EXPLOITING ROD TECHNOLOGY

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EXPLOITING ROD TECHNOLOGY

1.0 PURPOSE

To present an approach by which DARPA can establish with the interested Services the viability of the Rain of Darts (ROD) weapon and gain Service support for its development and fielding.

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2.0 BACKGROUND

2.1 GENERAL

Since 1988, DARPA and the Armament Research, Development, and Engineering Center (ARDEC) have been involved in the development of a high-velocity kinetic energy penetrator munition consisting of clusters of many small (3"-5") darts, conceptually delivered by several different carrier weapons. Because of the high velocities of impact (1.6-2.2km/sec), the flat angle of attack (5°-20°), and the large number of darts being delivered at fairly high density (more than 1.6 darts/m²) against potential target arrays, it was the opinion of the technical community involved that ROD was potentially an extremely effective, low- cost area weapon to be used against soft and lightly armored targets.

ROD development was proceeding apace until recent budgetary decisions caused funding support for ROD development to be drastically reduced. The funding which was originally provided by DARPA and the Balanced Technology Initiative (BTI) Office has been cut back to zero from \$800K. To determine the aeroballistic coefficients of a candidate dart, ARDEC is currently supporting development out of its own 6.2 funds at about \$100K. ARDEC has made slow progress toward achieving this end because of failures in the original dart during testing. It appears that the next dart design to be tested will diverge from the original concept visualized by DARPA and Science and Technology Associates (STA). STA, the design engineer, takes exception to these changes on the basis of inappropriate test conditions and insufficient testing. At this time, the full resolution of this issue will be difficult because of the current management structure, which separates the developer (ARDEC) from the designer (STA).

ROD development was initially classified. As a result, Service knowledge of the concept has been limited, if not denied. It is probably correct to say that if support cannot be obtained from at least one of the Services, a technology that appears to have high military potential will be put on the shelf prematurely. A condensed version of Service views on future ROD development follows.

2.2 ARMY

2.2.1 GENERAL

The Army user, the Training and Doctrine Command (TRADOC), knows little or nothing about ROD. Because the technology is not mature, actual performance data do not exist, and no thought has been given by the Army to the possible applications for ROD. Enthusiastic support for its development could not be found. While there is some Strategic Defense Command and Air Force interest, an attitude of "come back later when you've got something" generally characterizes the situation.

This view has been further reinforced by the philosophy expressed in the Army Investment Strategy, which implies that technology initiatives supported by the Army must provide an obvious "leap-ahead" capability.

2.2.2 FIELD ARTILLERY

ROD must show a major improvement over DPICM and APAM to be supported by the Field Artillery. Furthermore, an MLRS-delivered ROD, which can be shown to be less costly and much more effective than DPICM, has been perceived as a threat to SADARM. Both munitions are employed in the counterbattery role, but, potentially, ROD is capable of destroying more elements in that

target array than SADARM and at a much lower cost. Ameliorating factors to this perceived threat to SADARM are the great difference in possible fielding dates and the fact that SADARM is actually an antiarmor as well as a counterbattery munition. Responding effectively to these two issues - a "quantum leap" over DPICM/APAM effectiveness and no concurrent threat to SADARM - could make ROD a highly effective and acceptable warhead for MLRS and ATACMS.

2.2.3 ARMOR/ANTIARMOR

One area of potential Armor/Antiarmor application for ROD appears significant: hostile explosive reactive armor (ERA) stripping/detonation. The appearance of ERA on Soviet main battle tanks has raised serious concerns in the U.S. and NATO defense forces. ERA virtually neutralizes U.S./NATO Anti-Tank Missile (ATM) effectiveness. Consequently, greater dependence is being placed on more highly energetic, long-rod penetrators to defeat Soviet tank main armor. The upper limits of tank gun technology will be severely tested by the kinetic energies required of the next generation of main guns. Thus, a way to neutralize the ERA shield could restore the antiarmor effectiveness of shaped-charge ATMs and take some of the technological and economic pressure off the development of more powerful tank guns. It appears that ROD has considerable potential not only to strip away the ERA shield but to do so explosively, with attendant collateral effects - crew kill or even tank kill.

2.2.4 AIR DEFENSE

The user reaction to an antihelicopter ROD round was mixed. There appeared to be support for the concept; however, critics felt that the danger to friendly troops from the spent darts plus potential fire control problems make the concept impractical. As

2.3.2 ARM APPLICATIONS

An area that appears to have the greatest potential and to arouse Air Force interest in a ROD technology application is its use as an alternative warhead for an antiradiation missile (ARM).

