide support to treaties and conventions restricting development and deployment of NBC weapons and associated production and delivery system capabilities. Because verification must be accomplished within an international political context, some of these developments produce products that can be released to foreign parties without compromising sensitive information collection capabilities. For example, DoD has developed a suite of equipment that can be used by international inspectors involved in verification of compliance with the Chemical Weapons Convention.

Prompt Planning and Execution of Attacks. Counterproliferation targets are often time critical. A target planning cycle that requires many hours (or days) may not respond to requirements. Unlike some other types of target planning for conventional munitions, there is a concurrent requirement for prompt, accurate assessment of the collateral hazards that might be associated with attack options being considered.

Part of the needed response to these requirements involves development and validation of automated systems to support planning and execution of operations. To ensure timeliness, emphasis is also given to the integration of these systems with other mission planning and communications capabilities.

Military support to nonproliferation also requires timely planning and implementation; windows of opportunity may be of limited duration. There are additional requirements for technical capabilities enabling prompt, accurate collection and assessment of potential violations of treaties and norms restricting development and deployment of NBC weapons and production capabilities.

Target Defeat With Minimal Collateral Hazards. Target defeat options vary along several dimensions. Once an NBC facility has been located and characterized, the challenge is to defeat the facility with appropriate weapons yet minimize collateral hazards resulting from both the weapon and the facility itself. A conventional munition incorrectly targeted could create a cloud of chemical or biological agent having far-reaching effects from dispersion in the environment. For all target sets, this objective is the same. However, for some targets, this is not always possible, resulting in efforts to develop and validate new, more effective munitions or enhancements to existing weapons or employment methods.

Developing improved conventional weapons for defeat of chemical and biological threats is a specific priority. The objective is to be able to completely remove the capability for employment of chemical and biological agents that the facility would normally support. One aspect

of this is development of improved agent defeat capabilities that would employ methods to either directly neutralize agents or otherwise make them unusable to the adversary.

For the foreseeable future, it will not be possible to physically defeat all NBC targets, particularly buried or otherwise hardened facilities, using standoff conventional weapons. See also Chapter XV, Hard and Deeply Buried Target Defeat. In such circumstances, the targeting objective instead devolves to functional disruption that prevents the target from accomplishing NBC missions. For example, the entrance to a tunnel facility might be attacked in ways that prevent mobile missile launchers from deploying to firing positions. This necessitates post-attack monitoring of the target facility and re-attacks to preclude resumption of operations.

For both physical defeat and functional disruption, the objective is to be able to defeat targets at times and under circumstances chosen by the United States. This results in requirements for effective weapon systems that have the range required to reach targets and that are capable of penetrating defenses to reach targets. It also entails requirements for weapon systems that can accomplish missions during adverse environmental conditions.

For military support to nonproliferation, target defeat is not a consideration in the same sense. However, there is a need to develop technologies that provide for the safe, secure, and effective disposition of NBC weapons and materials, as is currently being done by both DoD and DOE in support of Cooperative Threat Reduction in the New Independent States.

Combat and Collateral Hazard Assessment. A range of consequences must be considered in counterproliferation mission planning and operations. These include prediction and mitigation of the collateral hazards that might result from:

- Attacks or strikes against NBC targets
- Enemy use of WMD against U.S., allied, or coalition forces during a major theater war or other circumstances
- Accidental or deliberate release of NBC agents from a facility.

A common set of technical capabilities provides the basis for accomplishing these tasks. Key factors include:

- Characterization of within-facility sources to develop an understanding of the potential hazards that might be dispersed
- Atmospheric transport modeling
- Real-time weather forecasting integrated with atmospheric transport modeling
- Accurate characterization of any hazards that might be produced
- Measures for mitigating NBC hazards
- Automated systems capable of providing target-specific and attack-option-specific assessments of both the hazards that might be associated with options and of the efficacy of methods for mitigating such effects
- Remote detection, tracking, and agent identification of the collateral effects resulting from a facility attack.
- Prioritization of force protection for U.S., allied, and coalition units in mission planning.

There is a requirement for prompt, accurate determination of the effectiveness of an attack to support planning for re-attack options. The same technical capabilities listed above are required for combat assessment (CA). For both CA and collateral hazard forecasting, automated systems must be integrated with other planning support and communications capabilities to allow analysis and planning to be accomplished within demanding operational timelines.

Threat assessment is also important in military support to nonproliferation. Here the emphasis is on prompt, accurate detection of the signatures associated with violations of regimes prohibiting NBC weapons and their development (e.g., technical support for the Chemical Weapons Convention, development of the technologies needed for verification of a prospective Comprehensive Test Ban Treaty).

C. FUNCTIONAL CAPABILITIES

The interrelationships between the critical functional capabilities and operational capability elements are depicted in Table XII–5. The table also indicates the correlation between the critical functional capabilities and the key functional areas of the national counterproliferation program. The elements within each functional capability are presented in Section D, Current Capabilities, Deficiencies, and Barriers.

