DEFENSE THREAT REDUCTION AGENCY

BROAD AGENCY ANNOUNCEMENT

HDTRA1-11-16-BRCWMD-BAA

Amendment 1 (December 2011)

Research and Development Enterprise

Basic and Applied Sciences Directorate

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

March 2011

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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	
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	
TBD	Amendment to the BAA announced on Grants.gov with Period C 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 C Grants scheduled to be awarded
Period D	
Period E	
Period F	
Period G	
……	
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 using a fixed, quarterly invoice schedule; under no circumstances will these grants allow invoice of actual costs incurred. Note: The invoice schedule is subject to change, at DTRA's discretion.

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

[1] DoDI 3210.1, September 16, 2005

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

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 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—Cognitive and Information Science:*** The basic science of cognitive and information 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 "PerB" are only valid for Period B of this BAA. Only pre-application white papers responsive to the topics posted for Period B and submitted by the Period B 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 submissions labeled "PerA" are NOT valid topics for "PerB". Pre-application white papers that address "PerA" 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 using a fixed, quarterly invoice schedule; under no circumstances will these grants allow invoice of actual costs incurred. Note: The invoice schedule is subject to change, at DTRA's discretion.

II.1.1. The period of performance (POP) for the Single Scope Awards and the Multidisciplinary Awards (both 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 four (4) additional years as possible options, a base period of two (2) years with three (3) additional years as possible options, or a base period of three (3) years with 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, however, other base period and option combinations may not be proposed.

II.1.2. The POP for the Young Investigator Awards (award is detailed in Section II.4) may be up to five (5) years. Young Investigator Awards will be for a two (2) year base period 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, however, other base period and option combinations may not be proposed.

II.1.3. 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.

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.

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 may not participate as prime grantees for awards made under this BAA, but may 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.

[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.

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

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 must 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 must 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 must 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. DTRA WILL NOT review any of 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.

- Application packages submitted using the Competition ID of "Example."

Exceptions WILL NOT be made under any circumstances.

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 FedNonFed Budget Form	N/A	Required
R&R Subaward Budget (Fed/Non-Fed) 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 FedNonFed 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 (Fed/Non-Fed) 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 FedNonFed Budget Form.** The Research and Related Budget

(Total Fed + Non-Fed) 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 (Total Fed + Non-Fed) 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 (Fed/Non-Fed) 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 for incorporation into grant. 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 www.dtrasubmission.net/portal (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 www.dtrasubmission.net/portal (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.

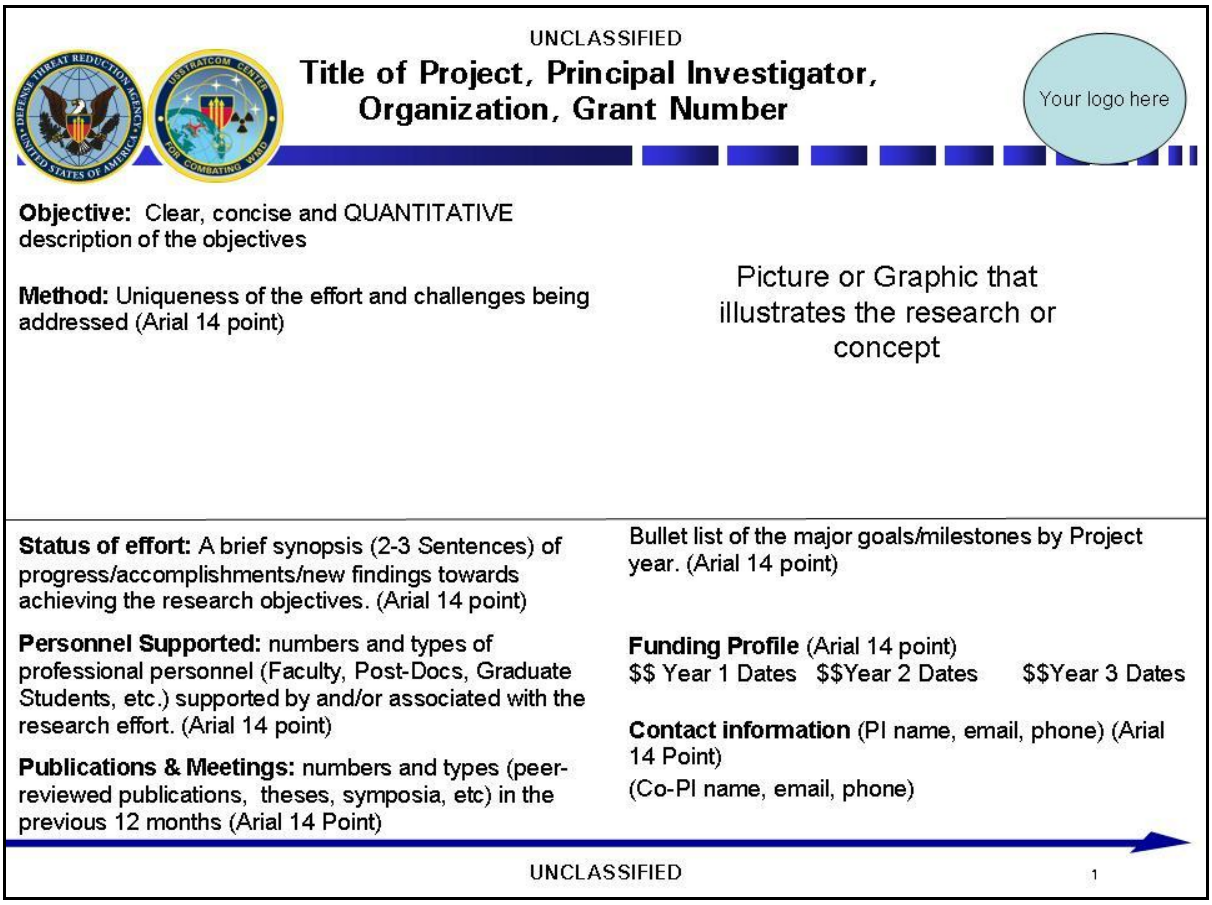


Figure 1: Sample Quad Chart.