2.3.3 STAND-OFF WEAPON

A second application that aroused Air Force interest is a bomber-class stand-off weapon for use against naval shore-support targets such as harbors, ports, docks, etc.

2.4 NAVY/MARINE INTEREST

The best assessment of Navy/Marine interest in ROD is that it is lukewarm. Contacts at both the Naval Air Systems Command and the Marine Corps Research, Development, and Acquisition Command were reluctant to commit themselves until more performance and effects data are available.

3.0 SUMMARY ANALYSIS

The following discussion by Service addresses:

- ROD-related Service Needs
- Principal Issues
- Conclusions

3.1 ARMY

3.1.1 ROD-RELATED ARMY NEEDS

In the Army, ROD technology appears to have the greatest potential applications in the areas of:

- Indirect fire applications
 - Counterartillery, MLRS-delivered munition: Targeted against all elements of the hostile battery, achieving either a k-kill or a mission-kill, at low cost compared with existing or programmed munitions.
 - Counterartillery, anti-light material, ATACMS-delivered munition: High effectiveness at low cost is the principal attribute of this warhead.
- Dual-purpose tank round:
 - Primary purpose: ERA stripping/detonation
 - Secondary application: Antihelicopter defense.

3.1.2 INDIRECT FIRE APPLICATIONS

3.1.2.1 COUNTERARTILLERY

The Army has or will have two MLRS-delivered submunitions for counterartillery use, DPICM and SADARM. The former is not very effective, but is not very costly. The latter, which is currently in development, is at least an order of magnitude more effective and could be six times more costly. The number of darts in the MLRS-ROD dispersal pattern (about 6,400), the very flat angle of attack, the high velocity of impact (1.6-2.0km/sec), the large area of the dispersal pattern, and the very low cost of the munition payload are characteristics that favor the adoption of the MLRS-ROD.

3.1.2.2 ANTIMATERIEL, DEEP ATTACK

Two munitions are also visualized for application in ATACMS, APAM and TGSM (as a Block II warhead). ROD appears appropriate for ATACMS for the same reasons that it appears applicable to MLRS. The footprint of the 32,000-dart payload is very large, and, although the antiarmor applications are limited to lightly armored vehicles and materiel, the greater majority (80%-90%) of the vehicles in a second-echelon march column are either lightly armored or have no armor at all. The nature of the target and the higher lethality of these KE penetrators, coupled with their low cost, make ATACMS-ROD a concept worthy of further evaluation.

3.1.2.3 ROD INDIRECT-FIRE ISSUES

To accept ROD in an indirect-fire application, the Field Artillery user will have to be convinced that a number of potential problems applying to both MLRS and ATACMS are manageable:

- Achieving adequate footprint size
- Achieving the claimed lethality within the footprint
- Realizing the very low costs per MLRS-ROD and ATACMS-ROD that appear possible for this concept
- Showing that ROD is not a current threat to SADARM acquisition
- Showing that MLRS-ROD and ATACMS-ROD technology are indeed "leap ahead."

The user is already faced with an abundance of missions and payloads for MLRS and ATACMS. DARPA's presentations must be factual and convincing in responding to these issues or the ROD concept for indirect fire will never be supported. Target response will not be an issue as it is with the tank round, but comparative cost and effectiveness will be.

3.1.3 DUAL-PURPOSE TANK ROUND

3.1.3.1 ANTIARMOR

As noted in the discussion in Section 2.2.3, ERA presents a serious challenge to U.S./NATO shaped-charge, ATM technology. Current concepts for defeating ERA include such ideas as tandem warheads, which use a precursor blast to clear away the intervening ERA tiles for the main charge, which follows the first in a few milliseconds. This "one-on-one" approach is susceptible to a number of countermeasures, and it appears that currently the only sure-fire way to achieve a kill is with higher and higher velocity, large L/D, KE penetrators. However, this technology is

challenging the physical limits of conventional tank gun ballistics.

