DEFENSE THREAT REDUCTION AGENCY

BROAD AGENCY ANNOUNCEMENT

HDTRA1-11-16-BRCWMD-BAA

Amendment 3 (December 2013)

Research and Development Enterprise

Basic and Applied Sciences Directorate

Basic Research for Combating Weapons of Mass Destruction (C-WMD)

March 2011

TABLE OF CONTENTS

SECTION NO.		PAGE NO.
	OVERVIEW INFORMATION	3
I.	FUNDING OPPORTUNITY DESCRIPTION	7
II.	AWARD INFORMATION	8
III.	ELIGIBILITY INFORMATION	11
IV.	APPLICATION AND SUBMISSION INFORMATION	12
V.	APPLICATION REVIEW INFORMATION	27
VI.	AWARD ADMINISTRATION INFORMATION	29
VII.	AGENCY CONTACTS	36
VIII.	OTHER INFORMATION – TOPICS	37

OVERVIEW INFORMATION

1. Federal Agency Name:

   Defense Threat Reduction Agency (DTRA)
   Research and Development (R&D) Enterprise
   Basic and Applied Sciences Directorate
   8725 John J. Kingman Road
   MS 6201
   Fort Belvoir, VA 22060-6201

2. Funding Opportunity Title:

   FY2011 – 2016 Basic Research for Combating Weapons of Mass Destruction (C-WMD) Broad Agency Announcement (BAA)

3. Announcement Type:

   The BAA, which is in effect from March 2011 through September 2016, established the multi-year process and served as the announcement for the first round of submissions (referred to as "periods").

   Over this timeframe there will be multiple opportunities/periods to electronically submit research ideas. Each period will have a two-phased submission process. *Phase I* is the pre-application white paper submission and is open to all qualified entities; *Phase II* is an invitation-only full proposal submission resulting from Phase I pre-application white paper review as decided by the DTRA Selection Authority.

   This Amendment alerts applicants to several administrative updates to the BAA and serves as the announcement for the next round of submissions.

4. Funding Opportunity Number:

   HDTRA1-11-16-BRCWMD-BAA

5. Catalog of Federal Domestic Assistance (CFDA) Number:

   12.351

6. Dates:

   This BAA will have multiple, consecutive opportunities/periods which are not predetermined; however, it is anticipated that there will be at least one opportunity for each year announced in the December timeframe; there may be additional opportunities/periods in any year. Subsequent submission opportunities/periods with corresponding topics, application packages, applicable deadlines, will be published via amendments to this BAA.

The Phase I (pre-application white paper) and Phase II (invitation-only proposal) submission deadlines are/will be shown in Table 1 (below and in Section IV.3.3). The Tables will be updated (by amendments to this BAA) as changes are made to the schedule.

All submissions (pre-application white papers and invited proposals) must be made in accordance with the submission instructions in this BAA through Grants.gov using the application packages provided with this BAA. Applicants are responsible for ensuring compliant and final submission of their Phase I pre-application white papers and Phase II applications. Any submission that does not conform to the requirements outlined in the BAA and in the invitation for proposal may not be reviewed or considered further at the discretion of DTRA.

Date	Event
1 March 2011	BAA announced on Grants.gov
Period A	
CLOSED	
~~2:00 PM EST,8 April 2011~~	~~Phase I pre-application white paper receipt deadline~~
~~2:00 PM EST, 27 June 2011~~	~~Phase II invitation-only proposal receipt deadline~~
~~January – March 2012~~	~~Period A Grants scheduled to be awarded~~
Period B	
CLOSED	
~~1 December 2011~~	~~Amendment to the BAA announced on Grants.gov with Period B topics, application packages, and applicable deadlines~~
~~Midnight EST,~~ ~~13 January 2012~~	~~Phase I pre-application white paper receipt deadline~~
~~Midnight EST, Not prior to 2 April 2012, and not later than 20 April 2012 *~~	~~Phase II invitation-only proposal receipt deadline~~ ~~* The exact due date and time for the full proposals will be provided in the letters of invitation.~~
~~October – December 2012~~	~~Period B Grants scheduled to be awarded~~
Period C	
CLOSED	
~~3 December 2012~~	~~Amendment to the BAA announced on Grants.gov with Period C topics, application packages, and applicable deadlines~~
~~Midnight EST,~~	~~Phase I pre-application white paper receipt deadline~~

~~14 January 2013~~	
~~Midnight EST, Not prior to 5 April 2013, and not later than 3 May 2013 *~~	~~Phase II invitation-only proposal receipt deadline~~ ~~* The exact due date and time for the full proposals will be provided in the letters of invitation.~~
October—December 2013	Period C Grants scheduled to be awarded
Period D	
2 December 2013	Amendment to the BAA announced on Grants.gov with Period D topics, application packages, and applicable deadlines
Midnight EST, 13 January 2014	Phase I pre-application white paper receipt deadline
Midnight EST, Not prior to 1 April 2014, and not later than 2 May 2014 *	Phase II invitation-only proposal receipt deadline
October—December 2014	Period D Grants scheduled to be awarded
Period E	
TBD	Amendment to the BAA announced on Grants.gov with Period E topics, application packages, and applicable deadlines
TBD	Phase I pre-application white paper receipt deadline
TBD	Phase II invitation-only proposal receipt deadline
TBD	Period E Grants scheduled to be awarded
Period F	
Period G	
Period H	
……	
Period 'n'	

Table 1: List of important dates

ADDITIONAL OVERVIEW CONTENT

This BAA is focused on soliciting **basic research** projects that support the DTRA mission to safeguard America and its allies from WMD (e.g., chemical, biological, radiological, nuclear, and high-yield explosives) by providing capabilities to reduce, eliminate, and counter the threat and mitigate its effects. To this end, DTRA seeks research across broad strategic thrust areas:

- ***Science of WMD Sensing and Recognition***
- ***Cognitive and Information Science***
- ***Science for Protection***
- ***Science to Defeat WMD***
- ***Science to Secure WMD***

Detailed descriptions of these thrust areas can be found in Section I.3. The specific research opportunities (topics) for each period that align to these thrust areas are listed in Section VIII. Research topics are only valid for the submission period in which they are posted, and only pre-application white papers responsive to the topics posted for a given submission period will be considered.

Resulting awards from this announcement will be **grants only**. These grants will be paid in advance, subject to the conditions described in 2 CFR 215.22(b).

I. FUNDING OPPORTUNITY DESCRIPTION

I.1. This BAA is an extramural endeavor that combines basic research needs of DTRA and the Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD) to address the full spectrum of counter-WMD challenges. Both DTRA and JSTO-CBD share the mission to safeguard America and its allies from WMD and provide capabilities to reduce, eliminate, and counter the threat and effects from chemical, biological, radiological, nuclear, and high-yield explosives. Each seeks to identify, adopt, and adapt emerging and revolutionary sciences that may demonstrate high payoff potential to counter-WMD threats.

I.2. This announcement solicits pre-application white papers for long-term challenges in specific fundamental areas of basic research that offer a significant contribution to the current body of knowledge or further the understanding of phenomena and observable facts and may have impact on future capabilities that support the DTRA and JSTO-CBD missions. Responses to this BAA must address **only basic research**. Pre-application white paper and proposal submissions that address applied research, advanced technology development, or combine basic research with applied research and/or advanced technology development will be considered not responsive and will not be evaluated further.

I.2.1. Basic research is the systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted, high payoff research that provides the basis for technological programs.[1]

I.2.2. In contrast to basic research, applied research is the systematic study to understand the means to meet a recognized and specific need. It is a systematic expansion and application of knowledge to develop useful materials, devices, and systems or methods. The boundary between basic research and applied research occurs at the point when sufficient knowledge exists to support a hypothesis involving a specific application.[2]

I.3. DTRA seeks unclassified basic research across five major functional counter-WMD research thrust areas. Specific research topics that align to one or more thrust areas are presented in Section VIII. The five thrust area descriptions are outlined below.

- ***Thrust Area 1—Science of WMD Sensing and Recognition:*** The basic science of WMD sensing and recognition is the fundamental understanding of materials that demonstrate measurable changes when stimulated by energy, molecules, or particles from WMD in the environment. This research thrust involves exploration and exploitation of interactions between materials and various electromagnetic frequencies, molecules, nuclear radiation or particles. These interactions and the specific form of recognition they provide are used for

[1] DoDI 3210.1, September 16, 2005

[2] DoD Financial Management Regulation Volume 2B, Chapter 5

subsequent generation of information that provides knowledge of the presence, identity, and/or quantity of material or energy in the environment that may be significant.

- ***Thrust Area 2—Network Sciences:*** The basic science of network science is the convergence of computer, information, mathematical, networks, natural, and social science. This research thrust expands our understanding of social networks and advances knowledge of adversarial intent with respect to the acquisition, proliferation, and potential use of WMD. The methods may include analytical, computational or numerical, or experimental means to integrate knowledge across disciplines and improve rapid processing of intelligence and dissemination of information.
- ***Thrust Area 3—Science for Protection:*** Basic science for protection involves advancing knowledge to protect life and life-sustaining resources and networks. Protection includes threat containment, decontamination, threat filtering, and shielding of systems. The concept is generalized to include fundamental investigations that reduce consequences of WMD, assist in the restoration of life-sustaining functions, and support forensic science.
- ***Thrust Area 4—Science to Defeat WMD:*** Basic science to defeat WMD involves furthering the understanding of explosives, their detonation, and problems associated with accessing target WMDs. This research thrust includes the creation of new energetic materials or physical approaches that enhance the defeat of WMDs by orders of magnitude, the improvement of modeling and simulation of these materials and various phenomena that affect success and estimate the impact (lethality) of defeat actions, including the assessment of event characteristics using various dynamic analytical methods.
- ***Thrust Area 5—Science to Secure WMD:*** Basic science to support securing WMD includes: (a) environmentally responsible innovative processes to neutralize chemical, biological, radiological, nuclear, or explosive (CBRNE) materials and components;
(b) discovery of revolutionary means to secure components and weapons; and (c) studies of scientific principles that lead to novel physical or other tags and methods to monitor compliance and disrupt proliferation pathways. The identification of basic phenomena that provide verifiable controls on materials and systems also helps arms control.

I.4. DTRA seeks unclassified basic research ideas that are responsive to the goals and objectives of the topics outlined in Section VIII. The topics labeled "PerD" are only valid for Period D of this BAA. Only pre-application white papers responsive to the topics posted for Period D and submitted by the Period D deadline will be considered. A new list of topics will be posted for subsequent periods with corresponding pre-application white paper due dates. Note that topics from the original solicitation and Amendments 1 and 2, labeled "PerA", "PerB" and "PerC" are NOT valid topics for "PerD". Pre-application white papers that address "PerA", "PerB" and "PerC" topics will not be reviewed by DTRA.

II. AWARD INFORMATION

II.1. Resulting awards from this BAA will be **grants only**. These grants will be paid in advance, subject to the conditions described in 2 CFR 215.22(b).

II.1.1. The period of performance (POP) for the Single Scope Awards, the Multidisciplinary Awards, and the Young Investigator Awards (all types of awards are detailed in Section II.4) may be up to five (5) years. Awards may be for a base period of one (1) year with up to four (4) additional years as possible options, a base period of two (2) years with up to three (3) additional years as possible options, or a base period of three (3) years with up to two (2) additional years as possible options. The base period and option combination(s) will be specifically detailed in each and every topic. Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable. Additional guidance on the POP may be provided with the topic description or in the letter of invitation for the full proposal. Each of these supersedes the guidance provided here.

II.1.2. The POP for the Seed Awards will be for one (1) year or less. Seed Awards may not include option years.

II.2. The final number of grants and the amount of funds allocated for each period will be determined after all pre-application white papers and invited proposals are received and evaluated. On average DTRA expects to award 50-75 grants annually for a total grant value of approximately $66M.

II.3. The Government actions under this BAA shall adhere to the requirements of the Department of Defense (DoD) Grant and Agreement Regulations (DoDGARs). DoDGARs can be accessed online at http://www.dtic.mil/whs/directives/corres/html/321006r.htm. See also 32 Code of Federal Regulations (CFR) 22, which can be accessed online at http://ecfr.gpoaccess.gov/.

II.4. There are four (4) categories of awards, which are detailed below. The applicant does not need to specify the type of award sought. It will be inferred by the dollar amount requested and/or the topic to which the pre-application white paper is submitted.

1. Single Scope Awards: Research projects that focus on exploratory aspects of a unique problem, a high-risk approach, or innovative research in subjects with potential for high impact to C-WMD science. Research must support undergraduate, and/or graduate students, and/or postgraduate students.

   Single Scope Awards may have Co-Principal Investigators (Co-PIs) and subawards (grants and/or contracts). Single Scope Awards will be made by a single grant to the lead organization. Subawards, including all grants and contracts, are the responsibility of the award recipient; exceptions will not be made.

   Single Scope Awards will average $150K per year for DTRA sponsored topics and $250K per year for JSTO-CBD Program sponsored topics. Additional guidance for the average dollar value may be provided in the topic description or in the letter of invitation for the full proposal. Each of these supersedes the guidance provided here.

   The predominance of awards will be Single Scope Awards.

2. Multidisciplinary Awards: Research projects that involve a comprehensive program of innovative research in an interdisciplinary area with potential for high impact. The proposed research must involve fundamental contributions in research by multiple

investigators from diverse disciplines (proposal **must** be multidisciplinary). Investigators may be from a single institution or multiple institutions. Research must support multiple undergraduate, and/or graduate students, and/or postgraduate students.

Authors of these pre-application white papers and invited proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.

Proposals submitted under this category must have a single lead organization and single submission for the pre-application white paper and the invited proposal. Multidisciplinary Awards will be made by a single grant to the lead institution. Subawards, including all grants and/or contracts, are the responsibility of the award recipient; exceptions will not be made.

Multidisciplinary Awards will average $350K per year for DTRA sponsored topics and $500K per year for JSTO-CBD Program sponsored topics. Additional guidance for the average dollar value may be provided in the topic description or in the letter of invitation for the full proposal. Each of these supersedes the guidance provided here.

3. Young Investigator Awards: Research projects that focus on exploratory aspects of a unique problem, a high-risk approach, or innovative research in subjects with potential for high impact to C-WMD science from individuals currently employed by a U.S. accredited degree-granting college or university who received a Ph.D. or equivalent degree within five (5) years of the date of the pre-application white paper submission.

   Young Investigator Awards may have subawards; however, subawards that transfer substantive programmatic activity will be considered non-responsive to the Young Investigator topics. Young Investigator Awards will be made by a single grant to the lead organization. Subawards, including all grants and/or contracts, are the responsibility of the award recipient; exceptions will not be made.

   Young Investigator Awards will average $100K per year.

4. Seed Awards: Research projects that focus on the exploratory aspects of a research hypothesis or on the development of a high-risk approach with potential for high impact to C-WMD science.

   Seed Awards may have Co-PIs and subawards. Seed Awards will be made by a single grant to the lead organization. Subawards, including all grants and/or contracts, are the responsibility of award recipient; exceptions will not be made.

Seed awards will be less than $75K.

II.5. Funding for participation in this program is highly competitive and the cost of proposed research should strictly be maintained in the award amounts outlined for each award type and for each topic. Under no circumstances will awards exceed 10% of the averages as outlined for each award type and for each topic. Exceptions will not be made.

II.6. Subawards (grants and/or contracts) are permitted. Subawards may be used to carry out a portion of the research. In instances where the lead applicant is an accredited degree-granting college and/or university, applicants should note that substantive programmatic activity must be maintained at accredited degree-granting colleges and universities. DTRA will review and consider the proposed subawards for all pre-application white papers and proposals on a case-by-case basis.

II.7. Applications for renewal or supplementation of existing DTRA funded projects are not eligible to compete with applications for new awards.

II.8. The Government will not provide any hardware or software to execute the proposed research. Exceptions will not be made.

II.9. The Government reserves the right to fund all, some, or none of the proposals submitted; may elect to fund only part of any or all proposals; and may incrementally or fully fund any or all awards under this BAA. All awards are subject to the availability of funds.

III. ELIGIBILITY INFORMATION

III.1. Pre-application white papers and proposals submitted for this BAA will be considered from the following U.S. and foreign-based equivalents:

- Accredited degree-granting colleges and universities.
- Industrial/commercial basic research centers, including small businesses with a portfolio predominantly in basic research proposing a project with significant participation (minimum 30% of total effort value on the proposed project) by one or more accredited degree-granting colleges and/or universities. Note: Not eligible for Young Investigator Awards.
- Not-for-profit organizations/basic research centers with a portfolio predominantly in basic research proposing a project with significant participation (minimum 30% of total effort value on the proposed project) by one or more accredited degree-granting colleges and/or universities. Proof of 501(c)(3) status from the Internal Revenue Service may be required. For foreign-based establishments entirely based outside the U.S. and/or its territories, proof of not-for-profit status may be required. Note: ***Not eligible for Young Investigator Awards.***

III.2. The following entities <u>may not</u> participate as prime grantees for awards made under this BAA, but <u>may</u> act as collaborators, including as Co-PIs, and/or subawardees:

- Federal laboratories (including DoD and Department of Energy (DOE)[3] laboratories), Federal academic institutions, Federal agencies, and Federal organizations.
- DoD-sponsored Federally Funded Research and Development Centers (FFRDCs) specified in the Defense Federal Acquisition Regulation Supplement (DFARS) 235.017-1: http://farsite.hill.af.mil/VFDFARA.HTM and click on 'DFARS Part 35'.
- DOE-sponsored FFRDCs[4].
- Foreign government-owned institutions.
- Industrial/commercial firms other than those outlined in Section III.1.