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. Most documents should be uploaded as a Portable Document File (PDF) format. An exception to this is the quad chart (MS PowerPoint file compatible with the most recent version of MS PowerPoint) for the Phase II submission.

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 will not be reviewed if they are received after these deadlines. Exceptions will not be considered.

IV.3.1.1. 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.3.1.2. 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.3.1.3. 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.3.1.4. Please note 15 U.S.C. 260a establishes daylight saving time as the standard time during the daylight saving period.

IV.3.2. 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.3.3. 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	
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	
TBD	Amendment to the BAA announced on Grants.gov with Period C 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 C Grants scheduled to be awarded
Period D	
Period E	
Period F	
……	
Period 'n'	

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

IV.3.4. 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" and will not be considered. Exceptions will not be considered.

IV.3.5. 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 Basic Research funds but **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 Central Contractor Registration (CCR) by calling the CCR Assistance Center at 1-866-606-8220, or you may register online at http://www.ccr.gov. You will NOT be able to complete your CCR registration until CCR 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, BRTRC Inc, SBG Technology Solutions, 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. CCR Registration. In accordance with 2 CFR 25.200(b), each entity applying to this BAA (that is not exempt under 2 CFR 25.110) is required to:

- Be registered in the CCR prior to submitting an application (or plan);
- Maintain an active CCR 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, offerors 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 Volume III, Supplemental Information, of the Phase II full proposal. 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. 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.2.8. 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.2.9. 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 annually, no later than 90 days after the end of the reporting period for all grants. The reporting period shall be from 1 July–30 June. First year reports shall have a reporting period of the start date of the grant through 30 June. 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 to HDTRA1-BRCWMD-A@dtrasubmission.net.

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@dtrasubmission.net

Thrust Area 2: BRCWMD-TA2@dtrasubmission.net

Thrust Area 3: BRCWMD-TA3@dtrasubmission.net

Thrust Area 3 (CB): BRCWMD-TA3-CB@dtrasubmission.net

Thrust Area 4: BRCWMD-TA4@dtrasubmission.net

Thrust Area 5: BRCWMD-TA5@dtrasubmission.net

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

PerB-Topic 1: Post-Detonation Radiological and Nuclear Forensics (Thrust Area 1)

Average Award Amounts for PerB-Topic 1:

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

Award Structure for PerB-Topic 1:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 1 may not be proposed.

Background: This topic explores ways to enable accurate post-detonation analysis of debris from a radiological or nuclear event on a short time scale. 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 forensics. The current methodology includes a radiochemical assay that requires an inordinately long time to obtain statistically accurate results. The advancement of analytical techniques could lead to the ability to accurately analyze debris on time scales shorter than this current methodology. Ideally, this topic seeks novel methodologies which are non-destructive, allowing additional confirmation using the identical sample. Furthermore, a need exists to improve the capability of sample collection; to this end this topic seeks novel methods which have the potential of being more robust under a wide variety of adverse conditions. Also of interest are techniques for material reconstruction that may lead to the determination of the radionuclide source activity after an RDD (radiological dispersal device) detonation.

Impact: The development of advanced post detonation forensics addresses DTRA's counter WMD need to enable prevention of future detonations, enable identification of those responsible,

and aid 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 novel methods and advancements in the ability to collect samples of material, analyze radioactive debris, and identify signatures from debris analysis in a post detonation environment. Specific interests include the investigation of non-destructive analytical techniques and signatures for material reconstruction. Proposals that engage government laboratory institutions are also encouraged.

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

- Novel methods for rapid isotopic identification and measurement after a nuclear or radiological detonation
- Non-destructive analytical techniques
- Investigation of techniques with the potential to eliminate the need for time-consuming separative radio-chemistry
- Nuclear Magnetic Resonance (NMR), Neutron Activation Analysis (NAA), laser spectroscopy and mass spectrometry
- Identification of necessary signatures from debris analysis to enable material reconstruction of radiological dispersal devices
- New methods for sample collection after a nuclear or radiological attack
    - Includes water, airborne, and ground collection
- Investigation of the coalescing of airborne radioactive debris
- Exploration of zeolites as adsorbents for debris collection
- Investigation of microstructural analysis tools for post detonation debris analysis

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PerB-Topic 2: Methodologies for Autonomous Radiological and Multi-mode Information Collection (Thrust Area 1)

Average Award Amounts for PerB-Topic 2:

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

Award Structure for PerB-Topic 2:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 2 may not be proposed.