New tank armor technologies have been challenged with limited success by the approaches discussed. What has not been considered before, apparently, is an approach by which all of the exposed ERA tiles are detonated simultaneously. The unclassified literature gives persuasive statistics related to this approach. The T-80 tank carries an estimated 4 metric tons of ERA in the form of 185 to 221 explosive tiles. Assuming that approximately 50% of a tile's weight is explosive, this puts the amount of explosive in the reactive armor at 4,400 pounds. Approximately 70% to 75% of the tiles are exposed to frontal attack, or approximately 3,300 pounds of explosives. The shaped-charge jet of a TOW ATM impacting on a T-80 will be disrupted and neutralized by the detonation of 1 to 4 tiles or 20 to 80 pounds of explosives. However, should the exposed area of ERA be hit by the dispersed disk of ROD darts impacting at 1.6 to 2.2km/sec, the effect would be the nearly simultaneous (1.4-1.9msec) detonation of from 500 pounds to as much as 3,000 pounds of explosive. Using a simplified striker plate-hull plate model, the U.S. Army Ballistics Research Laboratory (BRL) has calculated that the stress placed on the T-80 tank hull by the simultaneous detonation of 1,500 pounds of ERA explosive is "about twice what the [hull] plate can sustain." The amount of ERA detonated would be dependent on the density of the darts in the disk-shaped dispersal pattern. (Enclosure 1 presents these data in more detail.) The design parameters of the tank-ROD (T-ROD) round, of course, are still undetermined, given the early stage of development of ROD technology and the lack of effects data and analysis, which will have to be obtained in order to support weaponization of the concept.

3.1.3.2 ANTIHELICOPTER

This application is a bonus capability of the anti-ERA T-ROD. Dart densities in the dispersion pattern can be much less than in the anti-ERA application to achieve a helicopter kill, thus allowing a disk larger in diameter (approximately 29m) and a larger pointing error of the tank gun. Different dart densities can be achieved for antihelicopter or anti-ERA application by varying the in-flight rotational velocity of the T-ROD round. This two-position selectability can be engineered into the T-ROD fuze mechanism.

3.1.3.3 PRINCIPAL T-ROD ISSUES

The issues that will have to be addressed by a T-ROD development program and used as a basis for convincing the Army of T-ROD effectiveness are as follows:

- Ability to achieve the desired dispersal patterns and densities for anti-ERA and antihelicopter use.
- Ability to achieve the necessary intensity of detonation: dart density needed, possibility for spontaneous detonation, correct dart velocity, shape, and material.
- Effects on tank and crew of nearly simultaneous detonation of many ERA tiles.
- Seriousness of the troop safety problem when using T-ROD as an antihelo weapon..
- Other effects achievable with a T-ROD round.

Army acceptance depends on the resolution of these issues for at least three reasons:

- First, because of the reputation of the FST for near-invulnerability, there is considerable skepticism as to the effect of simultaneous detonation of ERA tiles on a tank or its crew, regardless of the number of tiles detonated - 5 or 185.

- Second, the basic load of tank ammunition is very limited and will allow only the most valuable, mission-essential rounds to be carried. A convincing demonstration will be needed to achieve a place for T-ROD in the basic load.

- Third, in a "nonlinear," operational, antihelicopter scenario, there is a possibility that the darts not hitting the helicopter target might fall on friendly troops. The resolution of this concern will determine whether or not the T-ROD antihelicopter capability is desirable.

The basis for the above reasoning is primarily intuitive and not demonstrated fact; however, until these points are satisfactorily addressed in terms of acceptable and understandable responses to the listed issues, the T-ROD concept will be rejected by the Army.

3.1.4 CONCLUSIONS (ARMY)

From the above, one can draw conclusions in two areas: First, as they relate to persuading the Army to support further exploitation of ROD technology, and, second, as they relate to the general technical objectives of the ROD development program itself.

- Army support

- Either in the antiarmor/antihelicopter or in the indirect-fire application, DARPA must be able to show that ROD offers "leap-ahead" technology.

- The elements of proof of a "leap-ahead" potential must include the factual results of a convincing concept feasibility demonstration that addresses the issues as related in the preceding sections.

- The potential offered by a successful T-ROD development appears to fit the "leap-ahead" definition.

- Realism of the perceived troop safety problem must be carefully evaluated.

- The indirect fire application of ROD does not appear to present as obvious an advantage. Careful and realistic technical and operational analysis and impressive "tech demos" will be needed to convince the Army to support MLRS- and ATACMS-ROD.

- Technical or program objectives

- The current status of ROD development leads to the conclusion that, after dart flight dynamics are understood, the next logical technical issue to address is effective dart dispersal techniques, starting with the least complicated and proceeding to the more complex, after which technical issues of system integration can be resolved. The T-ROD application is a natural result of the early dart dispersal investigation.

•• The appropriate technical approach to ROD development for Army applications appears to have four phases:

- Phase I - Fixing of dart configuration and aeroballistic coefficients.

- Phase II - Understanding the physics of dart dispersal. Testing in 105mm or 120mm tank gun. Development of T-ROD prototype. Evaluation of warhead effects on surrogate T-80 hulls protected by ERA.