Note: DoD degree-granting academic institutions that are Federal government organizations, e.g. United States Military Academy at West Point, The Air Force Institute of Technology, etc., are eligible to submit pre-application white papers and proposals in response to the intramural Service Call issued by the DTRA Basic Research and Applied Sciences Directorate, see http://www.dtrasubmission.net and after logging in, follow the link to the 'FY11-16 Basic Research for Combating Weapons of Mass Destruction (WMD) Service Call for DoD Degree-Granting Academic Institutions'. Please note that the Service Call link will also contain the submission periods. Eligibility requirements under the Service Call are subject to change.

III.3. Cost sharing and/or matching is not required.

III.4. Other.

III.4.1. DTRA uses the Excluded Parties List System (EPLS) to exclude recipients ineligible to receive Federal awards. EPLS can be accessed online at http://epls.arnet.gov (Reference 2 CFR 1125).

III.4.2. There is no limit on the number of pre-application white papers and invited proposals that an applicant (PI/Co-PIs) may submit in response to this BAA.

III.4.2.1. Applicants (PI/Co-PIs) may submit pre-application white papers and invited proposals to one or more topics.

III.4.2.2. Applicants (PI/Co-PIs) may submit pre-application white papers and invited proposals to one or more periods under this BAA, regardless of a previous submission's disposition.

III.4.2.3. Applicants (PI/Co-PIs) are **strongly** encouraged to minimize overlap in scope and level of effort if multiple projects are submitted for pre-application white papers and invited proposals. Further, individual PIs and Co-PIs are discouraged from repackaging research and submitting multiple redundant Phase I submissions in any given period of this BAA.

IV. APPLICATION AND SUBMISSION INFORMATION

[3] DOE-sponsored laboratories must obtain authorization from the DOE sponsor. DTRA does not require documentation of this authorization.

[4] DOE-sponsored FFRDCs must obtain authorization from the DOE sponsor. DTRA does not require documentation of this authorization.

IV.1. Address to Request Application Package.

IV.1.1. This announcement contains all information required to submit a pre-application white paper and invited proposal.

IV.1.2. For convenience, Microsoft (MS) Word and MS PowerPoint templates for Phase II proposal submissions are provided on the www.dtrasubmission.net/portal for applicant use, as noted in the text of this announcement. Applicants are encouraged to use the templates for preparing submissions; however, use of the templates is not required. Note: There is not a template available for the pre-application white paper.

IV.1.3. The required application packages for the pre-application white papers are provided with this announcement. Note that each topic outlined in Section VIII has a unique application package posted with this BAA. **The application package corresponding to the topic of interest should be used for submission of pre-application white papers.**

IV.1.4. The required application packages for the invited proposals will be posted at a later date. As with the Phase I submissions, each topic outlined in Section VIII will have a unique application package**. The application package corresponding to the topic of interest should be used for submission of invited proposals.** Application packages for Phase II submissions will be posted following the notification of invitation for proposals.

IV.1.5. Example application packages for both pre-application white papers and invited proposals are included with this posting. These example packages are for demonstration purposes only and should not be used to submit applications pursuant to this BAA. These packages are clearly noted with the Competition ID of "Example" and the Competition Title of "Phase I Example Pre-Application White Paper" and "Phase II Example Application," respectively.

IV.1.6. While the review of all submissions is at the discretion of DTRA, in general, DTRA will not consider the following:

- Pre-application white papers that attempt to address multiple topics.
- Pre-application white papers that are submitted to topics from previous periods.
- Application packages and proposals for Phase II submissions that were not invited.

IV.1.7. The application packages posted to www.Grants.gov consist of the forms detailed in Table 2, which must be completed as part of the submission process. Additional files are required to be uploaded as attachments. Refer to Section IV.2.3 for more information on Phase I requirements and Section IV.2.4 for more information on Phase II requirements:

Form Name	Phase I Pre-Application White	Phase II Invited Proposal
SF-424 (R&R) Application for Federal Assistance Form	Required	Required
RR Budget Form	N/A	Required

R&R Subaward Budget Attachment(s) Form(s)	N/A	If Applicable
Research & Related Senior/Key Person Profile Form	N/A	Required
Research & Related Other Project Information Form	N/A	Required
Disclosure of Lobbying Activities (SF-LLL)	N/A	If Applicable
Attachments Form	N/A	Required

Table 2: Forms. The instructions for completing each of these forms may be found online at the following web link: http://www07.grants.gov/agencies/forms_instruction_information.jsp.

IV.2. Content and Form of Application Submission. Each period of this BAA will be conducted in two phases. Phase I is for receipt of pre-application white papers. Phase II is for receipt of invited proposal applications. Invitation to the Phase II, invited proposal submission, will be based on the evaluation results of the Phase I pre-application white paper.

IV.2.1. Pre-application white papers and invited proposals **must be** submitted electronically using Grants.gov and the corresponding application packages provided with this BAA on Grants.gov.

IV.2.2. Applicants are responsible for ensuring compliant and final submission of their Phase I pre-application white paper and Phase II invited proposal application. Note that this also applies to applicants using third party systems to submit application packages and attachments. Any submission that does not conform to the requirements outlined in the BAA and in the invitation for proposal may not be reviewed or considered further at the discretion of DTRA.

IV.2.3. **Phase I Pre-Application White Paper Submission and Content.**

IV.2.3.1. Each pre-application white paper must address only one of the research topics detailed in Section VIII for the *relevant period*. Each pre-application white paper must use the application package for the specific topic number as presented in Section VIII of this BAA.

IV.2.3.2. Each Phase I application package contains the following form (Note: all other BAA guidelines must also be met to be considered a true complete package):

Form (Section in the BAA)	Attachment	Action
SF-424 (R&R) Application for Federal Assistance Form (IV.2.4.2.1)	Up to four (4) page white paper.	Enter the appropriate information in data fields

Table 3: Phase I Pre-Application White Paper Package Chart.

IV.2.3.2.1 Each Phase I application package contains the **SF 424 (R&R) Application for Federal Assistance**. To be considered a complete package, an up to four (4) page white paper is required to be uploaded as an attachment to the SF 424 (R&R) (Note: all other BAA guidelines must also be met to be considered a true complete package). DTRA-specific instructions for completing the SF 424 (R&R) Application for Federal Assistance are below, general application instructions can be found on Grants.gov:

- **Block 1 – Type of Submission.** Applicants should indicate the Phase I submission is a "Pre-Application."
- **Block 2.1 – Applicant Identifier.** Not applicable.
- **Block 3 – Date Received by State.** Not applicable.
- **Block 3.1 – State Application Identifier.** Not applicable.
- **Block 5 – Applicant Information.** You must provide a Business Office Point of Contact (BPOC) with an e-mail address.
- **Block 19 – Authorized Representative.** The "signature of AOR" is not an actual signature and is automatically completed upon submission of the electronic application package. ***Hard copies or email attachments of applications will not be accepted.***
- **Block 20 – Pre-application.** Must be used to attach an up to four (4) page white paper. The white paper itself should provide sufficient information on the research being proposed (e.g., the hypothesis, theories, concepts, approaches, data measurements, and analysis, etc.) to allow for an assessment by a technical expert.

  Any pages submitted for the white paper that exceed the limit of four pages will not be read or evaluated. A page is defined as 8 1/2 x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The white paper must be provided in portrait layout.

  At minimum, the white paper should address the following:

  - A project abstract, which should be concise (less than 250 words), provide a summary of the proposed work, and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.
  - Potential scientific impact to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts, including how the research contributes to the C-WMD science needs outlined in the topic.
  - The impact of the research on C-WMD science must be clearly delineated.
  - Cost estimate by year and total dollars required to accomplish the research as presented in the white paper (no details or breakout of costs is required).

- Potential team and management plan, including details on student involvement.
- Multidisciplinary white papers should carefully detail each of the institutions/departments involved and the contribution that will be made by each of the investigators.
- Do NOT include corporate or personnel qualifications, past experience, or any supplemental information with the white paper. References may be included within the 4-page limit at the discretion of the applicant; however, extensive references are not required.
- The topic number and name should be included as a header on the white paper and in the text of the white paper.

IV.2.4. **Phase II - Invited Proposal Submission and Content.**

IV.2.4.1. Each invited proposal must address the research topic for the corresponding Period that was the subject of the corresponding pre-application white paper, as detailed in Section VIII. Each invited proposal must use the application package for the specific topic number as presented in Section VIII of this BAA.

IV.2.4.2. Each Phase II application package contains the following forms (Note: all other BAA guidelines must also be met to be considered a true complete package):

Form (Section in the BAA)	Attachment	Action
SF-424 (R&R) Application for Federal Assistance Form (IV.2.4.2.1)		Enter the appropriate information in data fields
RR Budget Form (IV.2.4.2.2)	Budget Justification for entire performance period	Attach to Section K in budget period one
R&R Subaward Budget Attachment(s) Form *(if applicable)* (IV.2.4.2.3)	Individual subaward budgets	Attach a separate budget with justification for each subaward
Research & Related Senior/Key Person Profile Form (IV.2.4.2.4)	PI Biographical Sketch	Attach to Biographical Sketch field
	PI Current/Pending Support	Attach to Current & Pending Support field
	Key Personnel Biographical Sketches	Attach to Biographical Sketch field for each senior/key person
	Key Personnel Current/Pending Support	Attach to Current & Pending Support field for each senior/key person

Research & Related Other Project Information Form (IV.2.4.2.5)	Proposal Summary/ Abstract	Attach to Block 7 Project Summary/ Abstract
	Technical Proposal	Attach to Block 8 Project Narrative
Disclosure of Lobbying Activities (SF-LLL) (IV.2.4.2.6)	N/A	N/A
Attachments Form (IV.2.4.2.7)	Attachment 1 – SOW	Upload as Attachment 1
	Attachment 2 – Quad Chart	Upload as Attachment 2

Table 4: Phase II Proposal Package Chart.

IV.2.4.2.1 **SF 424 (R&R) Application for Federal Assistance.** DTRA-specific instructions for completing the SF 424 (R&R) are below, general application instructions can be found on Grants.gov:

- **Block 1 – Type of Submission.** Applicants should indicate the Phase II submission is an "Application."
- **Block 2.1 – Applicant Identifier.** Not applicable.
- **Block 3 – Date Received by State.** Not applicable.
- **Block 3.1 – State Application Identifier.** Not applicable.
- **Block 5 – Applicant Information.** You must provide a Business Office Point of Contact (BPOC) with an e-mail address.
- **Block 19 – Authorized Representative.** The "signature of AOR" is not an actual signature and is automatically completed upon submission of the electronic application package. ***Hard copies or email attachments of applications will not be accepted.***

IV.2.4.2.2 **RR Budget Form.** The Research and Related Budget Form provided as part of the application package for the Phase II submission should be filled out in entirety for each project year proposed. Applicants are responsible for ensuring appropriate, approved rates are used in their budget forms. When notified of selection, applicants will be requested to provide their current rate agreement and the rate agreement of their subcontractor(s), if applicable. Applicants should note that in accordance with 32 CFR 22.205(b), grants shall not provide for the payment of fee or profit to the recipient.

Applicants should plan and budget for travel to accommodate the two meetings outlined below:

- National Conferences/Workshops/Symposia: Applicants are strongly encouraged to attend a nationally recognized conference, workshop, or symposium in the field of research each calendar year (1 at minimum). Research should be presented as soon

as adequate data are available to support posters and presentations. Conferences/workshops/symposia should be attended by the PI and students supporting the research, as appropriate.

- Annual Technical Review: Applicants should plan to attend an annual technical program review meeting. For planning purposes the review will be for five days and will be held in Northern Virginia. DTRA encourages graduate students to attend the Annual Technical Review.

Budget Justification. Applicants are required to submit a budget justification. The budget justification should be prepared as outlined in the instructions for the Research and Related Budget and uploaded as an attachment to Section K "Budget Justification" of the Research and Related Budget Form. The budget justification does not have a page limit, but should include sufficiently detailed information for meaningful evaluation. In addition, the budget justification must specifically address subaward costs and type to include the portion of work to be subawarded with a supporting rationale. The budget justification must include **a statement discussing how the subawardee(s) was determined to be fair and reasonable**.

IV.2.4.2.3 **R&R Subaward Budget Attachment(s) Form (if applicable).** Detailed cost estimates and budget justifications are required for each proposed subaward. The cost estimate for the subawards should include sufficiently detailed information for meaningful evaluation, including labor rates and indirect cost rates.

IV.2.4.2.4 **Research and Related Senior/Key Person Profile Form.** The Research and Related Senior/Key Person Profile Form should be completed in its entirety for each of the PIs and Co-PIs on the project. The inclusion of additional personnel is at the discretion of the PI. A **biographical sketch** is required for each PI and Co-PI on the project. DTRA does not have a preference for the format of the biographical sketch; however, it should be limited to 1 page per person. The biographical sketch should be uploaded as an attachment to the corresponding field on the Research and Related Senior/Key Person Profile Form.

Additionally, a **statement of current and pending support** must be provided for each PI and Co-PI on the project. This statement should include a summary of the current and pending support of related work and requires all grants and contracts through which each PI and Co-PI is currently receiving or may potentially receive financial support to be disclosed.

IV.2.4.2.5 **Research and Related Other Project Information Form.**

- **Block 7 – Project Summary/Abstract.** The uploaded project abstract should be concise (less than 250 words) and provide a summary of the proposed work and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.

- **Block 8 – Project Narrative.** The uploaded technical proposal must not exceed 20 pages (including references). If the proposal exceeds 20 pages, only the first 20

pages will be reviewed. A page is defined as 8 ½ x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The technical proposal must be provided in portrait layout. A **template** for the technical proposal format may be found online at www.dtrasubmission.net/portal (MS Word format).

The technical proposal must include the following components:

- ***Abstract.***
- ***Scope.***
  - ***Objective.*** A clear and concise objective of the proposed project.
  - ***Background.*** Provide the necessary technical and scientific background to support the scientific and/or technical merit of the proposed project.
  - ***Programmatics***. Describe your organization's management plan for the proposed project; list supporting and collaborating centers, and the roles/responsibilities of each identified academic and/or industrial subcontractor supporting the project. Authors of multidisciplinary proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.
  - ***Relevance.*** Describe the relevance of the proposed project in terms of advancing the state of the science and the anticipated scientific impact on capabilities to potentially reduce, eliminate, counter, provide greater knowledge or understanding of the threat, and mitigate the effects of WMD fundamental aspects of phenomena and of observable facts.
- ***Credentials.*** Describe the PI's qualifications and the organization's qualifications to perform the proposed work. Summarize the credentials of the primary performing center, and supporting academic and industrial partners to perform the work. Describe specific examples of equipment and/or facilities available to perform the proposed work. Focus on information directly relevant to the proposed work.
- ***Work to be Performed.*** Provide details of the work to be performed by task and subtask. Tasks must be grouped by project year.
- ***Performance Schedule.*** Provide a table of tasks and subtasks and the duration of performance of each in a Gantt or other suitably formatted chart.
- ***References.*** List any relevant documents referenced.

IV.2.4.2.6 **Disclosure of Lobbying Activities (SF-LLL) Form.** The Disclosure of Lobbying Activities Standard Form-LLL, if applicable, should be completed.

IV.2.4.2.7 **Attachments Form.**

- **Attachment 1 – SOW.** The SOW does not have a page limit, but should be approximately 3-5 pages in length and appropriate for incorporation into the grant

document. The SOW should not contain any proprietary data or markings. Pages should be numbered and the initial page should have a date (document date) shown under the title (the title of the SOW should match that of the proposal). The SOW must be provided in portrait layout. A **template** for the SOW format may be found online at https://www.dtrasubmission.net/portal/Forms.aspx (MS Word format).

The proposed SOW must accurately describe the research to be performed. The proposed SOW must also contain a summary description of the technical methodology as well as the task description, but not in so much detail as to make the SOW inflexible. The SOW format/guidance is as follows:

- ***Objective:*** Brief overview of the specialty area. Describe why the research is being pursued and what knowledge is being sought.
- ***Scope:*** Include a statement of what the SOW covers including the research area to be investigated, objectives/goals, and major milestones and schedule for the effort.
- ***Background:*** The applicant must identify appropriate documents, including publications that are applicable to the research to be performed. This section includes any information, explanations, or constraints that are necessary in order to understand the hypothesis and scientific impact on capabilities needed to reduce, eliminate, and counter the threat, and also mitigate the effects of WMD. It may also include previously performed relevant research and preliminary data.
- ***Tasks/Scientific Goals:*** This section contains the detailed description of tasks which represent the research to be performed that are contractually binding. Thus, this portion of the SOW should be developed in an orderly progression and presented in sufficient detail to establish the methodology and feasibility of accomplishing the overall program goals. The work effort should be segregated by performance period for all tasks to be performed and anticipated milestones realized in that year (e.g., Year 1, Year 2, etc., should be detailed separately). Identify the major tasks in separately numbered sub-paragraphs. Each major task should delineate, by subtask, the research to be performed by year and number each task using the decimal system (e.g., 4.1, 4.1.1, 4.1.1.1, 4.2, etc.). The sequence of performance of tasks and achievement of milestones must be presented by project year and task in the same sequence as in the Technical Proposal. The SOW must contain every task to be accomplished to include a detailed schedule.

  The tasks must be definite, realistic, and clearly stated. Use "the grantee shall" whenever the work statement expresses a provision that is binding. Use "should" or "may" whenever it is necessary to express a declaration of purpose. Use active voice in describing work to be performed. Do not use acronyms or abbreviations without spelling out acronyms and abbreviations at the first use; place the abbreviation in parentheses immediately following a spelled-out phrase. If presentations/meetings are identified in your schedule, include the following statement in your SOW: "Conduct presentations/meetings at times and places specified in the grant schedule."