Table XII–5. Functional Capabilities Needed—Counter Weapons of Mass Destruction

Functional Capabilities	Operational Capability Elements			
	Timely Target ID and Characterization	Prompt Planning and Execution of Attacks	Target Defeat With Minimal Collateral Hazards	Combat and Collateral Hazard Assessment
1. Identification and Characterization Sensors	●	○		●
2. WMD Target Planning Tools	○	●		●
3. Sensor Data Fusion	●	●		●
4. WMD Proliferation Path Analysis	●	●		●
5. Real-Time Weather Data and Forecasts	●	●	○	●
6. Collateral Effects Prediction and Mitigation		●		●
7. Enhanced Penetrating Munitions		●	●	
8. Enhanced Lethality Warheads		●	●	
9. Agent Defeat Payloads			●	
10. Hard-Target Smart Fuzing		●	●	
11. All-Weather Guidance		●	●	
12. Combat and Collateral Hazard Sensors		○		●
13. NBC Survivability	●	●	●	●
14. Preventative Defense/Arms Control Technology	○			

● Strong Support ○ Moderate Support

Identification and Characterization Sensors. Information and characterization requirements and development priorities vary across the three target sets addressed in counterproliferation operations:

- Fixed, on the ground, or shallow buried
- Fixed, deeply buried, or otherwise hardened
- Mobile.

For all three target sets, sensors must be capable of accurately and promptly detecting critical changes in target status (e.g., initiation of weapon-related activities at a fixed site; preparations for movement of mobile systems to the field; and, as occurred in Iraq immediately prior to the Gulf War, attempts to violate treaty commitments by attempting to develop a nuclear weapon using safeguarded nuclear materials). Because conventional munitions have a very limited radius of effectiveness, sensors must provide target information that has high resolution and fidelity. Range requirements vary from very short distances for SOF/first-responder operations to very long ranges for some attack options. Given the limitations of available signatures associated with these targets and activities, some of DoD's most challenging sensor development efforts are focused in this area.

WMD Target Planning Tools. For counterforce applications, automated systems are needed to accurately process and analyze large volumes of information in near-real time. These tools must support analysis of complex targets and allow alternative targeting options to be developed and compared. The tool set must also support appraisal of the collateral hazards that might be associated with attack options. Planning products must have connectivity to other tactical planning systems (e.g., systems that provide weather information). The objective is a suite of validated tools that seamlessly integrates with other tactical planning systems. DTO WE.71, Integrated Comprehensive Weaponeering Capability, employs software to integrate weaponeering, collateral hazard assessments, and combat assessment tools. Applied physics, e.g., for weapon-target interactions, provides the foundation for integration. DTO NT.04, Prediction and Mitigation of Collateral Hazards, is a program that involves meteorological predictions and atmospheric transport, weapon-target interaction modeling, and estimation of WMD source terms for target-induced collateral hazards.

For defeat of mobile NBC targets, qualitatively improved capabilities are needed. These include the automated support required for continuous monitoring of data developed by multiple sensors using different phenomenologies; near-real-time integration and evaluation of this information in environments in which camouflage, concealment, and deception (CC&D) is likely; and the ability to bring attack systems to bear in the limited time windows within which surface-to-surface missiles (SSMs) and other NBC mobile targets are most vulnerable. Most of these capabilities are under development elsewhere in programs that respond to multiple requirements for defeat of mobile targets.

Sensor Data Fusion. Multiple sensors based on different phenomenologies are directed at all of the counterproliferation target sets. These data streams vary along multiple dimensions, which include:

- Militarily relevant characteristics that can be identified
- Susceptibility to CCD and countermeasures
- Platform availability during major theater war scenarios in which there are many more requirements than available assets
- Time-stamping—some sensors (e.g., aerial photography) may provide intermittent observation; others may provide continuous 24/7 coverage (24 hours a day, 7 days a week).

- The amount of time and level of effort required for processing raw sensor data into usable information.

Greatly improved capabilities for automated transmission, integration, and analyses are required to support counterforce applications. Traditional stovepipe approaches in which separate data streams are sent to a command center are not responsive to requirements.

WMD Proliferation Process Analysis. The adversary proliferation continuum depicted below consists of nine generic activities, which together constitute a proliferation process. Automated systems are needed to support proliferation process analyses, both to manage the large volume of disparate types of data that must be collected and analyzed and to develop a valid model of the emergent (or in-place) NBC military capability. For military support to nonproliferation, this capability allows activities to be more effectively focused; for counterforce, it assists in identifying the key elements that need to be defeated.

ADVERSARY PROLIFERATION CONTINUUM

Real-Time Weather Data and Forecasts. In counterforce planning, two sets of requirements for real-time weather data and forecasts must be met. The first involves target planning. The effectiveness of some current delivery platforms and weapon systems is influenced by weather conditions. Hence, potential environments must be given consideration when attack options are under development. The second requirement is to support collateral hazard prediction and mitigation. Weather in the target area has a very significant impact on atmospheric transport.

Collateral Effects Prediction and Mitigation. A priority here is development of improved automated systems for collateral hazard forecasting that can be operated in field command centers by nontechnical personnel. This capability must be integrated with the other systems that support tactical planning, and must interface with existing C^4I (e.g., to receive weather updates). The state of the art in fieldable automated systems that can be effectively employed by nontechnical personnel has increased tremendously in recent years. However, there are limits as to what can be deployed in the field and used by operational forces. Hence, a second thrust uses CONUS-based DoD high-performance computing resources to develop and validate advanced models for collateral hazard prediction. In addition to providing results that can be applied in successive generations of fieldable systems, this capability can also support operations from CONUS in direct technical support for hazard prediction, as was done during the Gulf War.