Background: Sensing of short range radiological signatures in limited access environments is a difficult problem. Because most direct radiological signatures can often only be detected at close range (< 100 m), mechanisms to employ autonomous platforms permitting close, discrete information collection is desirable. Further, the ability for these platforms to successfully select between a range of detection algorithms and methods based on information gained from secondary signatures also likely to be present (such as magnetic, optical, infra-red, seismic,

acoustic, or others) is also potentially necessary. Rapid ability to choose among these disparate methods may require automatic action in a disturbed and quickly changing environment.

Impact: Autonomous platforms capable of using minimal data exchange between each other and/or support from reachback or other command resources will reduce the limitations that may be introduced by dependence on human reaction times. Furthermore, such platforms will be able to successfully navigate a wide range of terrain either on their own or via collaboration with a variety of heterogeneous land/air platforms. Detection systems would also be enhanced by capabilities to collect from challenging environments and return samples to staging points. Additionally, the ability to identify and deploy sensors as part of long dwell (mission dependent, but may extend to months or longer) "leave behind" capability improves persistent surveillance.

Objective: The focus of this topic is on identification of the key scientific obstacles to the deployment of autonomous counter-WMD search assets especially useful for detection of radiological signatures. This topic investigates the identification of approaches towards this kind of autonomous search capability, and does not address the development of hardware for platform mobility or sensors. Proposals that engage government laboratory institutions are also encouraged.

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

- The investigation of appropriate autonomous search algorithms, communication-minimal cooperation schemes, and detection algorithm/method decision logic supporting the employment of multiple autonomous search platforms against a radioactive source located in a large (~km^2) complex area that may contain obstacles, including shielding structures
- The exploration of multi-mode, one mode being a radiological signature, detection summary reporting methods suitable for employment over long latency small bandwidth wireless communications links
- The identification of methods to deploy long dwell detectors from these platforms as needed, and the identification of methods (i.e. hierarchically distributed sensors) for such platforms to autonomously choose deployment locations for these long dwell detectors based on radiological (i.e. varying signal to noise environments), or operational constraints
- The investigation of autonomously assigning roles to assets, self-organizing techniques, and the optimization of resources for radiological signature sensing

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PerB-Topic 3*: *Advancing Knowledge of Network Theory for Network Analysis and Response to Attacks (Thrust Area 2)

Average Award Amounts for PerB-Topic 3:

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

Award Structure for PerB-Topic 3:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 3 may not be proposed.

Background: In order to preserve essential military capabilities following an attack employing weapons of mass destruction (WMD), one must be able to predict the interdependent responses of the military and national infrastructure networks that define the military capability in response to damage and to changes in network demand that result from such an attack. These include military networks (US and coalition), like the defense strategic communications system, global information grid (GIG) and battlespace networks; non-military networks, the national power grid and transportation grids. Critical considerations in the face of WMD disruption are network availability, interoperability, robustness and recovery. The basic nature of a WMD attack is that multiple nodes will be compromised simultaneously to varying degrees through a multitude of failure mechanisms – some common mode, others implementation-specific, still others as a result of dependencies. The space- and time-correlated details of the damage and the specific nature of the faulty behavior are not known a priori. The WMD stressors to networks can include, for example, 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. Many current management approaches and policies of network systems contain static assumptions about the structure of network, and they do not account for time dependent variation in traffic type, significant changes in the number of operating nodes, changing security conditions and user demands, including the potential need to prioritize network traffic. In order to understand the critical vulnerabilities and develop avoidance/recovery strategies of such diverse, yet interdependent networks to WMD attack, a fundamental understanding of the approaches which capture network dynamics is required. This effort is intended to answer questions such as: What are the essential elements of any network? How do different implementations impact on interoperability, vulnerability, survivability and recovery of networks in a WMD environment? What is the mix of implementations that optimize these measures? What data would be most valuable to collect from existing networks to supplement/validate the mathematical and statistical models that will be developed under this effort? What are adaptive network policies and optimization methods? What are routing approaches for networks with variable connectivity and information content? What policies are suitable for managing user demand in the event of major attacks?

Impact: This research will advance theoretical understanding and methods necessary to improve network robustness, management and recovery. Understanding the fundamental properties that contribute to the robustness of networks will support system reliability, survivability and security. This research will identify methods to use indirect information (e.g. peacetime performance indicators or network outages from natural events) for determining what data and how much data are needed to adequately understand the impact of WMD stressors on complex networks. This will impact many areas such as sensor networks, telecommunications, and systems of systems. Defense systems and operating procedures can be optimized to ensure the maintenance of capabilities rather than individual systems, reducing acquisition costs and increasing WMD survivability and operability.

Objective: The objective of this effort is to conduct basic research to advance current knowledge of physical, social and techno-social network behavior and to identify optimal responses to large scale/global, network outages that occur almost simultaneously due to a single Weapons of Mass Destruction (WMD) threat event. High value is placed on science-based mathematical and statistical methods to determine intra- and inter-network failure modes and dependencies and methods to increase network robustness to avoid/minimize WMD stressor impacts. The main thrust of this network topic is to extend prior research to be more specific in defining WMD environments and target networks layers.