- **Attachment 2 – Quad Chart.** The quad chart must be presented on one (1) page. The quad chart must not contain any proprietary data or markings. The quad chart must be provided in landscape layout. A **template** for the quad chart format may be found online at https://www.dtrasubmission.net/portal/Forms.aspx (MS PowerPoint format). A pictorial representation of the quad chart is provided herein and includes the relevant fields that must be included in the Phase II proposal submission. The inclusion of the DTRA logo is not required. The quad chart should be uploaded as "Attachment 2" of the Attachments Form.

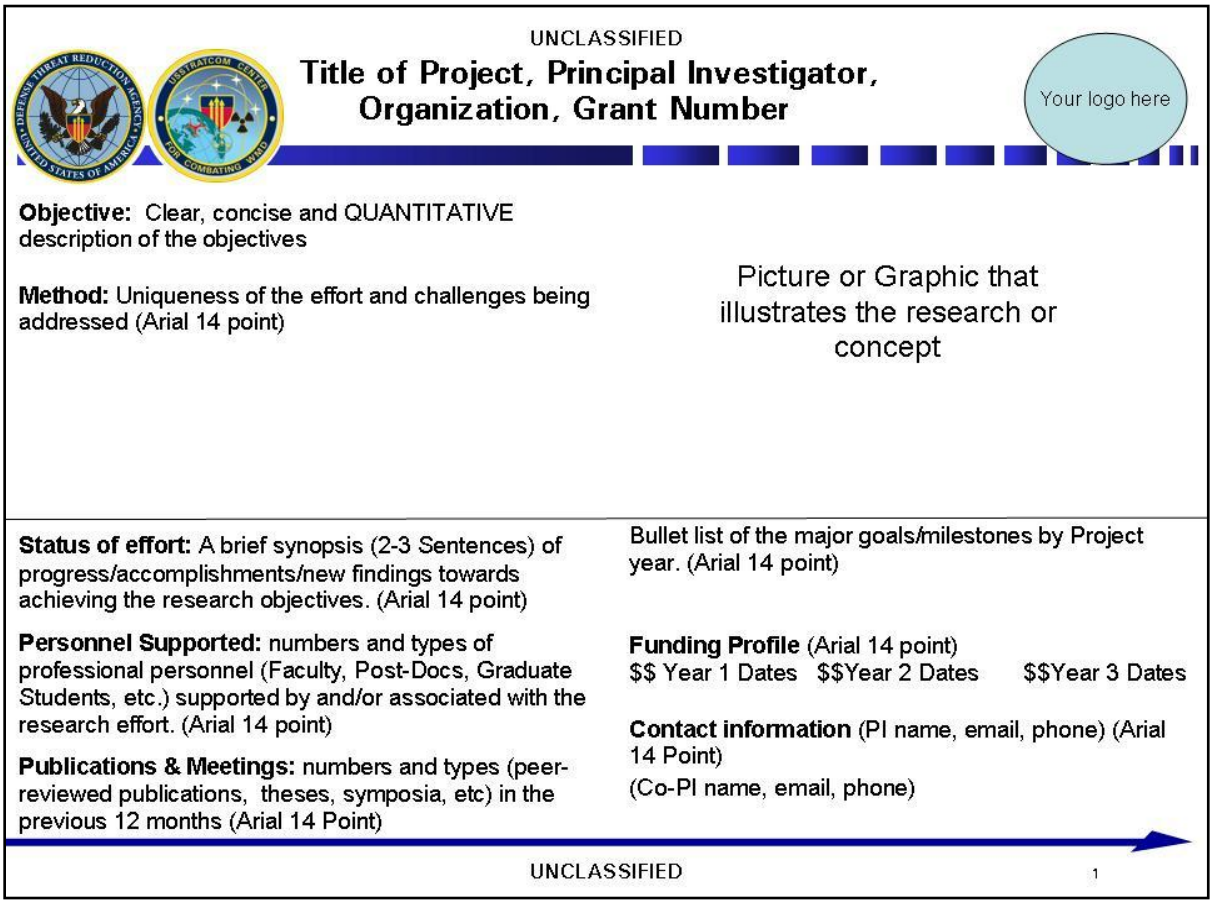


Figure 1: Sample Quad Chart.

IV.2.5. File Format.

IV.2.5.1. Perform a virus check before uploading any files to Grants.gov as part of your application package. If a virus is detected, it may cause rejection of the file.

IV.2.5.2. Do not lock or encrypt any files you upload to Grants.gov as part of your application package.

IV.2.5.3. Documents should be uploaded as a Portable Document File (PDF) format.

IV.2.5.4. Movie and sound file attachments will not be accepted.

IV.2.6. All submissions must be UNCLASSIFIED.

IV.3. Submission Dates and Times.

IV.3.1. Phase I pre-application white papers will be accepted based on periods as outlined in Table 5. A Phase II "receipt window" of 4 to 6 weeks will be provided in Table 5, however, the specific due dates for the Phase II invited proposal submissions will be provided in the letters of invitation. (The window is strictly for informational purposes only, to provide 'not prior to' and 'not later than' dates.) After the deadline date provided for a given period, the application packages will no longer be available for download from Grants.gov. Most importantly, applications received after these deadlines will only be reviewed under extremely limited circumstances, at the discretion of DTRA.

IV.3.2. When sending electronic files, the applicant should allow for potential delays in file transfer from the originator's computer server to the Grants.gov website/computer server, as well as the delay associated with the Grants.gov validation of applications, which may be up to 48 hours. Applicants are encouraged to submit their proposals early to avoid issues with file transfers, rejection of applications by Grants.gov, and delays due to high demand encountered as the submission deadline approaches.

IV.3.3. Applicants are responsible for submitting fully compliant pre-application white papers and invited proposals so as to be received by Grants.gov no later than the time and dates listed in Table 5 and the letter of invitation for proposals, respectively.

IV.3.4. Acceptable evidence to establish the time of receipt at the Government office includes documentary and electronic evidence of receipt maintained by DTRA. Applicants should also print, and maintain for their records, the electronic receipt following submission of a proposal to Grants.gov.

IV.3.5. Please note 15 U.S.C. 260a establishes daylight saving time as the standard time during the daylight saving period.

IV.3.6. Additional timeline details are available to all applicants at the DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal), e.g., estimated notification date for proposal invitations. Applicants are responsible for checking www.dtrasubmission.net/portal for changes and updates to the schedule.

IV.3.7. Additional opportunities for pre-application white paper submissions with applicable topics, due dates, and application packages will be posted as amendments to this BAA. Schedules of future amendments, topic information, and due dates will not be provided and questions requesting information relevant to future amendments, schedules, and/or topics will not be answered in advance of an amendment.

Date	Event
1 March 2011	BAA announced on Grants.gov

Period A	
CLOSED	
~~2:00 PM EST,8 April 2011~~	~~Phase I pre-application white paper receipt deadline~~
~~2:00 PM EST, 27 June 2011~~	~~Phase II invitation-only proposal receipt deadline~~
~~January—March 2012~~	~~Period A Grants scheduled to be awarded~~
Period B	
CLOSED	
~~1 December 2011~~	~~Amendment to the BAA announced on Grants.gov with Period B topics, application packages, and applicable deadlines~~
~~Midnight EST,~~ ~~13 January 2012~~	~~Phase I pre-application white paper receipt deadline~~
~~Midnight EST, Not prior to 2 April 2012, and not later than 20 April 2012 *~~	~~Phase II invitation-only proposal receipt deadline~~ ~~* The exact due date and time for the full proposals will be provided in the letters of invitation.~~
~~October—December 2012~~	~~Period B Grants scheduled to be awarded~~
Period C	
CLOSED	
~~3 December 2012~~	~~Amendment to the BAA announced on Grants.gov with Period C topics, application packages, and applicable deadlines~~
~~Midnight EST,~~ ~~14 January 2013~~	~~Phase I pre-application white paper receipt deadline~~
~~Midnight EST, Not prior to 5 April 2013, and not later than 3 May 2013 *~~	~~Phase II invitation-only proposal receipt deadline~~ ~~* The exact due date and time for the full proposals will be provided in the letters of invitation.~~
October—December 2013	Period C Grants scheduled to be awarded
Period D	
2 December 2013	Amendment to the BAA announced on Grants.gov with Period D topics, application packages, and applicable deadlines
Midnight EST, 13 January 2014	Phase I pre-application white paper receipt deadline

Midnight EST, Not prior to 4 April 2014, and not later than 2 May 2014 *	Phase II invitation-only proposal receipt deadline
October—December 2014	Period D Grants scheduled to be awarded
Period E	
TBD	Amendment to the BAA announced on Grants.gov with Period E topics, application packages, and applicable deadlines
TBD	Phase I pre-application white paper receipt deadline
TBD	Phase II invitation-only proposal receipt deadline
TBD	Period E Grants scheduled to be awarded
Period F	
Period G	
Period H	
……	
Period 'n'	

Table 5: List of important dates. (Same as Table 1 located in the Overview Information)

IV.3.8. Late Submissions. If the application package and required attachments are submitted to Grants.gov after the exact time and date specified in this BAA for the pre-application white paper (Phase I) and/or the letter of invitation for the invited proposal (Phase II), the application is "late". Applications that are "late" will only be reviewed under extremely limited circumstances, at the discretion of DTRA.

IV.3.9. Interruption of Government Processes. If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be submitted to Grants.gov by the exact time specified in this BAA for the pre-application white paper and/or the letter of invitation for the invited proposal, and urgent Government requirements preclude amendment of the BAA closing date, the time specified for receipt of applications will be deemed to be extended to the same time of day specified in the BAA on the first work day on which normal Government processes resume.

IV.4. Intergovernmental Review. Not Applicable.

IV.5. Funding Restrictions. Indirect costs may be restricted to less than 35% of the total grant value regardless of previously negotiated rates with the cognizant agency. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic

Research funds. This restriction does not apply to awards made using fiscal year 2011 and later Basic Research funds, but it **may** apply to future awards.

IV.6. Other Submission Requirements.

IV.6.1. Phase I and Phase II applications must be made through Grants.gov using the application package specific to the period/phase/topic of interest. Application packages for a *particular period* are posted with the announcement of the particular period (i.e., Period A is announced by the original posting of the BAA and the application packages are posted with it. When a new period is announced, an amendment will be published with new application packages). Applicants should take care to use the application package associated with the topic for which an application is being made.

Phase I and Phase II submissions made via any other means (e.g., hand-carried, postal service, commercial carrier, e-mail, etc.) will NOT be considered under any circumstances.

IV.6.2. Applicants should note that each organization must complete a one-time registration in order to submit its pre-application white paper(s) and application(s) through Grants.gov. Please see the following web link on information about registering with Grants.gov: http://www07.grants.gov/applicants/applicants.jsp. If your organization is already registered in Grants.gov, no further action should be required.

The registration process may take up to **four (4) weeks** to complete depending on your organization and requires multiple steps, some of which are detailed below.

- Identifying the Data Universal Number Systems (DUNS) number or registering for one with Dun & Bradstreet at http://fedgov.dnb.com/webform/displayHomePage.do if your organization does not have a DUNS number.

- Registering with the System for Award Management (SAM) by calling the SAM Assistance Center at 1-866-606-8220, or you may register online at www.sam.gov. You will NOT be able to complete your SAM registration until SAM has confirmed your Employer Identification Number (EIN) or Taxpayer Identification Number (TIN) with the Internal Revenue Service (IRS).

IV.6.3. All awards require certifications of compliance with Appendix A to 32 CFR 28 regarding lobbying. The full text of this certification is available at the DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal).

Proposers are certifying compliance with this regulation by submitting the invited proposal. It is not necessary to include the certification text with your invited proposal. If applicable, proposers should submit the Disclosure of Lobbying Activities (SF-LLL) Form, see Section IV.2.4.2.6.

IV.6.4. Marking Guidance for Pre-Application White Paper and Invited Proposal and Disclosure of Proprietary Information other than to the Government.

IV.6.4.1. The pre-application white papers and invited proposals submitted in response to this BAA may contain technical and other data that the applicant does not want disclosed to the public or used by the Government for any purpose other than application evaluation. Public release of information in any pre-application white paper and invited proposal submitted will be subject to existing statutory and regulatory requirements.

IV.6.4.2. If proprietary information which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, is provided by an applicant in a pre-application white paper and/or invited proposal, it will be treated in confidence, to the extent permitted by law, provided that the following legend is included on the front page of the pre-application white paper and/or invited proposal:

> "For any purpose other than to evaluate the pre-application white paper and/or proposal, this data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if an award is made to the applicant as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the agreement. This restriction does not limit the right of the Government to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) _____ of this pre-application white paper and/or proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the pre-application white paper and/or invited proposal from further consideration without assuming any liability for inadvertent disclosure.

IV.6.4.3. The Government will limit dissemination of properly marked information to within official channels. In addition, the pages indicated as restricted must be marked with the following legend:

> "Use or disclosure of the pre-application white paper and/or proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the front page of this pre-application white paper and/or proposal."

IV.6.4.4. The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

IV.6.4.5. In the event that properly marked data contained in a pre-application white paper and/or invited proposal submitted in response to this BAA is requested pursuant to the Freedom of Information Act (FOIA), 5 U.S.C. § 552, the applicant will be advised of such request and prior to such release of information, will be requested to expeditiously submit to DTRA a detailed listing of all information in the pre-application white paper and/or invited proposal which the applicant believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the applicant will ensure that any information released by DTRA pursuant to the Act is properly identified.

IV.6.4.6. By submission of a pre-application white paper and/or invited proposal, the applicant understands that proprietary information may be disclosed outside the Government for the sole purpose of technical evaluation. DTRA will obtain a non-disclosure agreement from the evaluator that proprietary information in the pre-application white paper and/or invited proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

IV.6.5. Pre-application white papers and invited proposals may be withdrawn by written notice received at any time before award. Withdrawals are effective upon receipt of notice by the Grants Officer via the e-mail address listed in Section VII.1.

V. APPLICATION REVIEW INFORMATION

V.1. Evaluation Criteria. The evaluation criteria to be used for review of applications are listed below. Only the first two (2) criteria will be used to evaluate pre-application white papers; all four (4) will be used to evaluate invited proposals.

1. Technical/Scientific Merit. This area addresses the technical approach and the contribution of the research to advancing the scientific body of knowledge. It evaluates what research will be performed and how it will be accomplished. Three (3) factors will be considered. The factors are listed in the order of importance.

   - *Soundness of Approach.* This factor addresses whether the proposal clearly identifies and demonstrates an understanding of the scientific challenges and whether the project has a well-designed methodology, based on sound scientific principles, and how technical risks are addressed, mitigated, and managed.
   - *Degree of Innovation.* This factor addresses the originality of the concept, its scientific merit, its creativity, and/or the novelty of the approach and the potential of the project to advance the scientific body of knowledge. The degree of innovation will be judged based on the innovation or originality that is appropriate to the proposed project.
   - *Anticipated Scientific Impact.* This factor addresses the potential of the proposed work to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts and the anticipated impact on the state of the science.

2. Responsiveness to Topic Area and Program. This area evaluates the extent to which the proposed research supports specific topic areas. It also considers the derivative benefit that may be realized by the performer and its organization through performance of the proposed research. The two (2) factors are weighted equal to each other.

   - *Responsiveness to Topic Area.* This factor addresses the responsiveness of the proposal to the objectives in the specific topic area and the contribution to the C-WMD science needs outlined in the topic.
   - *Derivative Benefit.* This factor considers training of students in science, engineering, and/or mathematics through the proposed research.

3. Program Capabilities. This area addresses key personnel, facilities, and major equipment required to accomplish the research. The two (2) factors are weighted equal to each other.

   - *Qualifications.* This factor will be scored based on the qualifications and availability of the proposed PI, co-PIs and other key personnel who are critical in achieving proposed objectives.
   - *Capabilities.* This factor considers the applicant's current or planned facilities and equipment that support achieving the proposed objectives. Capabilities evaluation will be based on the total capabilities of the assembled team that will be brought to bear as part of the proposed project.

4. Cost Realism and Reasonableness. This factor considers the adequacy and reasonableness of resources applied to each project task. This includes labor (in terms of time and mix), equipment, other direct costs, and indirect costs.

V.2. Review and Selection Process.

V.2.1. The pre-application white paper and proposal selection process will be conducted based upon a technical review as described in the DoDGARs [(32 CFR 22.315(c))] and includes the use of non-government peer-reviewers.

V.2.2. Each pre-application white paper and invited proposal will be reviewed within the period to which it was submitted.

V.2.3. Pre-application white paper (Phase I) evaluation will be based on two (2) equally weighted criteria described in Section V.1: (1) Technical/Scientific Merit and (2) Responsiveness to Topic Area and Program, which will each be scored as Green (acceptable), Yellow (acceptable with minor issues), or Red (unacceptable). The Government reserves the right to limit the number of Phase II invited proposals requested depending upon the volume of pre-application white papers submitted, the results of the Phase I evaluation, and the specific needs of the Agency.

V.2.4. Invited Proposal (Phase II) Evaluation will be based on the four (4) criteria described in Section V.1: Criteria (1) Technical/Scientific Merit and Criteria (2) Responsiveness to Topic Area and Program are equally weighted and are more important than Criteria (3) Program Capabilities which is more important than Criteria (4) Cost Realism and Reasonableness. All four (4) criteria receive a numerical score ranging from 1 (unacceptable) to 5 (outstanding).