Enhanced Penetrating Munitions. Improved penetrating munitions are needed for counterforce missions. Conventional munitions have a limited radius of effects. To defeat many NBC target elements, it is necessary to have the conventional munitions detonate in proximity to the target. It is also the case that many NBC target structures are hardened to varying degrees. Damage inflicted on the structure may or may not have any mission-critical impact on the NBC capabilities located within. Enhanced penetrating munitions make it possible to deliver warheads where they can have the needed effects. The objective is optimized detonation location regardless of target hardness.

Enhanced Lethality Warheads. Some warheads in the current conventional weapons inventory do not have sufficient lethality for decisive defeat of all NBC targets. This is exacerbated

when penetrating munitions are required for the mission. An aircraft may be capable of carrying a 2,000-pound munition on a hard point. The features that make the weapon capable of penetrating into a structure necessarily add to the weight of the munition; significant increases in warhead lethality may be needed simply to have the same lethality as a nonpenetrating munition of the same weight. In some situations, collateral hazard considerations may also affect the choice of munition.

Agent Defeat Payloads. Most NBC targets contain significant quantities of extremely hazardous materials. In a conventional attack against such targets, collateral effects may be target (rather than weapon) induced. For example, an attack against a CW or BW storage or production facility might result in dispersal of hazardous agents over a large area. Similar considerations hold for nuclear targets. Threats must be countered both within the United States and in potentially hostile environments; the types of weapons and facilities that must be defeated (or penetrated in order to accomplish defeat) vary; different options are appropriate for delivery by weapon systems versus SOF. Additional nonnuclear options that provide options for limiting collateral hazards are desirable.

Hard Target Smart Fuzing. Conventionally fuzed weapons have a limited radius of effects against hard targets. Hard target smart fuzing uses void sensing or other technologies to delay detonation of a conventional munition until it has penetrated into a target structure and is in closer proximity to critical target elements.

All-Weather Guidance. Some delivery systems and weapons cannot be used in all weather conditions or have their accuracy degraded in some environmental conditions. All-weather guidance is needed to enable 24/7 availability of these options.

Combat and Collateral Hazard Sensors. There are situations in which it can be difficult to assess the effectiveness of an attack, given the limits of current sensors (e.g., when a penetrating munition detonates inside a large facility or within an underground structure). The absence of reliable CA information may require forces to conduct unnecessary re-attacks, thus placing them at risk, and divert sorties from other priority missions. Improved and new sensors are needed to perform combat and collateral hazard assessment when visible clues are lacking.

NBC Survivability. The ability to withstand NBC and other threats is a necessary condition for the accomplishment of counterforce missions. For both military support to nonproliferation and counterforce, survivability has strategic significance. One of the potential incentives for acquisition or use of NBC weapons is as an "asymmetric counter" to offset the United States' conventional superiority. Deployment of forces capable of withstanding such proliferant threats reduces incentives for acquisition or use of NBC as an asymmetric counter. The CB defense program provides this capability through passive defense measures, as described earlier in this chapter.

Preventive Defense/Arms Control Technology. Preventive defense supports military support to nonproliferation through measures to ensure that NBC weapons and production capabilities are not at risk of diversion. It encompasses cooperative threat reduction and technical and operational support for verification of arms control agreements.

D. CURRENT CAPABILITIES, DEFICIENCIES, AND BARRIERS

Table XII–6 shows interrelationships between the operational and functional capabilities and related limitations (shortfalls in capability), technology requirements, and DTOs.

Table XII–6. Functional Capabilities and Related Limitations, Technologies, and DTOs—Counter Weapons of Mass Destruction