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

- Advances in theoretical understanding or mathematical modeling of the properties of complex networks that cannot be described in terms of graphs or methods used for simple networks and analysis of key aspects of topologies that govern network response to WMD stressors.
- Classification and modeling of attacks on interdependent and/or multilayer networks to define survivability metric accounting for robustness, fragility, reconfigurable and self-healing of the network.
- Advances in inference algorithms capable of identifying damage via targeted and limited tests. Advances in network control and routing strategies to mitigate network damage. The technique should target design of properly balanced distributed and centralized control of the damage.
- Analysis of optimal structure of networks built to withstand very rare but devastating attacks/outages and capable of fast and least centralized recovery.
- Advances in network forensic for detecting and predicting rare malicious activities and distinguishing them from benign activities over the networks.
- Development of stable and effective network management algorithms for real time allocation of network resources with minimum latency, overhead, and complexity.
- Analysis of key aspects and dynamics in socio-technical networks including cross-layer interactions between social networks and underlying physical and communication layers under WMD stressor impacts.

PerB-Topic 4: Science for Novel Radiation-Hardened Robotics for Sampling and Rescue (Thrust Area 3)

Average Award Amounts for PerB-Topic 4:

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

Award Structure for PerB-Topic 4:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 4 may not be proposed.

Background: Recent and historical serious nuclear events have underscored the need for long duration robotic operations in high radiation environments where people cannot operate, or can only safely operate for very limited periods. Unfortunately, robots have not yet demonstrated sufficient radiation hardness to survive for an adequate period of time at the high levels of radiation associated with a serious failure at a nuclear power plant or post thermonuclear explosion near the epicenter of such an event. Robotic systems were not in place or immediately available in the aftermath of the Fukushima Daiichi power plant disaster. The robotic systems later utilized for sampling, observation, and surveillance either suffered electronic/mechanical failures or were not sufficiently sophisticated to fulfill their missions. Various types of robot utilization after a serious nuclear event for forensic sampling, system manipulation, and human rescue would be an essential component of DTRA's post CBNRE event mission.

There is little fundamental understanding of the complex, radiation-induced failure mechanisms in the multi-faceted, integrated electro-opto-mechanical systems represented by robots. Although industry has developed robotic systems to perform conventional function within nuclear power plants and assist with the handling of radioactive materials, robotic systems to deal with non-conventional operating conditions, serious accidents, and nuclear event recovery and forensics are not being adequately explored. For example, these special robots would have to deal with debris, perform tasks deep within a building or structure, provide sophisticated situational feedback and analysis, deal with delicate human rescue tasks, and possibly handle highly radioactive materials while operating in a highly varying radiation environment.

Impact: Radiation hard robots and their associated mechanisms will improve response time while reducing the human risk in dealing with a nuclear event, contribute to the predictive analysis of the nature of the event and the perpetrator, minimize both short and long term effects, provide for effective remediation, and assist in restoration. In the case of human exposure, robots can provide safe rescue without additional radiation exposure to first responders.

Objective: The objectives of this topic are to conduct theoretical and some experimental research to further the fundamental understanding of the radiation induce failure mechanisms of robotic system and components, and to determine the hypothetical sensitivity of particular sub-assemblies and components. The emphasis will be on understanding the basic mechanisms of radiation interaction with the variety of robotic subsystems. In addition, the vulnerability of the overall assembly of subsystems should be explored in order to determine where redundant systems and additional robustness are important. The approach will be based on a combination of theory, simulation, and some basic research experiments. New test capabilities for characterizing radiation effects in robotic systems will be developed, taking into account the emerging needs for specialized autonomous systems.

This topic is open to any basic research proposal that directly addresses the radiation hardness of robots or the performance of robots in high radiation environments. Proposals must be for basic scientific research and not for device/component development or system engineering. While proposals need to address the relevance of the research to DTRA's counter weapons of mass destruction mission and specifically the use of robots and robotics for rescue, reconnaissance, and remediation in the aftermath of a nuclear event, the use of specific applications or scenarios

is discouraged. This topic seeks to develop a fundamental understanding of interaction of radiation and radioactive material (dust, debris, water, gas) with robots and robotics. Studies that focus on cataloging effects or determining relative radiation hardness are discouraged. Prospective investigators are encouraged to collaborate with DoD facilities, DoE laboratories, NASA resources, FFRDC's, and/or industrial and academic laboratories.

PerB-Topic 5: Basic Science of Laser Filamentation for Counter-Weapons of Mass Destruction Utilization (Thrust Area 3)

Average Award Amounts for PerB-Topic 5:

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

Award Structure for PerB-Topic 5:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 5 may not be proposed.

Background: Experiments at the University of Michigan in 1995 demonstrated a unique offsetting pair of non-linear phenomena that allows the long distance propagation of powerful femtosecond laser pulses through transparent gaseous, liquid or solid media with a significant portion of the energy remaining in an intense and highly localized lighted core surrounded by ionized plasma. This laser filamentation is associated with several non-linear effects which have numerous prospective applications. This topic focuses on research on the basic science that might enable possible applications related to DTRA's mission on counter weapons of mass destruction, in the chemical, biological, radiological, nuclear, and high explosive (CBRNE) regimes.

The laser filament phenomena has been described as a successive interaction of the optical Kerr effect, which focuses the beam as it propagates, and the creation of a surrounding ionized plasma, which leads to beam defocusing. These successive and complex interactions allow for continuous laser core regeneration over extended distances within the transparent media through which the beam propagates. Prior work has observed pulse compression which broadens the spectral bandwidth. For example, an initial 800 nm femtosecond pulse from a Ti:sapphire laser will spread across the visible and near IR spectrum creating a "white light" or super continuum pulse.