V.2.5. Other factors that may be considered during the selection process are the possible duplication with other research currently funded by the Government, program balance across research topics, and budget limitations. Accordingly, proposals may be selected for funding which are not reviewed as highly as others, which are of higher risk and/or which may be of a higher cost. ***Preference will be given to university-led awards, single scope awards, and young investigator awards.***

V.2.6. The Government reserves the right to select all, some, or none of the proposals, or any part of any proposal, received in response to this BAA and to make awards without discussions

with applicants; however, the Government reserves the right to conduct discussions, if determined necessary.

V.2.7. Additional details, including the due date for Phase II submissions, may be provided to applicants in the invitation email.

V.3. Technical and Administrative Support by Non-Government Personnel

V.3.1. It is the intent of DTRA to use non-government personnel to assist with the review and administration of submittals for this BAA.

V.3.2. All invited proposals will be reviewed by subject matter experts (peer reviewers) who are non-government personnel.

V.3.3. Participation in this BAA requires DTRA support contractors to have access to pre-application white paper and invited proposal information including information that may be considered proprietary. Existing DTRA contractors include but may not be limited to the following: TASC Inc. (advisory and assistance services) and their subcontractors, Suntiva Executive Consulting (contract specialist support) and their subcontractors, SBG Technology Solutions and their subcontractors, and Terremark Worldwide Inc. Each contract contains organizational conflict of interest provisions and/or includes contractual requirements for non-disclosure of proprietary contractor information or data/software marked with restrictive legends.

V.3.4. All individuals having access to any proprietary data must sign a non-disclosure agreement that states the information in the pre-application white paper and/or invited proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

V.3.5. All applicants to this BAA consent to the disclosure of their information under these conditions.

VI. AWARD ADMINISTRATION INFORMATION

VI.1. Award Notices.

VI.1.1. A detailed review timeline is available to all applicants at the DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal). Applicants are responsible for checking the timeline at the www.dtrasubmission.net/portal for changes and updates to the schedule.

VI.1.2. Applicants of pre-application white papers that are not selected for invitation will be notified of the decision via e-mail to the BPOC listed in Block 5 of the SF-424 and the PI listed in Block 14 of the SF-424 provided at the time of submission.

VI.1.3. An invitation to submit a proposal will be extended to those applicants whose submissions were selected in Phase I. The invitation will be transmitted via e-mail to the

BPOC listed in Block 5 of the SF-424 and the PI listed in Block 14 of the SF-424 provided at the time of submission.

VI.1.4. Applicants will be notified by DTRA of their selection/non-selection for award from the Phase II invited proposals via e-mail to the BPOC listed in Block 5 of the SF-424 and the PI listed in Block 14 of the SF-424 provided at the time of submission. Notification of proposal selection is not an authorization to begin work.

VI.1.4.1. A notice of selection should not be construed as an obligation on the part of the Government; only duly authorized procurement personnel may commit resources, this will be done by issuing a grant document to the selected applicant. Also, this notification must not be used as a basis for accruing costs to the Government prior to award. Selected applicants are not authorized to begin work, as any award is subject to successful negotiations (if determined necessary by DTRA) between the DTRA contracting division and the selected organization, and to the availability of funds.

VI.1.5. A debrief summary will be provided as part of all notification e-mails.

VI.1.6. All notifications will be made from notification@dtrasubmission.net. **E-mails to this e-mail address will not be answered or forwarded.**

VI.1.7. The applicants must be aware that it is their responsibility to ensure: (1) correct e-mail addresses are provided at the time of submission, (2) this e-mail notification reaches the intended recipient(s), and (3) the e-mail is not blocked by the use of 'spam blocker' software or other means that the recipient's Internet Service Provider may have implemented as a means to block the receipt of certain e-mail messages.

VI.1.8. If for any reason there is a delivery failure of these e-mail notices, **DTRA will not further attempt to contact the applicants**.

VI.2. Administrative and National Policy Requirements.

VI.2.1. The DTRA Grant Terms and Conditions may be found online at the DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal). (Note: There are different versions for different recipients. As the Terms and Conditions are updated, they will be posted on the www.dtrasubmission.net/portal.)

VI.2.2. All awards require certifications of compliance with national policy requirements. Statutes and government-wide regulations require some certifications to be submitted at the time of proposal submission. See Section IV.6.3 for the certification(s) required at the time of submission.

VI.2.3. SAM Registration. DTRA uses the SAM to exclude recipients ineligible to receive Federal awards. SAM can be accessed online at http://sam.gov (Reference 2 CFR 25.200).

:

- Be registered in the SAM prior to submitting an application (or plan);

- Maintain an active SAM registration with current information at all times during which it has an active Federal award or an application (or plan) under consideration by an agency; and

- Provide its DUNS number in each application (or plan) it submits to the agency.

VI.2.4. Protection of Human Subjects.

VI.2.4.1. It is not anticipated that human subjects would be involved in basic research. If the proposed research does involve human subjects or materials, applicants are asked to justify the use of human subjects and to address the following issues: outline the human use, to include the source of the human subjects or materials involved in the research. Further information may be required if the proposal is successful.

VI.2.4.1.1 The Common Federal Policy for the Protection of Human Subjects, codified by the Department of Health and Human Services at 45 CFR 46 and implemented by the Department of Defense at 32 CFR 219.

VI.2.4.1.2 The recipient shall adhere to DTRA local clause 252.223-9002. The full text of this clause is as follows:

All research under this grant involving human subjects must be conducted in accordance with 32 CFR 219, 10 USC 980, and DoDD 3216.02, as well as other applicable federal and state regulations. Grantees must be cognizant of and abide by the additional restrictions and limitations imposed on the DoD regarding research involving human subjects, specifically as regards vulnerable populations (32 CFR 219 modifications to subparts B-D of 45 CFR 46), recruitment of military research subjects (32 CFR 219), and surrogate consent (10 USC 980). DTRA Directive 3216.01 establishes the DTRA Human Subjects Protection Program, sets forth the policies, defines the applicable terms, and delineates the procedures necessary to ensure DTRA compliance with federal and DoD regulations and legislation governing human subject research. The regulations mandate that all DoD activities, components, and agencies protect the rights and welfare of human subjects of study in DoD-supported research, development, test and evaluation, and related activities hereafter referred to as "research". The requirement to comply with the regulations applies to new starts and to continuing research.

The DTRA directive requires that research using human subjects may not begin or continue until the Defense Threat Reduction Agency's Research Oversight Board (ROB) has reviewed and approved the proposed protocol. Grantees and subcontractors are required to submit a valid federal assurance for their organization (institution, laboratory, facility) that has been issued by either DoD or the Department of Health and Human Services, and documentation of review of proposed protocols by the local Institutional Review Board (IRB) to include consent forms for any planned research using human subjects to the DTRA ROB for its review through the Grants Officer's representative (if assigned) or the Grants Officer. The ROB review is separate from, and in addition to, local IRB review.

Written approval to begin research or subcontract for the use of human subjects under the proposed protocol will be provided in writing from the DTRA ROB, through the Grants Officer. A copy of this approval shall be maintained by both the Grantee and the government. Any proposed modifications or amendments to the approved protocol or consent forms must be submitted to the local IRB and the DTRA ROB for review and approval. Examples of modifications/amendments to the protocol include but are not limited to:

- a change of the PI
- changes in duration or intensity of exposure to some stimulus or agent
- changes in the information requested of volunteers, or changes to the use of specimens or data collected
- changes in perceived or measured risks or benefits to volunteers that require changes to the study

Research pursuant to such modifications or amendments shall not be initiated without IRB and ROB approval except when necessary to eliminate apparent and immediate hazards to the subject(s).

Research projects lasting more than one year require IRB review at least annually, or more frequently as required by the responsible IRB. ROB review and approval is required annually. The Grantee or subcontractor must provide documentation of continued IRB review of protocols for ROB review and approval in accordance with these Terms and Conditions. Research must not continue without renewed ROB approval unless necessary to eliminate apparent and immediate hazards to the subject(s).

Non-compliance with any provision of this clause may result in withholding of payments under the grant pursuant to the grant's payments clause(s) and/or grant termination pursuant to the grant's termination clause(s). The government shall not be responsible for any costs incurred for research involving human subjects prior to protocol approval by the ROB.

VI.2.5. Animal Use.

VI.2.5.1. It is not anticipated that animal use would be involved in basic research. If the proposed research does involve animal use, however, applicants are asked to justify the use of animals and to address the following issues: any proposals that include animal studies or animal work must submit detailed information on the animal protocols to be used and verify the location where the studies will be conducted. Animal studies are subject to review and approval for safety and adherence to regulations. Further information may be required if the proposal is successful.

VI.2.5.2. The recipient shall adhere to DTRA local clause 252.235-9002 – Animal Use (Jul 2010). The full text of this clause is as follows:

If the proposed research involves the use of live nonhuman vertebrate animals, applicants

are required to justify the use of animals by providing detailed information on the proposed animal use, to include the proposed species and number of animals planned, along with the location(s) where the animal study(ies) are planned. This information, if applicable, must be included in the project narrative. Additional information will be required if the proposal is selected for award subject to successful negotiations. The Animal Care and Use Review Office (ACURO), a component of the USAMRMC Office of Research Protections (ORP), must review and approve all animal use prior to the start of working with animals. Therefore principle investigators will be required to complete and submit the animal use appendix titled "Research Involving Animals", after award of the procurement instrument, which can be found on the ACURO website (https://mrmc-www.army.mil/index.cfm?pageid=Research_ Protections.acuro&rn=1). Allow 2 to 4 months for regulatory review and approval processes for animal studies. Offerors are to build this review time into their project schedules.

DoD Directive 3216.1, dated April 17, 1995, provides policy and requirements for the use of animals in DoD-funded research along with Army Regulation 40-33. The DoD definition of animal is any live nonhuman vertebrate. All proposals that involve the use of animals must be in compliance with DoD Directive 3216.1 and AR 40-33. DTRA requires that research using animals not begin or continue until the ACURO has reviewed and approved the proposed animal use. For animals, the provisions include rules on animal acquisition, transport, care, handling, and use in: (i) 9 CFR Parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Action of 1966 (U.S.C. 2131-2156); and (ii) the "Guide for the Care and Use of Laboratory Animals," National Institutes of Health Publication No. 86-23.

VI.2.6. Biological Defense Research Program (BDRP) Requirements: BioSurety and Select Agent Use.

VI.2.6.1. Proposals must specify what Select Agent work will be conducted at the applicant's facility and what Select Agent work will be performed in other facilities. Proposals also must provide the source of the Select Agent(s), any appropriate registration information for the facilities, and specify the Laboratory Bio-safety Level. All Select Agent work is subject to verification of information and certifications. Further information may be required if the proposal is successful.

VI.2.6.2. For those institutions in which PI's are conducting research with Bio-safety Levels 3 and 4 material, a Facility Safety Plan must be prepared and made available during the project award phase in accordance with 32 CFR 626.18. For grants awarded to foreign institutions, you must follow either local or U.S. laws (as stated above) depending on which laws provide stronger protection. (DTRA requires that research using Select Agents not begin or continue until DTRA has reviewed and approved the proposed agent use. See URL: www.access.gpo.gov/nara/cfr/waisidx_99/32cfr626_99.html for a copy of 32 CFR 626.18, Biological Defense Safety Program.)

VI.2.7. Dual-Use Potential. In accordance with National Science Advisory Board for Biosecurity (NSABB) recommendations, DTRA will not support research that, based on current understanding, can reasonably be anticipated to provide knowledge, information,

products, or technologies that could be directly misapplied to pose a significant threat with broad potential consequences to public health and safety, agricultural crops and other plants, animals, the environment, materiel, or national security. Research involving select agents and toxins is within scope of the DTRA mission; however, the use of select agents and toxins in certain experimental categories is considered "dual-use research of concern" (DURC) according to U.S. policy [http://oba.od.nih.gov/biosecurity/news_events_oba.html#NSABB]. Proposals that contain DURC will not be funded. Dual-use potential will be assessed based on application of the following criteria:

- **Use of select agents or toxins.** This factor evaluates whether the proposed research involves use of one or more select agents or toxins [as identified by the Select Agent Program under Federal Law (7 C.F.R. part 331, 9 C.F.R. part 121, and 42 C.F.R. part 73)] which pose significant risk of deliberate misuse with potential for mass casualties or devastating effects to the economy, critical infrastructure, or public confidence.

- **Scope of proposed experiments.** This factor evaluates whether the proposed research involves experiments that will produce, aim to produce, or is reasonably anticipated to produce: (a) Enhanced harmful consequences of the agent or toxin; (b) Disruption of immunity or effectiveness of an immunization against the agent or toxin without clinical or agricultural justification; (c) Conferred resistance by the agent or toxin to clinically or agriculturally useful prophylactic or therapeutic interventions against the agent or toxin, or facilitated ability to evade detection methodologies; (d) Increased stability, transmissibility, or dissemination ability of the agent or toxin; (e) Altered host range or tropism of the agent or toxin; (f) Enhanced susceptibility of a host population to the agent or toxin; or (g) Eradicated or extinct select agents or toxins.

VI.2.8. Military Recruiting. This is to notify potential applicants that each grant awarded under this announcement to an institution of higher education, with exception of any grants awarded to institutions of higher education entirely located outside the United States and/or its territories, must include the following term and condition: "As a condition for receipt of funds available to DoD under this award, the recipient agrees that it is not an institution of higher education (as defined in 32 CFR 216) that has a policy of denying, and that it is not an institution of higher education that effectively prevents, the Secretary of Defense from obtaining the following for military recruiting purposes: (A) entry to campuses or access to students on campuses; or (B) access to directory information pertaining to students. If the recipient is determined, using procedures in 32 CFR 216 to be such an institution of higher education during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DoD funds under this agreement and all other DoD grants and cooperative agreements, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award." 32 CFR 216 may be accessed electronically at http://ecfr.gpoaccess.gov/. If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558 of Public Law 103-337, then: (1) no funds available to DoD may be provided to your institution through any grant, including any existing grant; and (2) your institution is not eligible to receive a grant in response to this BAA. This is to notify potential applicants that each grant awarded under this announcement to an institution of higher education, with exception of any grants awarded to institutions of higher education entirely located outside the

United States and/or its territories, must include the following clause: 32 CFR 22.520 (DoDGARS 22.520), Military Recruiting and Reserve Officer Training Corps Program Access to Institutions of Higher Education.

VI.2.9. Export Control Notification. Applicants are responsible for ensuring compliance with any export control laws and regulations that may be applicable to the export of and foreign access to their proposed research. Applicants may consult with the Department of State with any questions regarding the International Traffic in Arms Regulation (ITAR) (22 CFR Parts 120-130) and/or the Department of Commerce regarding the Export Administration Regulations (15 CFR Parts 730-774).

VI.2.10. It is the policy of the DoD that the publication of products of basic research will remain unrestricted to the maximum extent possible. Pursuant to DoD policy, awardees are strongly encouraged to publish the results or findings of their research in peer-reviewed journals.

VI.2.10 Combating Trafficking in Persons. The recipient agrees to comply with the trafficking in persons requirement in Section 106(g) of the Trafficking Victims Protection Act of 2000 (TVPA), as amended (22 U.S.C. 7104(g)).

VI.2.11 Reporting Subawards and Executive Compensation. The recipient agrees to ensure they have the necessary processes and systems in place to comply with the reporting requirements of the Transparency Act, as defined at 2 CFR 170.320, unless they meet the exception under 2 CFR 170.110(b).

VI.3. Reporting. General requirements are provided below; however, each grantee should check the award agreement and its terms and conditions to determine the requirements for that specific award.

VI.3.1. Annual Progress Reports: Annual progress reports will be due no later than 1 September of each year. Grants effective after 31 May will not require a progress report until 1 September of the following year.

VI.3.2. Final Technical Reports: A comprehensive final technical report is required at the end of an effort, due on the date specified in the terms and conditions of the grant document.

VI.3.2.1. The purpose of the final report is to document the results of the effort.

VI.3.2.2. The final report will always be sent to the Defense Technical Information Center (DTIC) and reports may be available to the public through the National Technical Information Service (NTIS).

VI.3.3. The Federal Financial Report, SF425 is due quarterly, no later than 30 days after the end of the reporting period. Reporting periods are as follows: 1 January – 31 March, 1 April – 30 June, 1 July – 30 September, and 1 October – 31 December. Final reports shall be submitted no later than 90 days after the project or grant period end date.

VI.3.4. All reports shall be submitted to the Administrative Office identified in the Research Grant and as outlined in the Terms and Conditions of the award document.

VI.4. After-the-Award Requirements. Closeout, subsequent adjustments, continuing responsibilities, and collection of amounts due are subject to requirements found in 32 CFR 32.71 – 73 (Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations) and 32 CFR 32.61 – 63 (For-Profit Organizations).

VII. AGENCY CONTACTS

VII.1. All administrative and programmatic correspondence should be directed toHDTRA1-BRCWMD-A@dtra.mil.

Every effort will be made to provide a timely response to all inquiries; however, e-mails may not receive a response. Attachments will not be reviewed.

VII.2. Specific technical correspondence regarding the thrust areas as well as the topics may be directed to the following e-mail addresses:

Thrust Area 1: BRCWMD-TA1@dtra.mil

Thrust Area 2: BRCWMD-TA2@dtra.mil

Thrust Area 3: BRCWMD-TA3@dtra.mil

Thrust Area 3 (CB): BRCWMD-TA3-CB@dtra.mil

Thrust Area 4: BRCWMD-TA4@dtra.mil

Thrust Area 5: BRCWMD-TA5@dtra.mil

Please note that technical correspondence e-mails may or may not be reviewed and responded to; **attachments will not be reviewed**.