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Timely Target Identification and Characterization			
1. Identification and Characterization Sensors	Limits in WMD sensor capabilities	New sensors Enhanced data processing (e.g., for seismic information)	J.03*, 04; O.05; NT.11, 12
3. Sensor Data Fusion	Shortfalls in integration of inputs from multiple sensors/phenomenologies	Software engineering	J.06
4. WMD Proliferation Path Analysis	Poor understanding of proliferant-specific paths toward acquisition of NBC/M and of current status on paths; limited capability to manage and analyze large volumes of data	Automated proliferation path analysis for critical node identification	J.03*, 04
5. Real-Time Weather Data and Forecasts	Shortfalls in information timeliness and resolution	High-resolution, in-theater, real-time weather data and forecasts	B.33; BE.03, 04, 10
13. NBC Survivability	Electronics susceptibility to EMP and HPM threats	High-resolution, in-theater, real-time weather data and forecasts	NT.01, 02, 05, 10; SE.37
14. Preventative Defense/Arms Control Technology	Information not sufficiently timely	Low-cost and man-portable sensors	J.06; NT.11, 12
Operational Capability Element: Prompt Planning and Execution of Attacks			
2. WMD Target Planning Tools	Shortfalls in targeting calculation capabilities, including restrike decision based on CA	Computational physics and experimental assessments of weapon–target interactions	B.34; J.03*, 04; O.02, 03; IS.62; NT.04, 09; WE.57, 71
3. Sensor Data Fusion	No real-time, all-source data fusion	Real-time, all-source sensor data fusion	J.03*, 04; BE.10
	Sensor data stream stovepipes not sufficiently integrated with target planning capabilities	Multisensor imaging and fusion	J.03*, 04; BE.10
4. WMD Proliferation Path Analysis	No decision aid to determine where in WMD development, production, and employment process counterforce attacks have highest probability of success and minimum collateral effects	Automated systems capable of integrating proliferation path inputs	O.03; NT.04
5. Real-Time Weather Data and Forecasts	Shortfalls in targeting calculation capabilities, including real-time weather data input	High-resolution, in-theater, real-time weather data and forecasts	B.33; BE.03, 04
6. Collateral Effects Prediction and Mitigation	Shortfalls in targeting calculation capabilities, including optimization to minimize collateral effects	Advanced hazard prediction assessment computational capabilities	IS.71; NT.04, 09; WE.71
7. Enhanced Penetrating Munitions	Shortfalls in targeting calculation capabilities, including advanced conventional/enhanced weapon payloads	Advanced penetrating weapons	J.03*, 04; O.01, 02, 03; IS.62
8. Enhanced Lethality Warhead	Shortfalls in targeting calculation capabilities, including advanced conventional/enhanced weapon payloads	High-temperature incendiary and BW/CW agent defeat payloads	WE.70

* Completed DTOs

Table XII–6. Functional Capabilities and Related Limitations, Technologies, and DTOs—Counter Weapons of Mass Destruction (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Prompt Planning and Execution of Attacks (continued)			
10. Hard-Target Smart Fuzing	Lack of weapon effects proximate to target	Void-sensing, depth-sensing fuze	J.03*, 04
11. All-Weather Guidance	Weather impacts guidance	Improved environmental data	BE.03, 04
13. NBC Survivability	Electronics susceptibility to EMP and HPM threats	Hardening methodologies/technologies	NT.01, 02, 05, 10; SE.37
Operational Capability Element: Target Defeat With Minimized Collateral Hazards			
7. Enhanced Penetrating Munitions	Shortfalls in targeting calculation capabilities, including advanced conventional/enhanced weapon payloads	Advanced penetrating weapons	J.03*, 04; O.01, 07
8. Enhanced Lethality Warheads	Shortfalls in targeting calculation capabilities, including advanced conventional/enhanced weapon payloads	High-temperature incendiary and BW/CW agent defeat payloads	O.01; WE.70
9. Agent Defeat Payloads	No payloads for BW/CW agent defeat or neutralization	High-temperature incendiary and BW/CW agent defeat payloads	J.05; WE.70
10. Hard-Target Smart Fuzing	Fuzes not optimized for hardened facility targets	Void-sensing, depth-sensing fuze	J.03*, 04; O.01
11. All-Weather Guidance	Some precision systems cannot be optimally employed during adverse weather	Improved environmental information	B.33; BE.03, 04
13. NBC Survivability	Electronics susceptibilities to HPM and EMP threats	Balanced hardening methodologies	NT.01, 02, 05, 10; SE.37
Operational Capability Element: Combat and Collateral Hazard Assessment			
1. Identification and Characterization Sensors	Shortfalls in remote/standoff sensors for detection and characterization of BW/CW agents	Advanced SAR/radar imaging	J.03*, 04, 06; NT.11, 12
		Unattended ground sensors with seismic, acoustic, electromagnetic, and NBC capabilities	J.03*, 04, 06; NT.11, 12
2. WMD Target Planning Tools	No integrated, automated, and validated NBC hazard prediction tools for wide-ranging WMD targets and U.S. weapons	Accurate models for terrain effects on transport in NBC models	J.03*, 04; O.02, 03; NT.04, 09; WE.57, 71
3. Sensor Data Fusion	Sensor data stream stovepipes not sufficiently integrated with target planning capabilities	Real-time, all-source sensor data fusion	J.03*, 04; BE.10
	Some sensor information cannot be promptly processed	Multisensor imaging and fusion	J.03*, 04; BE.10

* Completed DTOs

Table XII–6. Functional Capabilities and Related Limitations, Technologies, and DTOs—Counter Weapons of Mass Destruction (continued)

Functional Capabilities	Related Limitations	Related Key Technologies	Related DTOs
Operational Capability Element: Combat and Collateral Hazard Assessment (continued)			
4. WMD Proliferation Path Analysis	No sensors and tools able to provide detailed equipment, enemy WMD, and WMD facility characterization	Sensors and tools for WMD facility, equipment, and enemy WMD weapon characterization	O.03
5. Real-Time Weather Data and Forecasts	Shortalls in information timeliness and resolution	High-resolution, in-theater, real-time weather data and forecasts	B.33; BE.03, 04
6. Collateral Effects Prediction and	Shortfalls in capabilities for prediction and monitoring	Improved sensors Near-real-time communications	B.29; BE.10; IS.63; NT.04
12. Combat and Collateral Hazards Sensors	No integrated, automated, and validated NBC hazard prediction tools for wide-ranging WMD targets and U.S. weapons	Accurate models for terrain effects on transport in NBC models	J.03*, 04; O.02, 03; NT.04, 09; WE.57, 71
		Targeting methods and advanced weapons to minimize expulsion of NBC materials	J.03*, 04; O.02, 03; NT.04, 09; WE.57, 71
13. NBC Survivability	Electronics susceptibility to EMP and HPM threats	Hardening methodologies/technologies	IS.37; NT.01, 02, 05, 10