Numerous prior applications of these phenomena have been explored, including laser breakdown spectroscopy and fluorescence. These filaments can act as a guide for high-voltage discharges such as lightening and, possibly, EMP effects. In addition to the production of high-order harmonics, power beaming, EM propulsion, terahertz pulse emission, creation of laser chirps, and terrestrial laser probes have all been suggested as possible applications. Other ideas may include remote intense X-ray production, and high altitude ionization effects.

Impact: Laser filamentation offers the potential to reduce risk and increase response distance by sensing and interacting with matter at great distances with little loss of power or increase in spot size. Laser filamentation and ultra-short laser pulses also offer a convenient platform for accessing non-linear phenomena, which are especially useful for the generation of broadband light, X-rays, γ-rays, THz pulses, and EMPs.

Objective: The objectives of this topic are to conduct theoretical and some experimental research to further the fundamental understanding of the laser filament phenomena and the associated plasma radiation mechanisms. This research will determine the possible efficacy of laser filaments for environmental considerations associated with a CBRNE circumstance, the use of these phenomena for WMD detection along with their constituents and the development of new utilization concepts and interactive testing to evaluate the possible use of these phenomena for DTRA mission focused activities. The emphasis will be on the basic mechanisms of pulsed laser radiation and propagation with ancillary ionized plasma interactions. In addition, the vulnerability of the propagation process should be explored in order to determine where the limitations and robustness are important. The approach will be based on a combination of theory, simulation, and basic research experiments. New test capabilities for characterizing radiation effects should be developed, taking into account the emerging and prospective needs for sensing, detection, power transport, broadband focused light transmission, and terahertz signal approaches, among other possibilities.

This topic is open to any proposal that directly addresses a basic science research focus on laser filamentation for enabling possible counter-weapons of mass destruction applications. The proposal must make the connection between the proposed basic physics research and countering chemical, biological, radiological, nuclear, or high explosive weapons. Possible applications of laser filamentation may be in detection, sensing, protection, weapon/agent defeat, remediation, and/or weapon effects replication. Submissions that focus on specific applications (not the basic enabling science), applied configuration research, or systems engineering are discouraged. Researchers are encouraged to gain an understanding of DTRA's core mission and propose novel research directions for laser filamentation that further DTRA's counter-WMD mission. Prospective investigators are encouraged to collaborate with DoD facilities, DoE laboratories, NASA resources, FFRDC's, and/or industrial and academic laboratories.

PerB-Topic 6: Production of Reactive Oxygen Species in Cancer Stem Cells Subsequent to Acute Radiation Exposure (Thrust Area 3)

Average Award Amounts for PerB-Topic 6:

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

Award Structure for PerB-Topic 6:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 6 may not be proposed.

Background: The current paradigm for defining the interactions between ionizing radiation and biological matter is largely based upon inference derived from secondary observation, primarily because real-time interrogation of irradiated systems was previously delimited by the available technologies for observing cellular processes without causing cell lethality. Indirect markers suggest that DNA damage, especially double strand breaks, is the ultimate cause of cell damage and/or death and, in the case of exposure to low-LET radiation (Linear Energy Transfer), may be mediated by reactive chemical species formed subsequent to the splitting of intracellular water molecules. Although specific laws predicting the kinds and amounts of injury in a given cell resulting from radiation exposure have yet to be elucidated, certain rules of thumb are applied to estimating radiation effects. Among the most recognized are those developed by French radiobiologists Bergonie and Tribondeau, who concluded that radiosensitive cells generally possess three properties: high division rate, long dividing future, and lack of differentiation.

Cancer research in the last few years suggests that both solid tumor and blood cancers harbor small populations of anaplastic cells that may drive tumor growth and metastasis through sustained self-renewal and multi-lineage differentiation. In apparent contrast to the Bergonie and Tribondeau rules of thumb, these cancer stem cells (CSCs) demonstrate remarkable resistance to radiation treatments sufficient to induce death in bulk tumor cells. The observed radioresistance has been attributed to a number of factors related to enhanced DNA repair and expression of anti-apoptotic proteins; however, specific identification of resistance mechanisms has been hampered by the ability to culture and purify adequate concentrations of CSCs for deeper interrogation. Recent advancements in culturing techniques (e.g., adherent culturing) that allow expansion of homogenous CSC populations provide promise for developing a unique model system to study mechanisms of radioresistance in human cells.

Because conventional wisdom suggests that deleterious effects related to ionizing radiation exposure (especially external exposure) are causally related to interactions between reactive oxygen species (ROS) and nuclear DNA, discerning the composition and relative concentrations of specific ROS following irradiation represents a reasonable starting point for the systematic study of interactions between radiation and biological matter. The overarching goal for this research topic is to contribute to fundamental knowledge regarding the biological consequences of radiation exposure by directly interrogating cellular systems using newly available methods and model systems.

Impact: Advancing the current mechanistic understanding of cellular response to acute ionizing radiation will allow the development of better pre-treatments, prophylaxes, and countermeasures for warfighters and others that may be exposed to radiation in the event of a deliberate or accidental nuclear release. In addition, data resulting from such studies will allow the development of experimentally validated risk models and can assist in the establishment of reasonable human protection standards.