VII.2.1. Dialogue that assists the applicants in developing better pre-application white papers and invited proposals is encouraged.

VII.2.2. Questions regarding debriefing summaries for pre-application white papers that are invited to full proposals are encouraged.

VII.2.3. Requests to reconsider pre-application white papers and/or proposals, requests for additional information beyond the debriefing summaries for non-invites/non-selections, and rebuttals to the debriefing summary (e.g., additional data, further explanation, etc.) WILL NOT

be considered under any circumstances.

VIII. OTHER INFORMATION – TOPICS

VIII.1. Topics for future periods with corresponding pre-application white paper due dates will be published via amendments to this BAA. Topics from previous periods may or may not be repeated. DTRA will not provide additional information regarding the posting of future topics, including dates for posting, the potential for a topic to be repeated in out years, the potential for similar topics to be posted, and/or topic details in advance of issuance of an amended BAA.

VIII.2. This BAA, in addition to any amendments issued in conjunction with this BAA, will be posted to the Grants.gov Grant Opportunities Website (www.Grants.gov) and for informational purposes to the DTRA Basic and Fundamental Research Portal (www.dtrasubmission.net/portal).

Note: The DTRA Basic and Fundamental Research Portal (www.dtrasubmission.net/portal) is available to all applicants. Information available at the portal includes, but is not limited to, the following: a detailed timeline for this BAA, templates that may be used when preparing pre-application white papers and invited proposals, sign-in for applicants to view the status of their submission(s), and a list of previous awards made by the Basic Research for C-WMD Program.

DTRA Basic Research Needs

PerD-Topic 1: Refractory Debris Dissolution Techniques for Nuclear Forensic Field Procedures (Thrust Area 1)

Average Award Amounts for PerD-Topic 1:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $250,000 to $350,000 per year.

Award Structure for PerD-Topic 1:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: This topic explores ways to dissolve post-detonation debris from a nuclear event using environmentally friendly, potentially field deployable, techniques on a reasonable time scale (<15 hour total dissolution time for a 5-10 gram sample), and/or a qualitative understanding of the impacts of various dissolution approaches on the fidelity of analytical measurements. The Department of Defense provides the capability to collect and analyze post-detonation debris. DTRA is responsible for research and development that will enable this post-detonation forensic analysis.

The current methodology includes a radiochemical assay that requires complete dissolution of difficult-to-dissolve refractory samples to obtain statistically accurate results. Current dissolution strategies utilize hazardous chemicals and hard acids such as hydrofluoric acid (HF) which requires a brick-and-mortar lab for personnel and environmental safety. The elimination of such hazardous materials could potentially allow for samples to be dissolved in the field. Ideally, these novel methodologies would also provide a qualitative understanding of the impacts of various dissolution approaches on the fidelity of analytical measurements, enabling increased interpretation of nuclear forensic analysis results. Disciplines which may advance the science for post-detonation nuclear forensics debris dissolution include but are not limited to radiochemistry, chemistry, chemical engineering, and instrument development.

Impact: The development of advanced post detonation forensics addresses DTRA's counter WMD need to enable prevention of future detonations, and improvement in response and recovery efforts. Such research has the potential to lead to a field deployable system with a real-time analysis capability.

Objective: This topic explores ways to dissolve post-detonation debris from a nuclear event using environmentally friendly, potentially field deployable, techniques on a reasonable time scale (<15 hour total dissolution time for a 5-10 gram sample), and/or a qualitative understanding of the impacts of various dissolution approaches on the fidelity of analytical. Specific interests include the investigation of non-hazardous chemical dissolution techniques, techniques mating fieldable instrumental dissolution assistance with chemical techniques, and an understanding of the fundamental phenomenology of such dissolution methodologies on the quality of forensic analytical measurements. Proposals that engage government laboratory institutions are also

encouraged. Research proposing direct ablation of surfaces into an analytical instrument (ex. LIBS) are not requested at this time.

Research areas may include but are not limited to the following areas:

- Organic methods to completely dissolve high-pressure, high-temperature, refractory debris with environmentally friendly chemicals (e.g. chemicals not requiring containment such as fume hoods, glove boxes, or inert environments)
- Inorganic methods to completely dissolve high-pressure, high-temperature, refractory debris with non-hazardous chemicals (e.g. chemicals not requiring containment such as fume hoods, glove boxes, or inert environments)
- Physically assisted methodologies for dissolving refractory debris such as microwave, sonic, or photon techniques

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PerD-YIP-Topic 1: Refractory Debris Dissolution Techniques for Nuclear Forensic Field Procedures (Thrust Area 1)

Average Award Amounts for PerD-YIP-Topic 1 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 1.

PerD-Topic 2: Photodetectors and Solid-State Neutron Sensors for Radiation Detection (Thrust Area 1)

Average Award Amounts for PerD-Topic 2:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $250,000 to $350,000 per year.

Award Structure for PerD-Topic 2:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Current radiation detection technologies suffer from setbacks generated by making tradeoffs for many desired features. Such tradeoffs are particularly evident in neutron detection and in the light collection stage of scintillation detectors. Tradeoffs include the following: high detector efficiency demands large area detectors with large power supply needs, good pulse shape discrimination from high radiation backgrounds may incur longer detection times, lightweight and low-cost detector designs generally yield high uncertainties from their poorly-resolved results. Furthermore, older technologies, such as photomultiplier tubes (PMTs) for light collection, remain the gold standard even though they are non-robust, have large associated monetary and power expenses, experience long response times, and may have relatively poor quantum efficiency ($\leq 25\%$).

Understanding the phenomenologies governing novel materials may expose new insights available for radiation-sensing materials and alternative sensing methodologies. For example, nanomaterials may have many exploitable advantages for neutron sensing applications: large surface area to volume ratio, variations in fundamental properties relative to its bulk material, and its potential for self-assembly.

As an example of areas that may be leveraged, the active field of solar cell technology development has the potential to enhance photodetection capabilities by increasing detection efficiency and accommodating flexible and scalable detector designs.

Impact: This topic is important to the counter-WMD mission of DTRA by transforming radiation detection technologies via the unique properties of novel materials which may yield increased sensitivity and specificity. Furthermore, it may enable the development of compact neutron sensors and photodetectors as replacements for older technologies (such as ^{3}He for neutron detection, and photomultiplier tubes for scintillator based detection of neutrons or gammas).

Objective: This topic seeks to surpass the present limitations of detection technologies by exploring novel methodologies and phenomenologies which may improve how neutrons or gamma rays are sensed and recognized from radiological and nuclear materials of interest. Please note that this topic is neither seeking to advance existing detectors nor to geometrically scale down current detection systems/methodologies. Additionally, materials exploring solid-state indirect conversion heterostructures for neutron sensing are not of interest at this time.

In general, neutron-sensing materials must aspire to include the following characteristics: fast response times, excellent neutron-gamma discrimination, non-toxicity, low noise, and an ability to perform neutron spectroscopy in high flux fields. In addition, photodetectors should have high quantum efficiencies in the wavelength region that is typical of current scintillators (near blue to deep ultraviolet).

Research areas exploring nanoscale or microscale materials and phenomenology may include but are not limited to the following areas:

- Investigation of new ecomimetic materials for photodetection
- Exploration of solid-state, direct conversion neutron sensors
- Photodetection techniques employing organic or polymer-based materials
- Current methodologies being investigated for solar cells, such as plasmonic nanostructures or Mott insulators

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PerD-YIP-Topic 2: Photodetectors and Solid-State Neutron Sensors for Radiation Detection (Thrust Area 1)

Average Award Amounts for PerD-YIP-Topic 2 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 2.

PerD-Topic 3: Sensing of Radiation Shielding Materials and Exploiting Interactions with Radiation from Radiological and Nuclear Sources (Thrust Area 1)

Average Award Amounts for PerD-Topic 3:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $250,000 to $350,000 per year.

Award Structure for PerD-Topic 3:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: The transportation of concealed special nuclear materials (SNM) most likely would be accompanied by sufficient quantities of radiographic shielding. Such shielding would unavoidably be heavy, composed of specific materials, and may be shaped within geometric constraints to be effective. Specific signatures will often accompany these shielding constraints. This topic is intended to identify and investigate novel signatures that would be unique to shielding materials which may then be used to indicate its presence.

Such signatures may be used to directly sense shielding materials and/or leverage interactions of radiological and nuclear (RN) material with common shielding materials. Many prior studies on similar materials have explored material response (e.g. mechanical) under neutron exposure for conditions relevant to fission and fusion reactor materials. Some of these studies explored bulk effects such as radiation embrittlement, swelling, and radiation creep on extended media at moderate to high temperatures.

The intent of this topic is not to investigate radiation interactions from RN materials with surrounding air or the specific RN material itself. Additionally, proposals outside the scope of basic research (i.e. device build) will not be considered. We are primarily focused on novel methods for direct identification of shielding materials. Specifically, we desire to better characterize radiation interactions from RN materials with potential shielding materials and identify how these resulting interactions might be exploited to reveal a unique signature that can be detected from a distance. Active probing methods that utilize particle radiation and hard photon (> warm x-rays) techniques are not of interest at this time.

Impact: This topic is intended to advance the science related to RN material detection by utilizing any surrounding shielding materials as an indicator of its presence. Currently available technologies present a new opportunity to identify signatures of shielding materials. The anticipated impact of this topic is to elucidate further understanding of novel signatures.

Objective: This research topic seeks basic research to significantly improve our understanding of identifying shielding materials. Collaboration across multiple disciplines is strongly encouraged in order to successfully confront some of the scientific challenges associated with this scale of work (e.g. atomic physics, materials science, radiation physics, remote sensing).

Research areas may include but are not limited to the following areas:

- Investigate accumulation of interfacial defects at high Z and low Z material boundaries
- Approaches for characterization of atoms or molecules to assist in the remote sensing of shielding materials
- Novel characterization of unique signatures of shielding materials (e.g. thermal effects on moderator materials)
- Novel sensing based on quantum properties or atomic interference to detect particles, electro-magnetic radiation, gravity, or motion (e.g. gravity gradiometry, mass tomography)
- Interactions and properties of quasiparticles and quantum condensates that can lead to sensing mechanisms
- Capitalize on high precision metrological techniques in microwave to UV frequencies to identify novel signatures (e.g. EUV acoustic nanometrology)

PerD-YIP-Topic 3: Sensing of Radiation Shielding Materials and Exploiting Interactions with Radiation from Radiological and Nuclear Sources (Thrust Area 1)

Average Award Amounts for PerD-YIP-Topic 3 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 3.

PerD-Topic 4: Development of Extremely Rapid Control Strategies for Mitigation of Cascading Failures on Multi-layer/Multi-dependent Dynamic Networks (Thrust Area 2)

Average Award Amounts for PerD-Topic 4:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerD-Topic 4:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: DTRA continues to reappraise the threat, its consequences, the best near term practices, and longer-term research needed for the preservation of essential military capabilities following an attack employing weapons of mass destruction (WMD). A low-cost observation and control methodology exploiting existing equipment has been an identified need since the Electromagnetic Pulse Task Force Report of 1984. Recent advances in network graph theory and the ability to rapidly observe the state of multiple interdependent military and national infrastructure networks, opens the possibility to now address this need and rapidly respond in a manner that will control/stabilize the complex system of networks against single or multiple cascades. Dependent (load), interdependent (load and control) networks, for both military (US and coalition) and national networks play a vital and complex role in this situation. WMD stressors to networks include widely distributed

failures of electronics from nuclear electromagnetic pulse or the long-term denial of network elements or segments due to WMD contamination from nuclear, biological, and chemical (NBC) material as well as direct physical damage.

Research involving single layer non-dynamic, low- or non-observable network strategies will not be considered. This effort is intended to answer questions such as:

- How do we effectively exploit existing control infrastructure to minimize/stop a cascade?
- What new procedures/controls are required to implement a sub-second control scenario?
- How to perform a sub-second network calculation after an event, combine that with pre-event planning calculations, and use that analysis to halt a cascade in progress?
- How to optimally island the damaged network in time to halt a cascade?
- How to perform all of these tasks with existing infrastructure (existing fiber optic lines and sensors judiciously placed in our networks) at very low cost?
- How to simulate this environment to answer these questions?

Impact: This research has the potential to minimize network outages, significantly reduce the area affected by a cascade, and advance the underlying methodology and theoretical understanding of methods necessary to improve multi-layer/multi-dependent network robustness, management and recovery, and resilience to cascading failures. This research will identify methods to use observable information from networks that are geographically spaced far apart in conjunction with novel pre-planned network analysis techniques for rapid determination of optimal network control to minimize the impact of WMD stressors on complex multi-layer networks. Such planning and control combined with new novel point protection of networks, has the potential to provide cost-effective solutions for EMP, reducing acquisition costs, and increasing WMD survivability and operability.

Objective: The main thrust of this topic is to extend prior network theory research to develop strategies to rapidly control the onset of pre-cascade behavior before the networks decay into full blown cascading failure. The emphasis is on sub-second response, coupled pre-planning and active rapid control strategies, and large realistic synthetic environments for prediction and control of the cascading failures that result from WMD attacks.

Research areas may include but are not limited to the following areas:

- Exploitation of currently available sensor information to observe the large geographical scale multi-layer/multi-dependent network state under a WMD attack so that observable data can be used as input for rapid real time network analysis.
- Sub-second network computations to enable decisions concerning real-time minimization of network instability.
- Novel advancements in extremely fast adaptive/computer relaying and other wide area measurement methods to rapidly reconfigure loads as appropriate to minimize the possibility of cascade in the system.
- Novel graph theoretical methods to incorporate distributed real time assessment of the network to be controlled.
- Theoretical understanding of novel point protection and other types of stabilization devices on overall network resilience/robustness. Analysis or development of individual point protection devices themselves is not included in the research areas, only how the fundamental network analysis changes in terms of reliability when networks of such devices are inserted into the networks under question.
- Optimal Rapid and Intelligent islanding/load shedding to limit the cascade affected area.

High value is placed on innovative approaches that have a high potential to yield low cost rapid solutions, can be easily tested physically, and can be inserted into real world large scale synthetic environments for analysis and simulation.

PerD-YIP-Topic 4: Development of Extremely Rapid Control Strategies for Mitigation of Cascading Failures on Multi-layer/Multi-dependent Dynamic Networks (Thrust Area 2)

Average Award Amounts for PerD-YIP-Topic 4 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 4.

PerD-Topic 5: Improved Semantic Analysis Theory to Identify WMD-Related Activities (Thrust Area 2)

Average Award Amounts for PerD-Topic 5:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerD-Topic 5:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: There is currently a failure in DTRAs ability to extract evidence of preparation of WMD attacks. 60% of events are missed or misclassified, however post hoc analysis indicates that evidence of these WMD events was usually manifest in reports and other communications that were available at the time. This evidence, for instances of WMD related activities, is buried in a sea of background data that is so vast that advanced machine reading capabilities are required. Often the individual pieces of WMD evidence are low observable and ambiguous. It is only when multiple pieces of evidence are collectively assessed, that detection can be made. This requires a high probability of detecting each piece of evidence, as small chances of failure compound exponentially when multiplied across the large number of necessary data. The WMD related evidence takes the form of extracted events. These events have a predicate-argument structure that provides the basis of meaning for a sentence. While these events are contained within sentences, there are limitations to understanding the events on the semantic level. Verb subcategorization, meaning components, selectional preferences, and semantic roles are poorly developed, and in some cases poorly understood. For example, ambiguous word senses and semantic roles are difficult to label. Furthermore, existing knowledge is distributed in diverse lexicographical resources, each having its own gaps. These limitations translate to the current limited ability to detect WMD related activity.

DTRA's unique operational demands push the envelope in this area. There is a strong need for extremely high detection (recall) of events in a computational demanding environment that has a high flow of information. The information is expressed in poor grammar, using diverse and irregular language which increases the demands on

the representations used. A primary driver to properly analyze events is to convert text to meaning, which depends on the semantic tools available (such as Wordnet, Verbnet, Framenet, etc.). To fulfill DTRA's operational requirements, work needs to be done to enhance lexicographic resources, build better ontologies, and develop methods that can automatically find semantic representations for words in their textural context.

Impact: This research will advance the theoretical understanding and methods necessary to improve an existing natural language processing. Specifically this research will directly improve lexicographic tools such as Verbnet, which is at the heart of DTRA's most important text analysis processes. It will also enable a new class of algorithms that will allow DTRA to move from the term level to the semantic level. Fundamentally it will enhance event analysis from its current unacceptable level of 40%. Improving this means improving detection of evidence relevant to WMD. Beyond text analysis, progress in representational learning will impact DTRA's pattern recognition systems across all types of data. In a broader sense, this research will enable many operational requirements that use text such as: information retrieval, question and answering systems, reasoning systems, machine translation and the semantic web and other semantically encoded applications.

Objective: The objective of this effort is to advance the fundamental understanding and discover improved methods to accurately analyze events. Proposed research may extend existing approaches, but preference will be given to developing innovative methods that mirror linguistic structures and lexicographic resources in new ways. The main thrust of this topic is to discover innovative and novel new automatic lexical acquisition approaches to improve semantic analysis on both lexical and predicate-argument structure levels. Areas of interest are:

1) Representation. Develop semantic representation schemes to unambiguously express meaning. For terms, example representations could include structures and components, for relative meaning example representations could include location or weights within some semantic space.

2) Identification. Develop automatic processing of corpora to identify both lexical semantics and semantic relationships involved in predicate-argument or some alternative to represent semantic structure for sentences.