* Completed DTOs

E. TECHNOLOGY PLAN

CWMD DTOs. Three programs are currently being accomplished within the CWMD technology plan:

- *J.04, Counterproliferation II ACTD,* develops, demonstrates, and transitions to the warfighter improved capabilities for planning, executing, and assessing strikes on WMD-related fixed facilities, including penetration of hardened facilities with standoff weapons. This DTO integrates and validates the current state of the art in technology, identifies shortfalls in operational capability, and redresses shortfalls in counterforce capabilities. As discussed below, it involves all four operational capability elements required for the Counter Weapons of Mass Destruction JWCO. Because this is a demonstration, the relationship to other technology development efforts is complex. As a demonstration, it is based on relatively mature technologies and relates primarily to completed programs.
- *J.05, Agent Defeat Ordnance,* will design and develop ordnance systems specifically engineering to engage WMD targets while minimizing collateral hazards caused by released or dispersion of WMD agents. These systems are designed to significantly disrupt production and storage facilities containing chemical and biological warfare agents, thus rendering such agents unusable as potential weapons. Some of the most important HDBTs contain WMD.

- *J.06, Arms Control Information Technology Program,* is a program of information technology research, development, and operations to enable USG compliance with arms control treaties and agreements. This DTO contributes to the earliest strategic-level, early warning of a nation's WMD activities. It also provides for the development of modernized nuclear, chemical, and biological arms control technology data management and notification processing for existing treaties and agreements, as well as evolving and new treaties and agreements.

Program Interrelationships. Key linkages among DTAP DTOs and this JWCO are presented in Table XII–7. Demonstrations are cross-referenced with the operational capabilities in Figure XII–6, and the relationships among DTOs are plotted in the technology roadmap, Figure XII–7. Figure XII–8 outlines some of the progress anticipated through FY05.

Table XII–7. Demonstration Support—Counter Weapons of Mass Destruction

	Operational Capability Elements						Type of Demonstration	
Demonstration	Timely Target Identification and Characterization	Prompt Planning and Execution of Attacks	Target Defeat With Minimized Collateral Hazards	Combat and Collateral Hazard Assessment	Service/ Agency	DTO	ACTD	ATD
Counterproliferation II ACTD	○	●	●	●	DTRA	J.04	X	
Agent Defeat Ordnance			●		Air Force	J.05		
Arms Control Information Technology Program	●	●			DTRA	J.06		
Battle Damage Assessment in the Joint Targeting Toolbox ACTD				●	Air Force	B.29	X	
Computerized Operational MASINT/Weather ACTD	●	●	●	●	Air Force	B.33	X	
Theater Integrated Planning System ACTD		●			Air Force	B.34	X	
Hard-Target Functional Defeat Ordnance	○	●	●	○	DTRA	O.01		
Target Characterization and Defeat Technology		●	●		DTRA	O.02		
Tunnel Defeat Technology Demonstrations		●	●		DTRA	O.03		
Counter Underground Facilities Program	●			●	DARPA	O.05		
Tactical Missile System—Penetrator ACTD			●		Navy	O.07	X	
Thermobaric Weapons ACTD			●		DTRA, Navy	O.08	X	
Weather/Atmospheric Impacts on Sensor Systems	●	●	●	●	Joint	BE.03		
On-Scene Weather Sensing and Prediction Capability	●	●	●	●	Joint	BE.04		
High-Resolution Meteorological Nowcasting for CB Hazard Prediction				●	Navy, DTRA, OSD	BE.10		
Effects of Weapons Simulation	○	○	○	○	DTRA, DMSO	IS.62		
Effects-Based Operations		●			Air Force	IS.71		
Nuclear Operability and Survivability Testing Technologies	○	○	○	○	DTRA	NT.01		
Radiation-Hard Microelectronics Enabling Technology	○	○	○	○	DTRA	NT.02		
Prediction and Mitigation of Collateral Hazards	●	●	●	●	DTRA	NT.04		
Balanced Electromagnetic Hardening Technology	○	○	○	○	DTRA	NT.05		
Nuclear Phenomenology		●	●		DTRA	NT.09		

● Strong Support ○ Moderate Support

Table XII–7. Demonstration Support—Counter Weapons of Mass Destruction (continued)