- Phase III - Assumption of program direction by the Army. Weaponization of T-ROD. DARPA/Army joint development of concepts for MLRS-ROD and ATACMS-ROD. Development of submissile prototypes. Evaluation of warhead effects on assigned targets parallel with or slightly in advance of weapon development.

- Phase IV - Army integration of submissiles into MLRS and ATACMS carriers. Technology transfer of submissile data to Air Force for application in ARM and stand-off weapons.

•• The concurrent weapon effects portion of the program is essential for establishing technical direction and developing user support. The first and most essential such investigation should address the effect of the high-velocity disk of darts at optimum density on the ERA of a Soviet tank. Follow-on investigations should consider similar effects of conceptual and prototype warheads on helicopters, lightly armored vehicles, and trucks.

•• An indispensable part of this plan will be a series of executive-level briefings and progress reports designed to gain and maintain Army support for ROD development. To be convincing,

these briefings must address the issues of Sections 3.1.2.3 and 3.1.3.3 and must be supported by the data in the development program and its concomitant effects investigations.

•• Unless the effects investigations conclude otherwise, top priority should go to T-ROD development. This is in keeping with the logical steps of ROD development. Later phases of the program would solicit Air Force interest (Phase III) and active involvement (Phase IV), depending on the degree of success of the Army program.

3.2 AIR FORCE

3.2.1 ROD-RELATED AIR FORCE NEEDS

In the Air Force, ROD technology could have application in two areas:

- An alternative ARM warhead
- A bomber-class stand-off weapon.

The latter could be targeted against naval shore-support facilities or other facilities of similar hardness; aircraft/aerospace factories, rebuild facilities, chemical agent production facilities, etc.

3.2.2 ARM WARHEAD

The HARM/ARM target is a relatively soft one (SA-11, -12, -13, -15, and -17) represented by 1/4 to 1/2 inch of steel. Soviet SAMs stay on the air for only a short time. Thus future ARMs will have to have a new type of guidance. The larger the warhead effects footprint is, the less sophisticated or accurate the

missile guidance need be. Thus, ROD technology could be appropriately applied to a replacement for the current warhead for HARM or for a next-generation missile.

3.2.3 BOMBER-CLASS STAND-OFF WEAPON

An emerging Army/Air Force concept for attacking area targets involves many aircraft delivering many weapons against many targets. The bomber-delivered stand-off weapon appears to have potential as an element of this concept. The ROD warhead could be valuable for use against shore-support targets such as harbors, ports, docks, and so forth.

3.2.4 AIR FORCE ISSUES WITH THE APPLICATION OF ROD TECHNOLOGY

The following issues will have to be addressed by a ROD development program and by DARPA efforts to persuade the Air Force to support such an ARM-ROD and a Stand-Off-ROD program:

- Practical minimum range
- Proper boost-sustain motor to provide optimum burnout velocity
- Tailored flight profile to maximize advantages of KE warhead
- Pseudo-ranging device or some other method to initiate the warhead
- Credible ROD pack-missile body separation technique
- Adaptation of HARM guidance to ARM/ROD application

- Ability to vary pattern density
- Relative cost of a missile.

3.2.5 CONCLUSIONS (AIR FORCE)

- It is much too early in ROD's development to expect the Air Force to agree to the weaponization of the concept.

- Most of the issues raised are more appropriate for consideration in later phases, probably Phase IV, of ROD development.

- Air Force interests initially can be met by "piggybacking" on an Army program with Air Force applications occurring as a spin-off of these later phases. [Note: Interest expressed during MSD meeting during week of June 4 - see paragraph 2.3.1 - may offer earlier/separate opportunities to pursue ROD development with the Air Force.]

- A computer wargame in which selected munitions (HARM, etc.) were simulated in a model, with the results then contrasted with the outcome obtained using ROD technology (ROD being the only variable), would be a useful adjunct to the weapons effects portion of the program (see paragraph 3.1.4, page 3-8). The results of this simulation would be a very effective addition to an executive-level briefing prepared to gain Service (in this case Air Force) support for ROD development.

3.3 NAVY/MARINE INTEREST

Navy/Marine interest can be described as lukewarm. Without experimental data, it was very difficult to generate interest. Once a productive ROD program is under way, this situation would probably change, especially with the Marines.