Objective: The primary goal is to develop fundamental knowledge related to the cellular effects of radiation exposure by using cultured CSCs as model systems. Preference will be given to research teams with demonstrated history in culturing CSCs, maintaining pluripotency, and selecting cell populations with specific potency. The particular focal point is quantifiably and reproducibly describing composition and relative concentrations of ROS upon exposure to acute gamma- or x-irradiation.

Research areas may include, but are not limited to:

- Interrogation of cellular effects related to acute ionizing radiation exposure, with the range of doses to include those typically delivered during radiation therapy for cancer treatments (0 - $\geq$ 8 Gy). Pluripotent as well as differentiated cell cultures should be evaluated to provide a basis for comparison.
- Monitoring of composition, and biological half-lives, of ROS previous to and upon cellular irradiation.
- Correlation of ROS levels with other cellular responses, particularly those related to DNA damage.

PerB-Topic 7: Multi-scale Coupling in Simulations of Multi-component Reacting Systems (Thrust Area 4)

Average Award Amounts for PerB-Topic **7**:

- Single Scope Awards will average approximately $150,000 per year.
- Only Single Scope Awards will be reviewed for this topic.

Award Structure for PerB-Topic 7:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 7 may not be proposed.

Background: It is desired to neutralize Weapons of Mass Destruction (WMD) using air-dropped ordnance that must penetrate or otherwise gain entry into WMD locations, activate a dispersal mechanism (typically driven by high explosives), couple with WMD items, and neutralize these items. Current inventory munitions impact targets at rates of ~300 m/s. Fragments driven by high explosives have initial velocities of 1,000-2,000 m/s. Shaped charges travel on the order of multiple km/s. As a result, counter-WMD events occur at high rates (10^2-10^7 s^{-1}) where physical and chemical changes can take place at nanosecond times scales, and necessarily include a wide variety of highly-heterogeneous materials such as: earth materials, energetic materials (e.g. high explosives, metal particles, reactive materials, etc.) and WMD component materials (e.g. chemical, biological, radiological, etc.), spanning many magnitudes of length scales and time scales.

WMD-defeating systems are designed by using engineering hydrocodes that simulate the behavior of proposed weapon designs and troubleshoot solutions prior to the performance of

expensive mid/full-scale tests. We are currently supporting many projects on meso-scale modeling of multi-scale, multi-component (heterogeneous) solid-sate systems that are initiated with a shock wave, causing reactions that yield gas-phase combustion and reaction products. We are also currently supporting measurements and models of high temperature, high pressure reactions associated with blast weapons, and fluid dynamic modeling of turbulent flows associated with weapon detonation and subsequent fireball generation.

With the current massively parallel computing power, it may now be possible to fully resolve the quantum mechanics of chemical kinetics, coupled with micro-scale of reacting heterogeneous explosives (including reactive cases or reactive liners), coupled with complex meso-scale physics of detonation and shock propagation, coupled with macro-scale blast effects on surrounding structures, and continue to simulate extended space and time by tracking the explosive plume to simulate the entire event, spanning many orders of magnitude of time and space. While each model is dominated by its own characteristic length and time scales, the challenge lies in interfacing/coupling the models and collapsing/linking/windowing the characteristic scales to satisfy the governing equations at each scale. Such an integrated end-to-end approach offers the best hope of predictive simulations of practical interest, whose results can be trusted.

Impact: This research will enable accurate weapon simulations that will improve lethality estimates for current weapons to defeat WMD, and it will allow intelligent design of new Counter-WMD weapon systems without needing multiple tests at multiple scales, making the development of new systems much cheaper and more efficient.

Objective: This topic seeks integrated weapon effect simulations where the power of computation at each scale (micro-, meso- and macro-) is fully exploited and properly coupled and scaled up to the higher level. To achieve this goal, we require a hierarchical approach where quantum mechanics predicts the molecular scale, accurate micro-scale material characterization; chemical reactions predict the meso-scale, shock physics; turbulence models predict the macro-scale mixing and transport; and, fluid dynamics predicts the entire continuum weapon effect. To bridge each scale, information could be synthesized into appropriate reduced-order coupling models that will enable truly micro-scale, physics- and chemistry-based simulations; however, strategies for accurate and efficient nesting of multi-level models must be carefully considered. In particular, the reduced-order models must accurately account for the compressible, inhomogeneous, highly time-dependent and extreme coupling that occurs between scales. When higher-order bases are used for more accurate predictions versus lower-order bases for less accurate predictions, systematic improvement in nodal density and arrangement could be optimized, using the difference in the solution between lower and higher bases to control and minimize computational time and error.

Research areas may include but are not limited to:

- Materials (solid state) modeling to computational fluid dynamics
- Continuum methods, finite volume, finite element and finite difference methods
- Particle methods, adaptive-mesh, mesh-free, and mesh-less approaches
- Eulerian or Lagrangian or Combined Approaches

PerB-Topic 8: Novel Signatures and Methodologies for Characterizing Nuclear Event Sites and Activities (Thrust Areas 1 and 5)

Average Award Amounts for PerB-Topic 8:

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

Award Structure for PerB-Topic 8:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 8 may not be proposed.