Demonstration	Operational Capability Elements: Timely Target Identification and Characterization	Operational Capability Elements: Prompt Planning and Execution of Attacks	Operational Capability Elements: Target Defeat With Minimized Collateral Hazards	Operational Capability Elements: Combat and Collateral Hazard Assessment	Service/ Agency	DTO	Type of Demonstration: ACTD	Type of Demonstration: ATD
Testable Design and Assessment Technology	○	○	○	○	DTRA	NT.10		
Strategic Arms Control Technology	●				DTRA	NT.11		
Nuclear Arms Control Technology	●				DTRA	NT.12		
High-Density, Radiation-Resistant Microelectronics	○	○	○	○	Air Force	SE.37		
High-Power Microwave C^2W/IW Technology			●		Air Force	WE.22		
Lethality/Vulnerability Models for High-Value Fixed Targets	○	●	●		DTRA	WE.57		
High-Power Microwave Narrowband Munitions			●		Air Force	WE.60		
Novel Energetic Materials			●		DTRA	WE.70		
Integrated Comprehensive Weaponeering Capability	○	●	●		DTRA	WE.71		

● Strong Support ○ Moderate Support

F. SUMMARY

Countering Asymmetric Threats During Regional Contingencies. The *Concept for Future Joint Operations* (Reference 22), published by the Joint Chiefs of Staff, presents a number of potential "asymmetric counters" developed in a Defense Science Board assessment—military capabilities that adversaries may develop and deploy to offset the United States' conventional superiority. Of particular importance are the potential asymmetric counters that are likely to be relatively more effective against the United States and relatively easier for adversaries to develop, deploy, and employ. The S&T activities in this chapter are directed at asymmetric counters involving WMD threats.

The spectrum of relevant military objectives and required military capabilities is shown in Table XII–8.

Table XII–8. Military Objectives and Capabilities During Major Theater War Scenarios Involving NBC-Capable Antagonists

Military Objective	Required Military Capabilities
Prevent Use of WMD • Deter and Reduce Incentives for Use • Destroy Prior to Use	Survivability against NBC weapons reduces incentives for acquisition or use of WMD by reducing the military value of such actions. If forces do not have requisite levels of survivability, perverse incentives for use of NBC weapons as asymmetric offsets may result. Counterforce capabilities that provide lethality options with minimized collateral effects contribute to deterrence and provide capabilities for destroying NBC weapons and facilities.
If WMD Are Used, Protect Against and Limit Damage	This objective requires active defense for defeat of threat weapons and passive defense/survivability capabilities.
If WMD Are Used, Proceed to Decisive War Termination	Counterforce capabilities are critical, particularly the military capabilities required to deny sanctuaries (targets that cannot be defeated with current weapons).

Defense Department Counterproliferation Objectives and Programs. "To minimize the impact of proliferation on American interests, it is the policy of the United States not only to prevent and deter NBC use, but also to operate and counterstrike successfully when faced with NBC threats or use" (Reference 27, p. 84). As outlined in the most recent report from the Counterproliferation Program Review Committee (Reference 24), critical support for achievement of required DoD counterproliferation capabilities is also provided in programs accomplished within the Department of Energy and the intelligence community.

It is the Defense Department's policy "to integrate proliferation concerns into the existing DoD planning process" (Reference 29, p. 48). The same integration is evident in DoD S&T programs; many of the critical military capabilities required for counterproliferation are accomplished in activities that are responsive to a range of military requirements.

Contribution of Capabilities Developed in CWMD. The DTOs within the Counter Weapons of Mass Destruction JWCO demonstrate improvements in capability that respond to shortfalls that were identified during the Gulf War and provide part of the technical basis needed for redressing remaining shortfalls in operational capabilities. Military support to nonproliferation is necessarily the first priority. Since prevention has already failed in some parts of the world and may not be successful in the future, additional enhancements in capability are needed. The priorities are to develop and deploy weapons that can effectively defeat WMD targets with minimized collateral hazards. Achieving these objectives will ensure that the warfighter is equipped with state-of-the-art capabilities that correct the deficiencies encountered during Operation Desert Storm and are effective in countering new and emerging WMD threats.