3) Interpretation. Develop automatic processes to translate sentences to a form that provides semantic characterization. The process should take into account contextual cues.

These areas are not independent but build on each other.

Research areas may include but are not limited to the following areas (proposed research focused on discourse analysis and methods will not be considered):

- Develop novel new lexicographic resources to include both semantic and quantitative information suitable to enhance or supplement existing resources. Semantic information could include meaning components, subcategorization, selectional restrictions, and which alternations a term will participates in. Quantitative information would principally be probabilistic such as frequency of occurrence. Of principle interest is material that can continue to support development and use for new purposes such as an annotation bank.
- Contextual and distributional analysis to automatically extract semantic representation from corpora. Proposals should specify both the method to infer representation and also the representational basis (e.g. vector space, network, hierarchy). In addition to explaining the approach, proposals should provide the reason as to why the approach was chosen over other potential approaches. The emphasis of this topic is on the diversity and innovativeness of how semantic information is extracted with the goal to significantly reduce both false positive and false negative results. For example, paradigmatic as

well as syntagmatic features might be considered. More importantly how the representation reflects meaningful semantic structures in contrast to mere statistical correlations that have no linguistic basis.

- Novel development of representational learning (e.g. deep learning) to represent semantic features such as meaning components and selectional preferences. Also innovative developments of methods to encode and fuse contextual or syntactic information with semantic information are of interest. Development would include insights from comparison of methods, improving performance, and understanding best practices of using such methods. The model used to encode the information (e.g. vector space, hierarchy, network, etc.) should be justified. Of particular interest is: verb sub-categorization, semantic role labeling, meaning components, selectional preferences, or other forms of semantic representation of sentences.
- New methods to rapidly and accurately relate semantic findings to language processing such as word sense disambiguation, advanced generalization of semantic role labeling, and parsing informed by a semantic representation. This area should build on the foundation of the other three areas, and only enter in during later years.

PerD-YIP-Topic 5: Improved Semantic Analysis Theory to Identify WMD-Related Activities (Thrust Area 2)

Average Award Amounts for PerD-YIP-Topic 5 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 5.

PerD-Topic 6: Area of Responsibility Centric Cultural Modeling for WMD Threat Detection (Thrust Area 2)

Average Award Amounts for PerD-Topic 6:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerD-Topic 6:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: DTRA, in its role as a combat support agency, is consistently in contact with the Combatant Commanders to maintain awareness of their operational needs. Recently DTRA has received notification of Combatant Commander requirements for modeling support of radical ideation for course of action analysis. Though some current models exist, these models are largely generic, and are insufficiently validated on Area of Responsibility (AOR)-based populations of interest to the Combatant Commanders.

Social network and behavioral modeling research is critical to understanding and predicting the behavior of adversaries under a variety of situations. In particular, research in the social and behavioral sciences provides

insights into ways the threat of WMD attack may be reduced by addressing factors that lead individuals, groups, and states to entertain such attacks and provides tools and methodologies for inferring likely hostile intent or illicit activity through analysis of network interactions.

While analysts and subject matter experts involved in direct personal assessment of WMD threat can directly analyze subjects of interest using their heuristics derived from personal experience, the basic research aimed at quantifying and developing reusable tools routinely makes broad claims about human psychology and behavior based solely on samples drawn from a limited sample of test subjects (Arnett '08). Researchers assume that either there is little variation across human populations, or that these "standard subjects" are representative of all other populations. However, broad analysis has shown that members of different societies have substantially unique characteristics that cannot be derived from general analysis. These findings extend across manifold fundamental aspects of psychology, motivation, and behavior.

This is of great concern, as WMD threats are increasingly from non-state actors; with over one hundred different groups in the past two decades alone from a diverse range of backgrounds. Individual analyst analysis of all of these groups presents a strain on available resources, calling for the need for mathematical and computational models to assist. The findings of distinct regional and cultural differences at the most basic levels (cf. Hermann '08, Heinrich '10, Burke '10, Du '12) call into question the extensibility and basic appropriateness of existing generic models and inferences to the diverse populations across the varied AORs.

WMD related activity is difficult to detect because evidence tends to be low observable and ambiguous. As such, combinations of evidence including actor motivation and ideation are critical to the detection of WMD related activity. Social networks both relate evidence and demonstrate patterns that can expose activity long before the activity would be evident by other means.

To enhance and enable this early detection, and to support the Combatant Commander needs, basic models of human social influence and decision need to be validated on the variety of cultures across the AORs from which groups and individuals shown or suspected of using or pursuing WMD have originated, and where necessary, expanded to include the distinct cultural and regional characteristics that affect said use and pursuit.

Impact: The primary impact of this research will be the development of new capabilities for the Combatant Commanders, enabling them to accurately model radical ideation with their AORs.

This research will advance theoretical understanding and methods necessary to accurately model those cultures from which the majority of adversaries possessing or seeking WMD arise. This will enhance tools to identify those organizations and individuals who have intent to acquire, proliferate, and possibly use WMD, by accurately tailoring them to take into account the unique features that arise from within their cultures of origin.

These enhanced tools can be used as an aid to direct combat, intelligence, or diplomatic efforts to prevent said acquisition, proliferation, or use, which could save both resources as well as lives, by preventing WMD attacks.

Additionally, as network science is a broad and multi-disciplinary field, the methods developed under this effort will likely enhance other DTRA capabilities in Network Science.

Objective: There are two main objectives of this research program: 1) validate (or invalidate) current generic models for social networks or social influence with data derived from populations across the varied AOR of the Combatant Commanders, and 2) where these models are explicitly shown to be invalid, expand mathematical, statistical, and analytical techniques to understand and represent the specific cultural factors and behaviors of those populations.

Research proposals should cover one or more of the following areas:

- Culturally and Regionally Dependent Social Network topography and evolution whether of the network (social ties/link prediction) or of information and influence using the network as a medium, including simultaneous treatment of interactions between multiple groups or actors with distinct cultural or regional characteristics through multiplex networks, multigraphs or hypergraphs.
- Culturally and Regionally Specific Socio-cognitive models of radicalism or other extremist behavior that relate to the use or pursuit of weapons of mass destruction.
- Culturally and Regionally Specific Integration of operational and technical capacity with knowledge of motivation and intent without losing meaning.
- Culturally and Regionally Aware Computational algorithms and methods that allow for culturally dependent variable incorporation and validation, such as extensions of techniques for tree decomposition, graph spectral systems, block representations, and embedded geometries, for increased complexity and increased efficiency. Methods that help to analyze special networks such as weighted, directed, bipartite networks, or hypergraphs. Methods to compute network representations more efficiently or to use representations to visualize complex, large networks.

While it may be necessary to generate data sets in order to accomplish the above tasks, the generation of a data set itself is not sufficient for this research work and should not represent a primary goal. Additionally, our regions of interest do not include NORTHCOM AOR or the Western European component of EUCOMAOR, and research focusing on these areas will not be considered.

PerD-YIP-Topic 6: Area of Responsibility Centric Cultural Modeling for WMD Threat Detection (Thrust Area 2)

Average Award Amounts for PerD-YIP-Topic 6 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 6.

PerD-Topic 7: Interrogation of Mechanisms for Cellular Resistance to Radiation Damage using Melanized Fungi as Model Systems (Thrust Area 3)

Average Award Amounts for PerD-Topic 7:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerD-Topic 7:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options. Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Exposure to ionizing radiation like that associated with military operations in CBRN environments can cause deleterious biological effects and result in psychological impacts that degrade mission performance. The ever-present risk of a radiological or nuclear incident, whether intentional in the form of a malevolent act or unintentional as in the case of the recent Fukushima accident, highlights the need for development of better radiation-protective measures for the warfighter in order to reduce morbidity and mortality associated with ionizing radiation exposure:

> *"The proliferation of nuclear material and technology has made the acquisition and adversarial use of nuclear and radiological weapons more probable. Additionally, military personnel may be deployed to areas that could be radiologically contaminated because of the presence of radioactive materials and nuclear facilities."*
>
> *~ Treatment of Nuclear and Radiological Casualties. 2001. Armed Services Field Guide.*

Despite six decades of work, the search for the ideal protective agent has languished. Currently, the majority of countermeasures for ionizing radiation are designed to be administered post-exposure, when biological damage may have already occurred. Such treatments can produce undesirable side effects or require specialized treatment regimens thus are not suitable for use in operational settings. Development of prophylactic treatments that are: (i) safe, (ii) effective, and (iii) cost-effective for exposures unique to the warfighter are critical for the protection of personnel and for sustaining operations in radiation-contaminated environments. Achievement of counter-WMD missions requires fulfillment of both aims.

In recent years, research on some of the world's most radioresistant organisms has yielded important clues regarding mechanisms of damage due to radiation exposure and could lead to the development of next generation radioprotectants with unprecedented efficacy. For example, *Deinococcus radiodurans* (a.k.a., "Conan the Bacterium") is an extremely resilient strain of bacteria that can endure radiation levels 2,000 times higher than the lethal human dose. Early work on the bacterium focused on investigating DNA repair mechanisms, as the conventional paradigm suggested that DNA was the principle target of damage and arbiter of observed radiation toxicity. However, the studies revealed that there was nothing unusual about radiation-induced levels of DNA damage or mechanisms of repair in *D. radiodurans* as compared to more radiosensitive strains.

Newer data counter previously-held beliefs and suggest that protection of crucial DNA repair proteins is a key contributor to radioresistance. Research on other taxa (e.g., bdelloid rotifers) known to be radioresistant provides evidence to substantiate the claim. Moreover, studies on both prokaryotic and eukaryotic radiophiles (i.e., "radiation loving" organisms) indicate that cellular protection is likely reliant upon not just one but numerous mechanisms. The sum total of results implies that development of radiation countermeasures may be more appropriately directed toward the protection of multiple cellular targets as opposed to only DNA. Leveraging multiple mechanistic strategies to counter damage is a common tactic in the biological world, thus it is reasonable to suppose that useful countermeasures will require a combination of approaches in order to be effective.

The present topic focuses specifically on mechanisms of protection in melanized fungi. The photoprotective effects of melanins are well-documented and appear to be associated with enhanced ability to scavenge reactive oxygen species as well as to act as biological quenching agents capable of electron de-excitation. Melanized fungi were found recently in highly radioactive zones near the Chernobyl Nuclear Power Plant, leading scientists to postulate that melanins may also protect against higher energy (e.g., gamma) radiation. Further evidence for the potential role of melanin in radioprotection is the documented radioresistance of human melanoma, a malignancy of the melanocytes which produce melanin. However, the specific mechanism by which melanin may exert its protective effects or whether it is actually the primary contributor to radioresistance

has yet to be elucidated. Melanized fungi represent suitable model systems to interrogate the role of melanin as well as other intracellular components or pathways in radioprotection.

The proposed line of research is a natural outgrowth of two previous topics which sought to characterize radioresistance in bacterial and mammalian cell lines. Although resilience against high levels of exposure has been documented as a cross-domain phenomenon, it is not known whether mechanisms of protection are analogous or are wholly divergent depending upon the species. Understanding the suite of strategies for radioresistance will allow down-selection of mechanisms for further study in mammalian systems and could inform the development of combined approaches as referenced above.

Impact: Work conducted under the auspice of the present topic will allow identification of radioresistance pathways in lower organisms that could lead to the development of countermeasures compatible with human physiology. The proposed research is responsive to the National Military Strategy to Combat Weapons of Mass Destruction (2006) with regard to its dictum for minimizing WMD effects in order to sustain military operations in a "WMD environment" and to provide support for domestic authorities in the event of a WMD incident. Developing a greater understanding of the mechanisms contributing to cellular protection against IR exposure will provide insight for future research efforts designed to develop novel prophylaxes.

Objective: The proposed research seeks to identify and characterize mechanisms of radioresistance in melanized fungi. The most competitive responses will interrogate multiple mechanisms rather than focusing on a single process (e.g., ROS-scavenging by melanin) in order to develop holistic knowledge of cellular response to ionizing radiation. Whole genome sequencing of melanized fungi is not of specific interest for the present effort.

Research areas may include but are not limited to the following areas:

- Identify means by which the cells sense ionizing radiation and transform the signal into a recognizable input for responsive chemical species.
- Investigate the identity and nature of small intracellular chemical species (including organo-metallic complexes, co-factors, nucleotides, peptides, among others) known or believed to be radioprotective and development of a deeper understanding of the mechanism by which such species confer protection.
- Identify the necessary location of action for the chemical species at the subcellular level.
- Characterize the mechanisms and pathways activated following radiation exposure to gain a more global understanding of the components activated or up-regulated directly or via signaling cascades.
- Determine whether radioresistance mechanisms in fungi may be extrapolated to mammalian cell lines and whole animal systems.

PerD-YIP-Topic 7: Interrogation of Mechanisms for Cellular Resistance to Radiation Damage using Melanized Fungi as Model Systems (Thrust Area 3)

Average Award Amounts for PerD-YIP-Topic 7 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 7.

PerD-Topic 8: Basic Science of Radiation Effects in Micro/Nanoelectromechanical Systems MEMS/NEMS (Thrust Area 3)

Average Award Amounts for PerD-Topic 8:

- Single Scope Awards will average approximately $150,000 per year.

- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerD-Topic 8:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Mircoelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS) have seen rapid adoption in commercial products (e.g. cell phones and automobiles) primarily as sensors. Since MEMS offer considerable size and weight advantages over conventional devices, their incorporation into advanced commercial and military systems is expected to increase. Some MEMS devices have been incorporated into satellites or other space vehicles as primary or secondary sensors without any reported radiation effects problems. However, there has not been a systematic investigation of the effects of radiation on these systems.

There have also been significant developments in micro/nanoscale mechanical switches and logic gates in terms of size, speed, reliability, and power requirements. While these mechanical logic gates are unlikely to be able to compete with CMOS based logic in terms of speed and density, they are promising for low power applications and applications in extreme environments. The mechanical design is likely to be extremely resistant to radiation induced single event effects. The effect of total dose radiation effects is more uncertain and has not yet been investigated systematically.

Impact: Radiation insensitive MEMS/NEMS and mechanical logic devices will reduce the size, weight, and power requirements for military systems operating in extreme environments, especially extreme radiation environments.

Objective: Investigate the effects of radiation (gamma, x-ray, ion, neutron, and high energy electron) on MEMS/NEMS and mechanical logic devices. Of particular interest are advanced devices employing thin films, small feature sizes, novel designs, or other advanced technologies. The proposed research should focus on the fundamental physics of radiation effects as it applies to MEMS/NEMS or mechanical logic devices. Research that is primarily device development or fabrication is not of interest, nor is the test and evaluation of commercial devices. The proposed research should separate any radiation effects in the support electronics from radiation effects in the devices themselves.

Significant literature exists on the radiation effects in silicon microelectronics and proposed research should build on this existing knowledge base. Submissions that focus on specific applications (not the basic enabling science), applied configuration research, or systems engineering are discouraged. Prospective investigators are encouraged to collaborate with NASA, DoD, DOE and other federally sponsored and overseas facilities in order to facilitate transition of the research to be performed to practice.

References: Shea, Herbert R; Radiation Sensitivity of Microelectromechanical System Devices, *J. Micro/Nanolith. MEMS MOEMS*, 8(3), 031303, **2009**.

PerD-YIP-Topic 8: Basic Science of Radiation Effects in Micro/Nanoelectromechanical Systems MEMS/NEMS (Thrust Area 3)

Average Award Amounts for PerD-YIP-Topic 8 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 8.

PerD-Topic 9: Crustal-Earth Materials and Manufactured Materials under Dynamic Extremes (Thrust Area 4)

Average Award Amounts for PerD-Topic 9:

- Single Scope Awards will average approximately $100,000 to $150,000 per year.
- Multidisciplinary Awards will average approximately $150,000 to $300,000 per year.

Award Structure for PerD-Topic 9:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Offensive Counter-WMD operations currently rely on air-dropped ordnance that must penetrate or otherwise gain entry into WMD locations, which are frequently protected in underground or hardened storage facilities. Once the WMD target is reached, the weapon payload is detonated yielding a shock wave whose energy must couple with the WMD target to destroy it. Munitions in current inventory impact targets at velocities of ~300 m/s. Fragments driven by high explosives typically have initial velocities of 1,000-2,000 m/s. As a result, Counter-WMD events occur at high rates (10^2-10^6 s^{-1}) where physical changes can take place on nanosecond times scales. Penetration, gaining entry to the WMD target, and weapon-target interactions (WTI), necessarily involve a wide variety of highly-heterogeneous materials such as concrete, grout, breccia, sandstone, granite, schist, gneiss, or mixtures of these materials, etc., under high dynamic loading conditions.

WMD-defeating systems are designed by using engineering hydrocodes that simulate weapon effects and WTI. The hydrocodes can produce accurate simulations only if high-fidelity constitutive material models are incorporated. Predicting the penetration trajectory of a weapon in concrete and various crustal-earth or manufactured materials require damage analysis of the crushing and cracking of materials. The final WTI requires accurate energy dissipation and stress propagation within these materials. Accurate energy dissipation should incorporate local stress in mixed media, involving order-of-magnitude differences in local hardness or toughness.

Recent advances in studying material behavior under high dynamic loads, especially using synchrotron sources such as the Dynamic Compression Sector beam lines at the Advanced Photon Source of Argonne National Laboratory or proton radiography at the Los Alamos Neutron Science Center, have enabled near-real-time visualization of damage.

Basic research on dynamic effects on crustal-earth materials and manufactured materials will be transitioned through improvements to computational methods, potentially improving micro-scale methods, focused on meso-scale methods, and ultimately improving macro-scale continuum mechanics models (such as EPIC, FLEX, or LS-DYNA) or other (e.g., peridynamic) methods that can be used directly to study real-world weapons effects.