Background: Verification and monitoring technologies are noted for their importance to support nuclear arms control and nonproliferation, and assure compliance with current and future nuclear weapon related treaties/agreements. It is important to conduct basic research to significantly improve existing approaches, or to identify and understand novel approaches, in order to explore opportunities for verification and compliance of the "treaty/agreement-after-next," as well as, significantly enhance verification regimes of current treaties. Recent events and historical trends serve to emphasize the continuing need for improvements in nuclear test monitoring such as may be conducted through on-site inspections or local area monitoring, wide area monitoring for illicit nuclear activities, and the importance of supporting fundamental advances in these areas. Seismic methods provide a major means of detecting and characterizing underground explosions. These methods can be augmented by other techniques; e.g., infrasound, hydroacoustic, or radionuclide networks. Sensing and characterization of suspected nuclear events may involve additional signatures or approaches than those of traditional monitoring systems. For example, there may be environmental factors near an underground explosion that are disturbed and which may be measureable during an on-site inspection. Basic research into observable phenomena may yield novel means for understanding events that represent potential nuclear explosions.

Impact: Advancements in fundamental science may foster future technologies and analysis methodologies help discriminate between nuclear and non-nuclear events, and processes; that extend both the lower limits and reliability of yield determination; enhance early detection of noncompliance; and, help assure nonproliferation of nuclear weapons. Science factors can facilitate early indication of intent to proliferate, as well as provide flexibility to identify events if access is available only in the long-term. It is desirable to advance knowledge of both near time measurements in the days and weeks following an event and longer term understanding of signatures that may extend the ability to verify and characterize given data collection months or years post-event. Scientific and technical approaches should enable a non-nuclear weapon state to participate in assurance of compliance with treaties/agreements, while not enabling proliferation capability to the participant.

Objective: The objective of this topic is to foster physical or life sciences basic research into alternative phenomena and novel methods to advance technologies and approaches in support of treaties/agreements, arms control, and nonproliferation.

Research areas may include but are not limited to:

- Conducting theoretical, computational, or experimental studies of novel observables to significantly improve understanding of topographical, geological, or depth factors that affect phenomena of non-seismic signatures measured for determination of weapon yield, type of event and reaction history.
- Conducting theoretical, computational, or experimental studies of fundamental changes in surface physical observables (or environmental factors) that result from above and underground tests.
- Exploring the generation, propagation, properties, and measurements of basic physics, e.g., electromagnetic phenomena, that may arise from explosions; e.g., changes in geophysical electrical properties, generation of currents, pulses, etc.
- Improving the prediction of chemical fractionation and speciation and neutron activation products starting from the plasma immediately after detonation to ambient temperatures in the underground environment and seepage to the atmosphere (i.e., fate and transport of event debris).
- Enhancing understanding for the concentration of isotopes by several orders of magnitude to increase probability of detection of trace or short-lived isotopes with half-lives on the order of hours or days; e.g., novel bio-concentration or physical chemistry processes to enhance selectivity.
- Enhancing understanding for the detection of water-borne radionuclides; e.g., through either selective absorption or bulk concentration of potential event products in large aqueous samples.
- Identification of pathways and biological half-lives in flora, fauna, or micro-organisms that may allow prediction or measurement of bio-concentration of isotopes to indicate recent underground explosions. These may be represented in a broad potential range of environments (terrestrial and aqueous, tropical, desert, etc.).

PerB-Topic 9: Novel Materials and Methods for Sensing and Transparency to Secure WMD (Thrust Area 5)

Average Award Amounts for PerB-Topic 9:

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

Award Structure for PerB-Topic 9:

- Will be for a base period of three (3) years with 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, however, base period and option combinations other than those detailed for PerB-Topic 9 may not be proposed.

Background: Monitoring for nonproliferation compliance and secure storage or transport of WMD-related materials or components contributes to reducing the WMD threat. Current uses for unattended monitoring systems include installation of sensors in nuclear facilities to act on a continuous basis to assist in safeguards; e.g., to monitor materials and processes in an effort to identify changes and queue further inspection as necessary. Other uses of unattended sensors may include distributed sensor networks in the field to detect nuclear or non-nuclear WMD and materials. Knowledge of tampering helps secure WMD by establishing the reliance which may be put upon data from such sensors, and needs to be resistant to spoofing. Basic physical principles can help ensure integrity of monitoring/sensing of properties for attached or near-by objects whether they change or remain fixed; e.g., integrity of seals, radiation levels, airborne particles/molecules, electrical currents, temperatures, humidity, location, etc. A challenge associated with cooperation is a preference toward minimally invasive techniques for monitoring and inspections. This challenge may include creating technical solutions with the ability to sense general but useful black-box properties of containers for which knowledge of the internal content may not be allowed in detail. In addition to scientific principles that promote future hardware, basic research into secure algorithms and software principles may yield insights into providing transparency while protecting those sensitive details reached in agreements or treaties. Transparency is desired for strong verification regimes to build confidence between parties to the agreement. A further challenge to monitoring is the need to be able to inspect arrays of measurement data, which may include mobile sensors, while understanding and discriminating signatures which may include very small signals. Treaties/agreements to reduce the threat of WMD will benefit from both (1) materials with built-in passive or active sensing properties, and (2) novel methods for securing weapons and increasing transparency.

Impact: Basic research will support future opportunities to build or extend partnerships in WMD threat reduction. For example, significant improvements in the ability to eliminate, secure, or consolidate WMD, related materials, and associated delivery systems and their infrastructure will build assurance in our ability to partner with willing countries to reduce the threat from WMD in the spirit of Cooperative Threat Reduction. Sensing material may, for example, be applied to weapons, systems, sites, or locks/seals as indicators of activity or integrity between inspections. Novel sensing materials can help provide unique assurance against tampering, thereby assisting verification of compliance. This may enable confidence: in greater reductions in arms; for agreements with new signatory nation states regarding their nuclear forces (or non-nuclear weapons); and, in existing or future treaties/agreements.