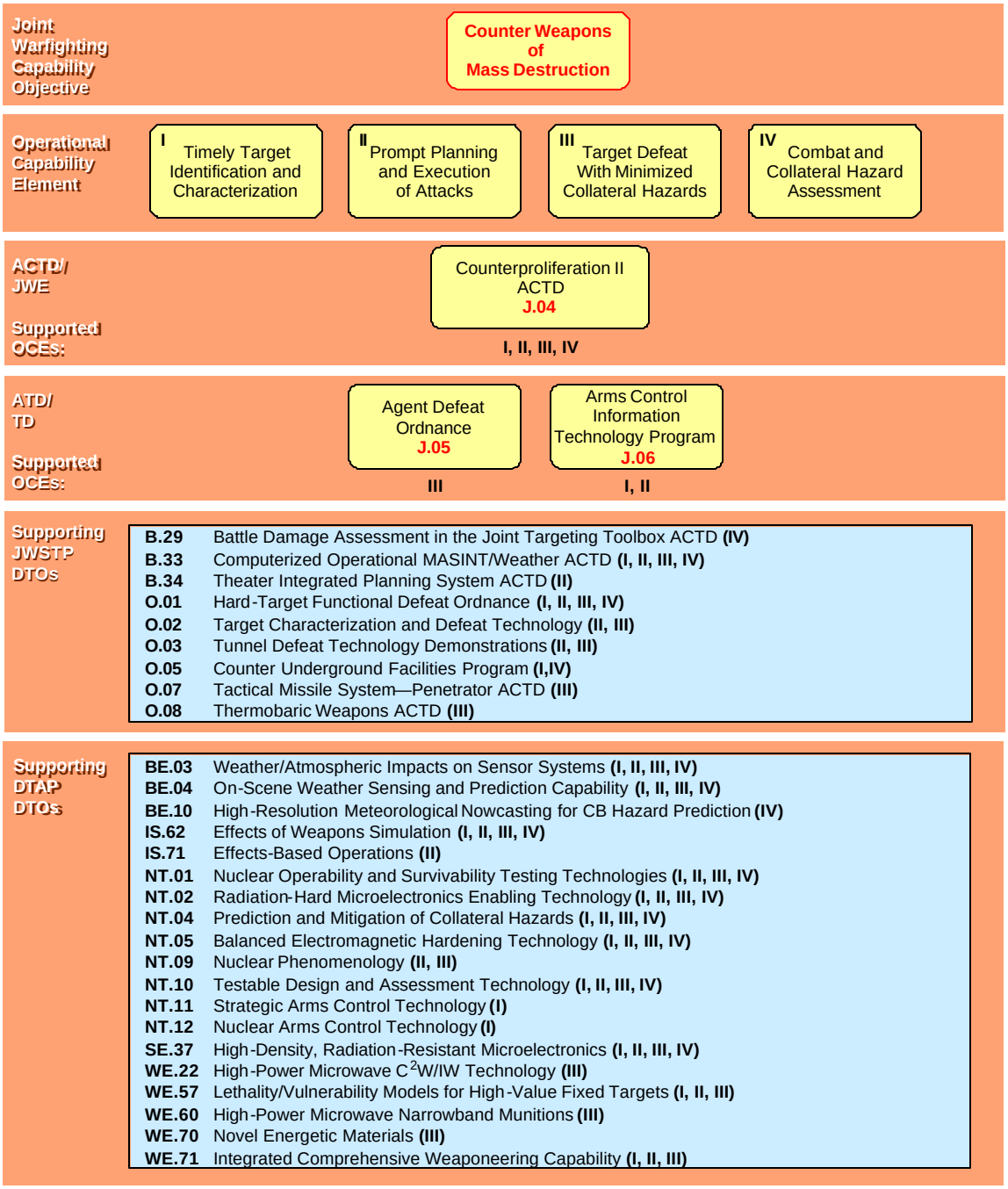

Figure XII–6. Technology to Capability—Counter Weapons of Mass Destruction

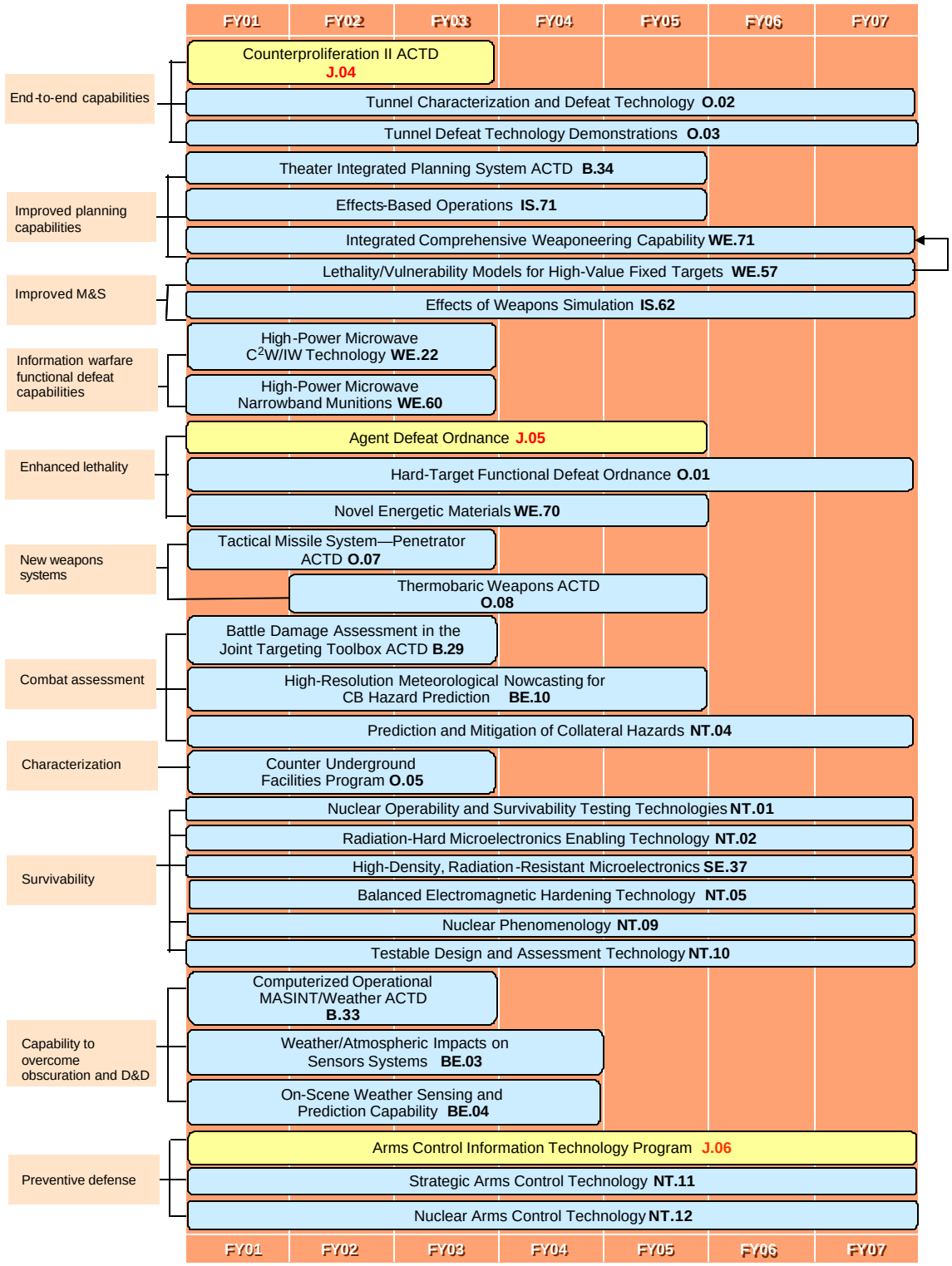