Impact: Accurate weapon simulations will allow intelligent design of improved capabilities to defeat WMD systems protected by hard and deeply buried targets (HDBT), and upgraded computational methods will allow more accurate engineering codes being integrated into weapon-effect decision-support tools, immensely improving HDBT attack and operational planning capabilities.

Objectives: This research topic seeks experimental and computational basic research to significantly improve our understanding of the effects of high-dynamic compression and tension on highly-heterogeneous crustal-earth and manufactured materials.

Research areas may include but are not limited to the following:

- Experimental dynamic studies, perhaps with near-real-time visualization of damage under high dynamic load, especially for detailed study of the penetration/cavity expansion physical process.
- Computational approaches for material damage modeling and prediction, at the micro-scale (pulverization of geo-materials around penetrator nose), the meso-scale (grain-boundary scale or pebble-scale in mixtures), and bridging to the continuum scale.
- Stochastic considerations to characterize weapon effects and WTI.
- Experimental or computational approaches to improve simulation of extremely high strain rate mechanics in pre-shocked/pre-stressed geo-materials, for enhanced understanding of multi-shock scenarios, such as penetration followed by detonation or penetration into already damaged materials.

PerD-YIP-Topic 9: Crustal-Earth Materials and Manufactured Materials under Dynamic Extremes (Thrust Area 4)

Average Award Amounts for PerD-YIP-Topic 9 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 9.

PerD-Topic 10: Energetic Materials for CWMD (Thrust Area 4)

Average Award Amounts for PerD-Topic 10:

- Single Scope Awards will average approximately $100,000 to $150,000 per year.
- Multidisciplinary Awards will average approximately $200,000 to $350,000 per year.

Award Structure for PerD-Topic 10:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.

- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: Counter-WMD operations in non-permissive environments currently rely largely on weapons with blast and fragmentation effects from standard energetic formulations to defeat WMD targets. Standard high-explosive formulations are insufficiently energy dense for penetration to, and destruction of, hard/ deeply buried targets. Further, when the targets contain chemical and/or biological agents, the use of such weapons can create unacceptable consequences by releasing hazardous chemical agent, or infectious biological agents into the environment with the explosively generated plume.

Therefore, this topic seeks energetic materials research which addresses one or both of the following needs:

- High-density energetic materials with fast energy release that exhibit significantly improved energy density over current energetics like CL-20, and that can survive weapon penetration, to maximize weapon energy on hard-or- deeply-buried WMD targets.
- Reactive materials that burn with high thermal output producing large amounts of WMD-defeating chemical products (for example, halogen-containing species) for WMD targets containing chemical-agent or biological-agents. Preferred solutions would destroy bulk agents stored in container(s), deactivate aerosolized agent within the immediate target area, and render useless any agent released with the plume. These materials should demonstrate capability for agent destruction orders-of-magnitude better than previously researched payloads, and/or provide more-than-stoichiometric neutralization (catalytic effects).

Once new materials are prepared and densities measured, they should be tested for sensitivity to air, water, and other environment factors, and for sensitivity to ignition or initiation. If the materials appear usable, and can be prepared in sufficient quantities, applicants should plan to collaborate with DoD labs for testing and evaluation of materials for WMD defeat application.

Impact: The success of this research would provide technological capabilities that will put adversarial WMD at risk, whether they are hard/deeply-buried targets or soft targets. Novel high-energy-density materials will enhance the ability of the DoD to defeat these targets with smaller/lighter/more versatile weapon systems, while agent-defeat materials will neutralize chemical and biological agent within the target and eliminate collateral damage that could result from a post-strike infectious/toxic plume.

Objectives: This research topic seeks new energetic materials with high energy density and fast energy release to significantly improve conventional weapons lethality; or reactive materials that produce persistent (milliseconds to seconds) high temperatures (1000ºC or above) and employ chemical kill mechanisms to significantly improve chemical-agent and biological-agent defeat capabilities.

Research areas may include but are not limited to the following areas:

- Materials that combine the exothermic nature of inter-metallic reactions with gas-producing oxidizing constituents that can break up the oxide shell formed
- Conglomerations of metal and energetic materials using supra-molecular chemical techniques, including co-crystallization, frame working, self-assembly, etc., resulting in an entire formulation in one material
- Metal-Inorganic-organic materials that deflagrate at high temperature and produce chemicals that decompose chemical agents or destroy bio agents

- Novel shock- or detonation-focusing techniques (not shaped charges) to achieve greatly enhanced shock damage to WMD storage, production or distribution facilities
- Other innovative, non-traditional materials and approaches for achieving high-energy-density and/or agent-defeat purposes
- Demonstration of the effect of these materials, including testing and evaluation of high-energy density materials or agent-defeat materials

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PerD-YIP-Topic 10: Energetic Materials for CWMD (Thrust Area 4)

Average Award Amounts for PerD-YIP-Topic 10 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 10.

PerD-Topic 11: Smart Materials with Unconventional Indicators for Facility Access Denial and Security of WMD Materials (Thrust Area 5)

Average Award Amounts for PerD-Topic 11:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerD-Topic 11:

- Will predominately be for a base period of three (3) years with up to two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Pre-application white papers and proposals that outline scope and effort for different base period and option combinations may also be considered. See Section II.1.1 for details on the possible structure of awards under this BAA.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: The purpose of this topic is to identify, investigate, and research innovative scientific solutions that can physically deny entry/exit or operational use of facilities that support the production, storage, and/or employment of Weapons of Mass Destruction (WMD) materials (i.e., Chemical, Biological, Radiological, Nuclear). These types of solutions are necessary to secure hazardous materials and equipment used to employ them before operations teams can arrive on site. Such access denial scenarios may be warranted to reduce illegal proliferation, control sensitive sites, and/or protect civilian populations. The desired period of denial effects may range from > 1 day to weeks which can be influenced by operational environments, mission scenarios, security personnel limitations, etc.

The focus of this effort will be on those sites in which friendly ground forces have limited or no direct access to either the entrances or mission space. This is different from the concept of access control which entails the controlled passage of personnel and equipment into and within a building or structure. Current physical security uses multiple methods to control or deny access to sites, installations, equipment, and materials. This can involve such means as barriers, locks, seals to provide evidence, and access control or alarm. Access control technologies often involve biometrics, such as iris scanners or fingerprint readers, card readers for access control, or closed circuit TVs and alarm systems with reach back connectivity to security forces. Basic research

can provide significantly improved methods that simultaneously address detection, control/denial, and containment of WMD materials and facilities.

Emerging science areas provide opportunity to address these needs. Polymer science, for example, can be enabled by nanoscale smart materials with material structures tailored to a particular function. For example, reconfigurable materials that act in response to stimuli can provide means to contain WMD facility ingress/egress points. Smart material may exhibit a structural change that allows it to follow the movement of the WMD, and progressively seal the areas where a material of interest is detected. Novel sensing mechanisms can be created to drive such a response. In addition, such unconventional indicators (unlike traditional detector system) can be readily deployed over an area or at a perimeter to control/deny access to add further uses for such scientific developments.

Impact: This topic is important to the counter-WMD mission of DTRA by addressing the operational need of rapidly securing WMD materials in time-sensitive denied areas. Such basic science could support access denial technology that secures the WMD from a standoff distance until proper security could arrive. Such a capability will give the warfighter a far greater capability to hold at risk WMD without fear of releasing WMD materials.

Objective: We seek unconventional indicators in combination with new smart materials to advance methods to detect, characterize, and control/deny WMD and WMD-materials. The combination should detect and characterize the presence of WMD or related activities, then respond to said presence in such a way that prevents it from spreading and controls access in WMD environments.

Research areas may include but are not limited to the following areas:

- Exploration of novel materials (e.g. biomimetic) to seal, encapsulate, or contain WMD vapors or other materials of interest; e.g., which will provide controls to section off vents, doors, or portal entrances to WMD
- Investigation of additional morphing materials (e.g., reconfigurable materials- shape memory, polymer chemistry, colloidal changes, functional nanostuctures, other mechanisms in rheology, programmable matter, nanoenergetics) that provide potential for forming expandable, thin membranes or other forms to aid containment including degradation of vital WMD components/equipment or interference with WMD transportation modalities
- Additional understanding of the properties of materials and cues from embedded sensors that enable material flow in response to where WMD presence is tracked to support containment
- Unconventional indicators of chemical/biological analytes to provide warning of intrusions or presence/movement of WMD, CW/BW precursors, or related equipment of interest
- Additional unconventional indicators (i.e., novel ways to measure or sense observables) of CBRNE presence or movement including sensing of environmental disturbances indicating movement or WMD activities

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PerD-YIP-Topic 11: Smart Materials with Unconventional Indicators for Facility Access Denial and Security of WMD Materials (Thrust Area 5)

Average Award Amounts for PerD-YIP-Topic 11 will be approximately $100,000 per year.

For topic description and award structure see PerD-Topic 11.

JSTO-CBD Basic Research Needs

The Chemical / Biological Technologies Department basic research program targets strategic, mission-focused basic research investments with high potential impact for the US Chemical and Biological Defense Program (CBDP). Chem-Bio Basic Research is seeking new and innovative proposals for fundamental research in the following topics:

PerD-Topic 12: Fundamental Understanding of in vitro Glycosylation: Methods, Stability, Immunogenicity, and Efficacy of Therapeutic Glycoproteins (Thrust Area 3)

Average Award Amounts for PerD-Topic 12:

- Single Scope Awards may be up to $500,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.
- Multidisciplinary Awards may be up to $1,000,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

Award Structure for PerD-Topic 12:

- Will be for a base period of two (2) years with up to three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: The goal of this basic research effort is to 1) explore the fundamental processes of glycosylation, an enzymatic process by which lipids, proteins, and other organic molecules are decorated with varying patterns of glycans depending on the host cell, and 2) recapitulate glycan modulation using *in vitro* approaches. As pharmaceutical glycoproteins are growing in the market, ensuring human-like patterns is becoming more critical in order to control immunogenicity, efficacy and stability of the protein.

Glycosylation provides the chemical basis by which a variety of structural and functional roles of membrane and secreted proteins are mediated. The patterns of glycosylation vary and are generally specific to the type of cell that is expressing them. Co- and post-translational glycosylation of proteins occurs within a cell through complex biochemical pathways and the subtleties of these modifications have fundamental implications for recombinant, protein based pharmaceuticals. In particular, administration of a protein produced through heterologous expression, and therefore with a foreign glycosylation pattern, may cause a reduction in efficacy, undesired immunogenicity reactions to some glycans (specifically Neu5Gc and α-Gal) and reduced stability both in terms of formulation and *in vivo* PK/PD. Converting the glycans to a more desired structure (i.e. more human-like N-glycans with terminal monosaccharide, sialic acid, Neu5Ac) may require the removal of some monosaccharaides and the addition of others. Neither re-engineering the glycosylation machinery *in vivo* or modifying glycosylation decorations *in vitro* are trivial matters. Typically in pharmaceutical development, the effect of glycan patterns on a protein is addressed on a case by case basis with each protein being brought forth in development, rather than developing an entire downstream process that can specifically address glycan patterns to optimize pharmaceutical development. Understanding processes which can control sialic acid addition and remove other immunogenic monosaccharides is crucial for the development of glycoproteins for medical countermeasures.

This topic will contribute to the fundamental knowledge of how specific glycan structures can control recombinant therapeutic glycoproteins' efficacy, stability and immunogenicity. In addition, this topic will explore *in vitro* methodology (either biologically or chemically) to add or remove glycan sugars to a protein which will ultimately will lead to approaches which can alter and optimize an individual protein's glycan structure.

Objectives: Proposals are invited that explore human glycan patterns and develop *in vitro* platforms that can modulate recombinant protein glycan structures from any expression system**.** It is preferred that applicants work with model proteins, as a proof of concept, that have prophylactic or therapeutic benefit to the chemical and biological defense medical countermeasures portfolio. Although there have been efforts to engineer human-like post-translational modifications into various expression hosts, these processes involve complex strain engineering and would need to be optimized for each expression host. *In vitro* methods to redecorate recombinant proteins with human-like glycosylation patterns may enable modification of any expressed protein, regardless of the host expression system. To facilitate the development of such *in vitro* methods and to simplify the process by which they may be accomplished, an understanding of how specific glycan moieties can be recapitulated "on-demand" outside of the cell is essential. This knowledge will result in the identification of specific and desired glycosylation reactions that may facilitate the development of processes to modify existing glycosylation patterns *de novo* with precision, in a manner that is easier and less expensive to achieve while ensuring desirable pharmaceutical behavior. This basic research topic is therefore not seeking proposals that involve strain or organism engineering of glycosylation pathways or reengineering of protein sequence to add or remove locations of glycan addition. In addition, work focusing on the addition of non-natural moieties (polymers, other sugars, etc.) not typically found on glycan structures is also outside the scope of this topic. Instead, work proposed should lead to more efficient *in vitro* processes for glycan redecoration and should be compatible with scalable processes.

Research of interest may include but is not limited to the following areas:

- Exploring the role of glycosylation in general and specifically, sialylation, in fundamental biological processes (efficacy, stability, immunogenicity).
  - Understanding the effect of heterogeneity in glycans that could affect process consistency in developing a pharmaceutical.
  - Understanding the needed pathway (e.g. specific genes and possibly sugar precursors) for glycan modulation so that the mechanism of action can be recapitulated *in vitro*.
- Develop *in vitro* methodology for homogenous control of glycans on glycoproteins to any expressed protein. This includes either removing sugars that are antigenic to humans or would not allow appropriate step-wise addition of human specific carbohydrates and processes to add specific sugars. In addition, these processes should be amenable to various types of expressed proteins and agnostic to host expression system (yeast, plant, insect cell, etc.).
  - Develop stepwise approaches for glycan addition using either enzymes to recapitulate biochemical glycan pathways, or use of chemicals or other abiotic methods for glycan redecoration.
  - Work may also include development of more efficient biochemical pathways (e.g. fewer steps or new enzymes) than that found in nature.

PerD-Topic 13: Predictive Understanding of the Blood-Brain Barrier in Threat Environments (Thrust Area 3)

Average Award Amounts for PerD-Topic 13:

- Single Scope Awards may be up to $500,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

- Multidisciplinary Awards may be up to $1,000,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

Award Structure for PerD-Topic 13:

- Will be for a base period of two (2) years with up to three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: The goal of this topic is to improve predictive understanding of the blood-brain barrier in certain environments relevant to chemical and biological threats, in order to enable both the development of medical countermeasures that are available within the central nervous system and also improved hazard analysis. The blood-brain barrier (BBB), formed by brain microvascular endothelial cells, is a functional and structural barrier that partitions the brain from the intravascular component, regulating the exchange of substances and cells between the brain and blood, and maintaining homeostasis in the central nervous system. This barrier facilitates the uptake of required substances (ions, amino acids, glucose, *etc*.) to meet the brain's high nutrient demands and also serves to protect the brain from toxicological and pathological insults. Entry of insults such as certain alphaviruses and nerve agents into the central nervous system (CNS), and their actions once present there, are critical facets of their mechanistic toxicology. Recent investigations have revealed new aspects of such CNS intrusion. For example, one recent study suggests that "scout" units of Venezuelan equine encephalitis virus may initially infiltrate the CNS through the olfactory pathways, where they initiate viral replication in the brain and induce increased permeability of the BBB, allowing ingress of a second wave of invading virus. [1]Transport across the BBB by P-glycoproteins has been revealed as an important factor in the activity of and resistance to organophosphate pesticides within certain insect populations, [2]and transient modulation of the blood-brain barrier tight junction and receptor potential channel gene expression appears to also play a fundamental role in the mechanistic neurotoxicity. [3]A complete understanding is also lacking of the neuroimmune crosstalk at the BBB, including communication between BBB astrocytes and the molecular effectors of activated immune cells, which is seen as potentially critical in dysregulation of endothelial signaling pathways and BBB destabilization resulting in brain inflammation.[4,5] Physical modulation of the BBB, including local electrical and mechanical changes that are coupled with molecular phenomena, appears to be an important underlying aspect which does not always result in permanent damage to the BBB.[6,7] Developing an improved, validated and predictive understanding of the BBB, its multimodal regulation, and its ability to selectively ingress particular highly polar or large molecules, is critical in the development of medical countermeasures that are available to the CNS.[8,9]

Impact: Establishing improved predictive understanding of the modulation of the BBB by viral and molecular penetrants, as well as correlated physical response modes, will enable both improved predictive toxicology of high priority threats and design of vastly improved strategies to CNS-available medical countermeasures. This will result in improved ability to analyze risk and protect civilians and warfighters from a range of neuro-damaging infectious diseases and molecular toxicants.

Objective: Acquire improved fundamental understanding, as demonstrated in part by substantially improved validated predictive capability of *in silico* models, of the mechanisms of interaction of the BBB with alphaviruses, pesticides, or highly polar molecules (*e.g.*, oximes, hydroxamates).

Development of such understanding may rely upon research activities such as the following:

- Elucidation of mechanisms of transport through the BBB, together with correlated modulation of neurochemistry and neurophysiology. This may include exploration of differential gene expression of

cells involved in transport, efflux, and those physicochemical or cellular mechanisms (*e.g.*, inflammation) that allow increased molecular and viral penetration. Identification of target pathways that may be modulated to allow increased permeability, including the time-dependent response of such pathways and relevant interactions with CNS cells.