Objective: The primary objectives of the research sought in this topic are: (1) to explore phenomena in materials that can provide passive or active indicators of interference with unattended monitoring (i.e., 24/7 sensing); (2) to understand interactions that reveal the nearby but greatly displaced presence of novel tag materials (i.e., not incremental improvements in RFIDs) structured for cooperative efforts; e.g., locate transported objects by sensors within ranges of 10s of meters; and, (3) to explore scientific methods that provide transparency into activities in a partner nation's facilities while being flexible in measurement and reporting (i.e., adjustable to not intrude in areas of knowledge protected by agreement).

Research areas may include but are not limited to:

- Study properties of unique micro/nanostructures that sense and store memories of the type, magnitude and time history of actions that change the structure. For example, investigation of changes in the state of materials on the molecular level that provides passive indication of external manipulation, such as unique changes in molecular structure; electrical, magnetic, or thermal properties; etc.
- Investigate active phenomena (e.g., processes that store and transduce energy) that help passive structures such as those identified above. For example, signal enhancement via methods to control molecular storage in caged molecules or nanotubes and subsequent energy generating interactions such as charge release.
- Explore quantum states that provide unique information that support knowledge of tampering or the state of objects; e.g., atom interferometry etc. for mass distribution, entanglement/decoherence of states to identify tampering, weak measurements of observables; etc.
- Explore properties—such as electrical, magnetic, radiative, chemical volatility etc.—of novel material structure and function, and how these interact with photons, acoustic energy, chemical sensors etc. to provide measureable observables such as location.
- Create monitoring algorithms or mathematical methods of complex systems to assist with transparency. For example: improve understanding of detector placement/type relative to improving CBRNE monitoring that clarifies what is present, and where. Explore the means to analyze sensor data histories for evidence of tampering, while characterizing false positives and false negatives.

PerB-YIP-Topic 1: Post-Detonation Radiological and Nuclear Forensics (Thrust Area 1)

Young Investigator Awards for PerB-YIP-Topic 1 will average $100,000 per year.

Awards for PerB-YIP-Topic 1:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 1 may not be proposed.

For topic description, please see PerB-Topic 1.

PerB-YIP-Topic 2: Methodologies for Autonomous Radiological and Multi-mode Information Collection (Thrust Area 1)

Young Investigator Awards for PerB-YIP-Topic 2 will average $100,000 per year.

Awards for PerB-YIP-Topic 2:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 2 may not be proposed.

For topic description, please see PerB-Topic 2.

PerB-YIP-Topic 3: Advancing Knowledge of Network Theory for Network Analysis and Response to Attacks (Thrust Area 2)

Young Investigator Awards for PerB-YIP-Topic 3 will average $100,000 per year.

Awards for PerB-YIP-Topic 3:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 3 may not be proposed.

For topic description, please see PerB-Topic 3.

PerB-YIP-Topic 4: Science for Novel Radiation-Hardened Robotics for Sampling and Rescue (Thrust Area 3)

Young Investigator Awards for PerB-YIP-Topic 4 will average $100,000 per year.

Awards for PerB-YIP-Topic 4:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 4 may not be proposed.

For topic description, please see PerB-Topic 4.

PerB-YIP-Topic 5: Basic Science of Laser Filamentation for Counter-Weapons of Mass Destruction Utilization (Thrust Area 3)

Young Investigator Awards for PerB-YIP-Topic 5 will average $100,000 per year.

Awards for PerB-YIP-Topic 5:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 5 may not be proposed.

For topic description, please see PerB-Topic 5.

PerB-YIP-Topic 6: Production of Reactive Oxygen Species in Cancer Stem Cells Subsequent to Acute Radiation Exposure (Thrust Area 3)

Young Investigator Awards for PerB-YIP-Topic 6 will average $100,000 per year.

Awards for PerB-YIP-Topic 6:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 6 may not be proposed.

For topic description, please see PerB-Topic 6.

PerB-YIP-Topic 7: Multi-scale Coupling in Simulations of Multi-component Reacting Systems (Thrust Area 4)

Young Investigator Awards for PerB-YIP-Topic 7 will average $100,000 per year.

Awards for PerB-YIP-Topic 7:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 7 may not be proposed.

For topic description, please see PerB-Topic 7.

PerB-YIP-Topic 8: Novel Signatures and Methodologies for Characterizing Nuclear Event Sites and Activities (Thrust Areas 1 and 5)

Young Investigator Awards for PerB-YIP-Topic 8 will average $100,000 per year.

Awards for PerB-YIP-Topic 8:
- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 8 may not be proposed.

For topic description, please see PerB-Topic 8.

PerB-YIP-Topic 9: Novel Materials and Methods for Sensing and Transparency to Secure WMD (Thrust Area 5)

Young Investigator Awards for PerB-YIP-Topic 9 will average $100,000 per year.

Awards for PerB-YIP-Topic 9:

- Will be for a base period of two (2) years with 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, however, base period and option combinations other than those detailed for PerB-YIP-Topic 9 may not be proposed.

For topic description, please see PerB-Topic 9.