Figure XII–7. Roadmap—Counter Weapons of Mass Destruction

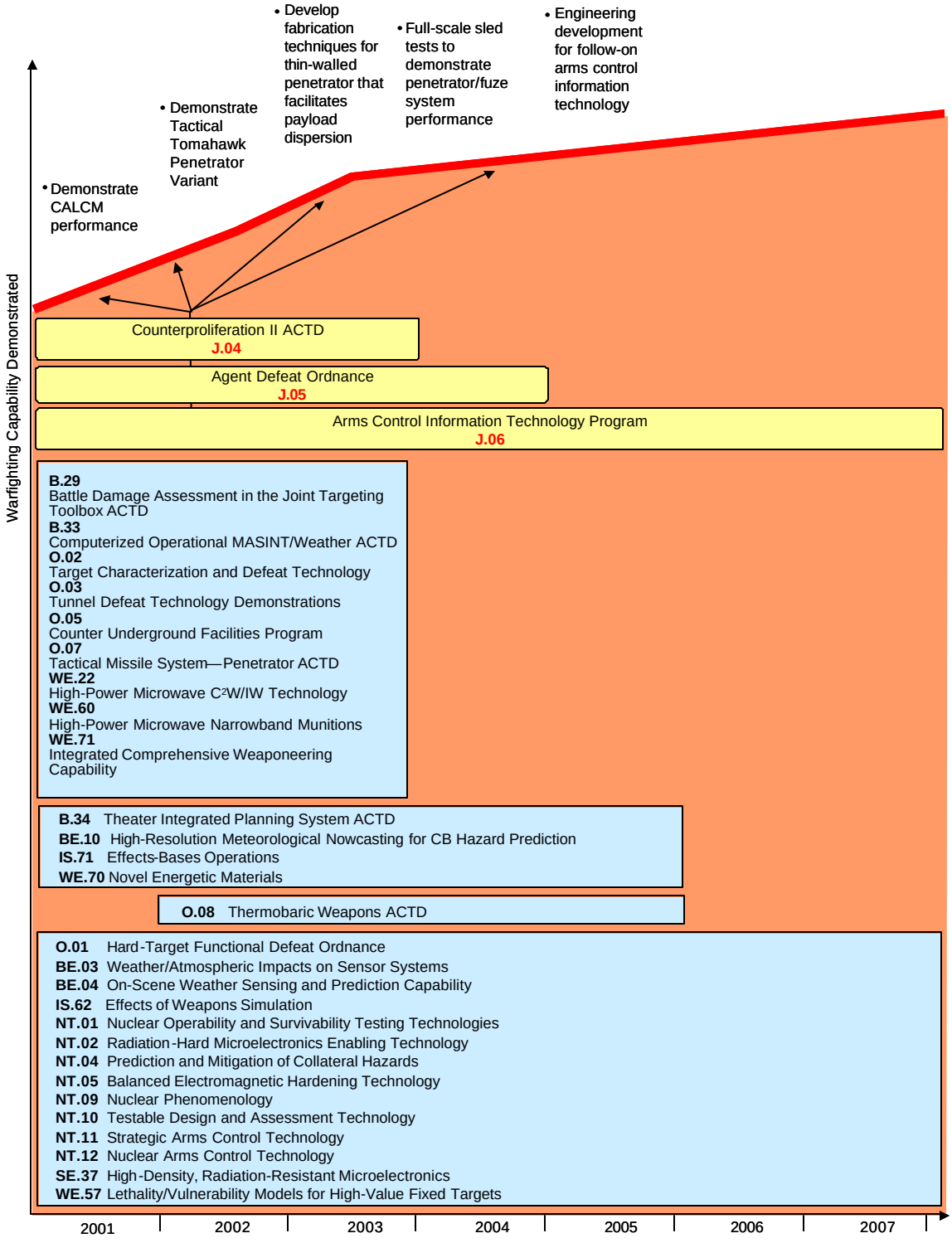

Figure XII–8. Progress—Counter Weapons of Mass Destruction