- Development of *in silico* models with *in vitro* validation that accurately mimic mechanisms of transport across the human BBB and that predict relationships among permeability, active transport, molecular structure and dynamics, together with relevant systemic and environmental factors.
- Development and application of dynamic quantitative chemical imaging or non-invasive tracking methods that can probe local mechanistic phenomena determining molecular and viral distribution and penetration across the BBB, with minimal perturbation to the local environment.

References:

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2. T. D. Anderson, "Mosquito P-glycoproteins and their emerging role in insectide resistance," *244th ACS National Meeting & Exposition, Philadelphia, PA*, **2012**, AGRO-122.
3. W. Li, M. Ehrich, "Transient alterations of the blood-brain barrier tight junction and receptor potential channel gene expression by chlorpyrifos," *J. Appl. Toxicology* 33, **2013**, 1187-1191. doi:10.1002/jat.2762.
4. N. J. Abbott, L. Ronnback, E. Hansson, "Astrocyte-endothelial interactions at the blood-brain barrier," *Nat. Rev. Neurosci.* 7, **2006**, 41-53. doi:10.1038/nrn1824.
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6. K. Benson, S. Cramer, H.-J. Galla, "Impedance-based cell monitoring**:** barrier properties and beyond," *Fluids and Barriers of the CNS* 10, **2013**, 5.
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8. I. F. Martins, A. L. Teixeira, L. Pinheiro, A. O. Falcao, "A Bayesian Approach to *in Silico* Blood-Brain Barrier Penetration Modeling," *J. Chem. Inf. Model* 52, **2012**, 1686-1697. doi:10/1021/ci300124c
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PerD-Topic 14: Bio-inspired Catalytic and Binding/Reporting Systems for Chemical/Biological Defense (CBD) (Thrust Area 3)

Average Award Amounts for PerD-Topic 14:

- Single Scope Awards may be up to $500,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.
- Multidisciplinary Awards may be up to $1,000,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

Award Structure for PerD-Topic 14:

- Will be for a base period of two (2) years with up to three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Goal: Knowledge for reliable and predictive capabilities to create custom-made catalytic and binding systems on demand (CBSOD) for CBD

- Discover components of catalytic mechanisms and their synergistic combinations to develop knowledge-based design rules for effective custom-made bio- (e.g. enzymatic, cellular) and abiotic catalytic systems

- Develop design rules for custom binding and reporting systems for CBDP using computational design and/or combinatorial approaches

Background: Robust functional systems have the potential to dramatically impact our ability to counter CB threats. For example, current technologies rely on stoichiometric chemistry for destruction of bulk chemical agent, which is the current DTRA focus, requiring large quantities of reactants, often used in great excess, as well as byproducts that are produced via neutralization. The practice has been limited to the development of large-scale reactor systems requiring transfer of agent from storage containers and/or within munitions. Development of effective catalytic system would significantly improve the process, *inter alia*, enabling novel *in situ* methods, which would be most desirable. However, the usefulness of approaches employing traditional biomolecules for CBD needs is complicated by their efficacy, fragility, cost, and production. Furthermore, the scope of their utility is restricted due to their restricted solvent compatibility and their specificity. The alternatives, such as optimizing the performance of biomolecules or development and production of efficient, rugged, and inexpensive synthetic substitutes are hindered by the lack of sufficient understanding of their functional mechanisms. Therefore, greater fundamental underpinnings are needed to enable the development of more robust, high-efficacy, and much cheaper bio-systems, as well as, abiotic, and hybrid substitutes.

Impact: The research under this topic would enable the design and production of efficient, rugged, and inexpensive functional materials for effective physical and medical countermeasures against chemical/biological warfare agents (CBWA). Specifically, developing design rules for more robust and efficacious bio- and abiotic materials should have a significant impact on developing effective countermeasures against both current and emerging CB threats for their decontamination/destruction, detection/analysis and prophylaxes/therapeutics.

Objective: The objective of this research topic is to develop fundamental knowledge for reliable and predictive capabilities to model and construct highly efficient, rugged, and inexpensive synthetic functional materials (e.g., binding and reporting systems, catalytic systems). The topic addresses the following: 1) understanding the mechanisms of the high efficiency phenomena of bio-systems; 2) using the acquired knowledge to design and construct more robust and efficient functional mimics; and 3) identifying new mechanisms that go beyond biomimetics for highly efficient synthetic substitutes. The ultimate goal is to develop reliable capabilities to predict functional efficiency of synthetic mimics and model highly efficient functional molecules.

Research areas may include but are not limited to the following areas:

- Designed biomaterials: understanding, design, and synthesis of more robust biomaterials with enhanced functionality
  - Enzymes
  - Enhancing biological material properties (e.g., ruggedness)
  - Engineered microbes
- Biomimetics and beyond
  - Enzyme mimics
  - Nucleic acid mimics

Highest consideration will be given to proposals that combine theory/heuristics and experimental verification with iterative (spiral) approaches to understand the underlying structure-activity relationships. The goal of this research topic is to provide improved fundamental understanding of functionalities in support of the development of a new generation of multifunctional materials that would allow warfighter to address the challenges posed by the current and evolving CB threats.

PerD-Topic 15: Ambient Surface Chemistry of Chemical Warfare Agent (CWAs) Air Purification Filtration Materials (Thrust Area 3)

Average Award Amounts for PerD-Topic 15:

- Single Scope Awards may be up to $500,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.
- Multidisciplinary Awards may be up to $1,000,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

Award Structure for PerD-Topic 15:

- Will be for a base period of two (2) years with up to three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Background: DTRA aims to establish a molecular level understanding of the effect of ambient compounds (including environmental and battlefield contaminants) on the surface structure, chemistry, and stability of chemical warfare agent (CWA) filtration/destruction materials under operational conditions, and use this information to guide new materials strategies for CWA filtration and decomposition.

DTRA is very interested in the detection, protection, decontamination and destruction of CWAs in order to protect personnel and retain the utility of materiel assets. Often, the first line of defense is in the form of filtration materials, which provide protection through sorption and catalytic decomposition of CWAs. Critical for the function of filtration materials is their surface area, composition and chemical reactivity. Current, and promising, filtration materials include activated carbons impregnated with active Zn and Cu catalysts; metal oxides, such as $Zr(OH)_4$, TiO_2, Al_2O_3, etc.; and polyoxometallates (POMs) — metal organic frameworks (MOFs).

When designing filtration material surfaces, we often think of them as retaining their idealized structure and composition. Yet, the ideal surfaces couldn't be further from reality, especially since they are constantly exposed to large dynamic fluxes of a variety of ambient compounds, including oxygen, water vapor and environmental pollutants, such as nitrogen oxides, sulfur dioxide, ozone, organic acids, and polyaromatic hydrocarbons, all of which drive changes in the surface structure, composition and chemistry of the filtration material.

Current experimental capabilities are ripe for developing a molecular level understanding of the effect of ambient gases and conditions on the long term stability or degradation of the filtration materials as well as the effect of interferent ambient gases on the adsorption and surface decomposition chemistry of CWAs. In recent years, linear and non-linear optical spectroscopies, and optical and scanning probe microscopies have permitted spatially and structurally resolved chemical and mechanistic maps of surface chemistries under realistic ambient conditions. Likewise, advances in ambient pressure photoelectron spectroscopy (APPES), otherwise known as ambient pressure XPS, as well as x-ray absorption spectroscopy (XAS), and X-ray emission (XES), have enabled the application of electron-based surface-sensitive element-specific spectroscopies that can elucidate the chemical state of the surface species *under realistic atmospheric conditions*. This has led to a better understanding of surface reactions of pollutants on airborne environmental catalytic materials, such as ice particles, aerosolized salt, soot nanoparticles, and mineral dust. For instance, using APPES, it was found that minor constituents of sea salt particles (e.g., Br-) segregate to the surface of the particles in the presence of atmospheric water and are very important to subsequent heterogeneous chemistry. It also was used to

demonstrate the role of O_2 pressure on the surface-to-bulk oxide transition of a metal nanoparticle, resulting in a gas pressure dependent phase diagram for the surface structure. Finally, APPES also has enabled the interrogation of surface structure during a catalytic reaction, revealing Rh or Pd preferentially segregate to the surface of a $Rh_{0.5}Pd_{0.5}$ catalytic nanoparticle depending on the composition *and pressure* of the surrounding gas.

Consequently, DTRA aims to capitalize on recent advances in ambient pressure surface analysis methods to establish a fundamental molecular understanding of the competitive and/or synergistic adsorption and reactivity of ambient gases (including environmental and battlefield contaminants) with chemical warfare agents and their surrogates on the surface structure and chemistry of air filtration materials under operational conditions. Initially, it is expected that the work will provide atomic and molecular-level insight into the stability and degradation of air filtration materials, and the chemistry of CWA decomposition under realistic conditions. Depending on the outcome of the initial studies, it is anticipated that the findings will guide new materials strategies for CWA filtration and decomposition and may lead to a broader understanding of the surface chemistry of protective coatings, fabrics, and sensors.

Objective: The goal of this research topic is to provide improved fundamental understanding of environmental surface reaction and decontamination processes that would allow warfighters to address the challenges posed by the current and evolving CWA threats. Thus, DTRA aims to establish and understand the effect of ambient compounds (including environmental and battlefield contaminants) on the surface structure, chemistry, and stability of CWA filtration/destruction materials under operational conditions, and to use this information to guide new materials strategies for CWA filtration and decomposition. This research topic will employ ambient surface analytical methods for understanding, *in situ* and *in operando*, surface reaction mechanisms of adsorption, and/or decomposition of chemical warfare agents, or their surrogates, on agent filtration materials and destruction catalysts. There is particular interest in understanding the influence of the ambient atmosphere, especially water vapor as a function of relative humidity, as well as atmospheric contaminants on the surface structure and chemistry of activated carbon materials that have been impregnated with Zn and Cu catalysts, as well as metal oxide filtration materials. Examples of CWA simulant systems of interest include – but are not limited to – the following: catalytic oxidation of gaseous sulfur mustard simulant (2-chloroethyle-thylsulfide (CEES)) in the presence of H_2O, NO_x, SO_x, and/or diesel fuel vapor; catalytic hydrolysis of di-isopropyl fluorophosphonate (DFP) in the presence of dimethyl methylphosphonate (DMMP) and/or of H_2O, NO_x, SO_x. In developing an understanding of the reaction mechanisms, the factors which influence enhancement/ degradation of competitive binding or turnover should be elucidated. Highest consideration will be given to proposals that combine theory and experiment.

PerD-Topic 16: Gene Amplification and Overexpression: Novel Mechanisms of Multidrug Resistance (MDR) Phenotypes (Thrust Area 3)

Average Award Amounts for PerD-Topic 16:

- Single Scope Awards may be up to $500,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.
- Multidisciplinary Awards may be up to $1,000,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

Award Structure for PerD-Topic 16:

- Will be for a base period of two (2) years with up to three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.

- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Goal: This effort should yield new knowledge leading to a basis for revolutionary approaches to diagnose and treat MDR infection. Fundamental research in this area may lead to significant improvement over existing diagnostic and therapeutic approaches to MDR infections.

Background: New antimicrobial resistance (AMR) of infectious diseases have proliferated in the past 20 years and continue to grow in the absence of novel diagnostic capabilities used to identify AMR pathogens. This emerging threat is both a public health problem and a concern for the US military. Specifically, AMR pathogens affect both combat readiness due to outbreaks among military recruits and the recovery and survival of soldiers following combat. With the spread of resistance mechanisms to more organisms, the public health impact of antibiotic resistant pathogens and associated costs could increase significantly in this decade. The list of bacteria resistant to antibiotics continues to grow to include New Delhi metallo-beta-lactamase-1 and methicillin resistant *Staphylococcus aureus* (MRSA), while old threats such as tuberculosis have reemerged; thus this AMR maybe considered a prototypical emerging threat.

Recently a novel mechanism of AMR was identified wherein the overexpression of proteins, such as efflux pumps and transporters, enable and enhance bacterial survival in the presence of anti-microbial compounds. This can be via direct gene amplification (i.e. multiple copies of an AMR gene) or increased transcription of existing AMR genes (Sandegren and Andersson, 2009, Nature Rev Micro 7: 578-88; Soo *et al.*, 2011, PNAS 108(4): 1484-9); in these cases, there is a direct correlation between increased gene expression and increased AMR. The gene amplification/dosage effect is a new, and poorly understood, mechanism of AMR and warrants further basic research. A separate paper (Barczak et al PNAS **2, 2012,)** demonstrated that after a brief antibiotic pulse, the behavior of a small set of bacterial transcripts can rapidly differentiate drug-susceptible and -resistant organisms and that these measurements can be made directly from clinical materials. This molecular approach is both novel and supported by limited data that demonstrates potential conservation across all types of AMR. Mechanistic elucidation and identification of (genomic, transcriptomic, and/or proteomic) novel biomarkers of AMR-associated gene amplification and overexpression are needed by the CBDP.

Impact: Significant improvement over existing diagnostic and therapeutic approaches to MDR infections. Accomplished through elucidation of mechanisms and identification of biomarkers of AMR to potentially include gene amplification, overexpression, or other alternative novel mechanisms. Further, these novel biomarkers for AMR identification and detection will feed a biosurveillance picture of emerging AMR pathogens and patterns of resistance.

Objective: This effort should yield knowledge leading to a basis for revolutionary approaches to diagnose and treat MDR infection. The objectives of this topic are to conduct theoretical and experimental research to further the fundamental understanding of novel biomarkers of gene amplification and overexpression derived AMR. The emphasis will be on the basic mechanisms of AMR derived from gene amplification and overexpression, identification of markers, and development of tools and methods for mechanistic analysis of gene amplification. Due to inherent cell population variability, the use of single-cell proteomics, transcriptomics and genomics tools to develop a coherent understanding of the mechanisms of recently discovered bacterial gene amplification/dosage effects can result in AMR are encouraged.

The bacterial gene amplification/over-expression resistance effect should address the following:

- Demonstration of one or more novel mechanisms for inducing AMR (e.g. catalytic substrate- binding specificity change)
- Demonstration that mechanism of AMR is induced upon exposure to antimicrobial compounds

- Demonstration of quantitative or threshold effects that may be leveraged to estimate MIC of antibiotics
- Determination if gene amplification is associated with point mutations
- Determination if gene amplification is linked to horizontal transfer or if it creates susceptibility to horizontally transferred plasmids
- Demonstration of housekeeping genes that are up-regulated/down-regulated
- Demonstration of host miRNA changes, that may indicate presence of AMR or MDR infection involvement
- Demonstrate if over-expressed proteins are preferentially modified to incur MDR behavior
- Demonstration that this mechanism may be able to confer not only AMR, but also MDR phenotype (i.e. could this be a broad protective mechanism).

PerD-Topic 17: WMD Signal Transducer Toolkit for Synthetic Biology Applications (Thrust Area 3)

Average Award Amounts for PerD-Topic 17:

- Single Scope Awards may be up to $500,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.
- Multidisciplinary Awards may be up to $1,000,000 per year. Further guidance on scope and cost will be provided in each full proposal invitation.

Award Structure for PerD-Topic 17:

- Will be for a base period of two (2) years with up to three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable.
- Note that pre-application white papers and proposals that outline scope and effort that exceed a total of five (5) years will not be considered.

Goal: To gain the necessary understanding and explore novel approaches to develop a toolkit for use in synthetic biology applications. This topic would enable the development of a suite of protein receptors that respond to nerve agents by acting as signal transducers for biological systems. The engineered protein receptors would be able to bind the nerve agent and initiate a cascade that produces some observable signature or other desired response from the biological system.

Background: Biological systems represent an attractive alternative for many technology solutions. Logistically, biological systems are highly scalable, require no external power source and may require no maintenance. Functionally, they can process information, manufacture highly complex molecules and respond to external stimuli. These naturally evolved abilities are now being engineered for many applications.

For sensing applications, an environmental stimulus is identified and triggers a response from the biological system. The molecules that typically act as signal transducers are receptor proteins that bind a target analyte and then stimulate the expression of a reporter gene or larger genetic network. However, receptors that can transduce a signal in response to weapons of mass destruction (WMD) are not widely available. This void creates a bottleneck in applying these newly engineered organisms to defense applications.

Impact: By creating a class of protein receptors that initiate signal cascades upon recognition or binding of a WMD threat, the functionality of engineered biological systems can be harnessed immediately.

Objective: This topic is to develop the knowledge base and potential new approaches to establish a suite of biological transducers, or proteins that bind an analyte and initiate a response cascade, that are specific to chemical weapon nerve agent targets. Potential transducers might include but are not limited to, periplasmic-binding proteins, extracellular receptors and DNA-binding proteins. Proposals must justify the chosen model organism and its potential utility for synthetic biology applications.

Research areas may include but are not limited to the following areas:

- To discover potential novel platforms for further engineering, projects are sought which develop new understanding of or identify naturally occurring pairs of receptors and their genetic response pathway. To demonstrate the new knowledge, proposals must show that the screened transducers can receive (sense target molecule) and transmit (initiate a cellular response). Efforts will be favored that focus on identifying response elements with receptors that bind small molecules similar to organophosphorous nerve agents.
- To explore the feasibility of creating novel signal transducers responsive to chemical nerve agents, projects are sought which engineer currently known receptors to recognize nerve agents or their surrogates. Strategies may include, but are not limited to, engineering existing receptors or creating fusion proteins with binding and signal components from separate proteins. Proposals must include methods to measure binding affinity and to demonstrate specificity for the nerve agent or surrogate chosen. Engineered proteins must also demonstrate the ability to initiate a cellular response in vivo.

Proposals that primarily focus on creating novel sensor pathways, rather than identifying and establishing novel transducing elements, will not be funded. Proposals which exclusively use in silico techniques without experimental validation will also not be considered.