The foregoing analysis leads to the following conclusions:

- ROD technology is not mature enough for the Services to appreciate, much less to embrace.
- Lack of funding delays the maturation process.
- A "leap-ahead" potential must be shown for ROD to be accepted by the Services.
- There appear to be several applications of ROD technology that hold promise.
- It appears that the Army has the earliest potential application.
 - This application is the T-ROD, which appears to be an innovative, "leap-ahead" approach and should be given top priority because of its operational potential and the evolutionary nature of its development.
 - Effects evaluations, especially in the T-ROD context, need to be conducted parallel with concept development.

5.0

RECOMMENDATIONS

It is recommended that DARPA:

- Fund ROD technology exploitation at a realistic level (about \$800K to \$1M) until the concept is proven or denied.
- Smooth out the program management structure so that issues such as those mentioned in Section 2.1 can be resolved quickly and satisfactorily.

Found at Enclosure 2 is a plan for the exploitation of ROD technology. This plan responds to the general and detailed analysis and conclusions developed in the preceding sections. It is recommended for use as a basis for DARPA to gain Service support for ROD.

Enclosure 1: EFFECTS ESTIMATE OF SIMULTANEOUS ERA DETONATION

Enclosure 2: ROD TECHNOLOGY EXPLOITATION PLAN

ENCLOSURE 1
EFFECTS ESTIMATE OF SIMULTANEOUS ERA DETONATION

Given: Frontal area of T-80 = 7.6m²
 Frontal area of ERA = 2.5m²
 Total No. of tiles = 185-221
 Total Weight of ERA = 8,800lbs (4 tons)
 Weight of explosive = 4,400lbs
 Explosive per tile = 20lbs approx.
 No. of darts in projectile = 750
 No. of tiles exposed frontally = 150-170

To determine relationship of dart density and disk radius to ERA explosive detonated and its 155mm projectile equivalent (blast only).

N = number of darts hitting ERA
 S_d = density of darts in disk
 A_e = area of ERA presented as a target
 r_d = radius of disk in flight containing 750 darts
 D = number of pounds of explosive detonated
 D = 20 x N = 20 x A_e x S_d = 50 S_d

$$S_d = \frac{750}{A_d} = \frac{750}{r_d^2} = \frac{238.7}{r_d^2}$$

$$r_d = \frac{238.7}{S_d}$$

<u>r_d</u>	<u>S_d (darts/m²)</u>	<u>D (lbs)</u>	<u>155_{eq} (rds)*</u>	<u>TOT_{eq}** (Bns[3x8])</u>
5	9.5	475	22	1-
4.8	10.4	520	24	1
3.29	22	1,100	51	2
3	26.5	1,325	61	2.5
2.5	38	1,900	88	4
2	60	3,000	138	6

* 21.7lbs comp B explosive per round

** TOT_{eq}: Time-on-target equivalent on tank frontal area

Conclusions:

a. Design of ROD anti-ERA projectile will depend on the amount of ERA tile explosive to be detonated to produce the desired effect on the target.

b. This amount must be determined by field experiment using instrumented surrogate Soviet tanks loaded with different amounts of "tile explosive."

c. The calculated dart densities greatly exceed the DARPA/STA notional figure of 1.6 darts/m²; however ...

d. Densities in excess of 10 darts/m² will probably be needed to produce the desired effect on the target.

e. The high dart density needed to kill a tank by ERA-detonation probably precludes the use of this application in an area-type weapon such as MLRS or ATACMS, unless the simultaneous impact of the four darts ($S_d = 1.6$ darts/m²) on the ERA tiles produce sympathetic detonations among the others. This should also be evaluated in field experiment.

f. The total weight of the explosive tiles comes from Jane's. The weight of explosive is an estimate based on 50% of the tile-weight's being metal and 50% explosives. Even if the estimated explosive weight is off by 50%, the amount of explosive would still be adequate to "kill" a T-80 tank.

ENCLOSURE 2
ROD TECHNOLOGY EXPLOITATION PLAN

1.0 PURPOSE

To provide a plan by which DARPA will be able to demonstrate ROD applicability to Service needs and gain Service support for its fielding.

2.0 PROGRAM CONCEPT AND APPROACH

2.1 GENERAL

2.1.1 ORGANIZATION

The plan is divided into five parts: General and Phases I through IV. Details of program orientation and briefing approaches will be found only in the first two parts because of the many technical and programmatic unknowns that pertain and the proposed transfer of program responsibility to the Services in Phases II and III.

2.1.2 PROGRAM GOALS

- Establish the viability of the ROD concept.
- Establish its military worth.
- Gain Army support for ROD prototyping and, later, its fielding.
- Provide for technology hand-off to the Air Force, Navy, and Marines.

2.2 CURRENT STATUS

2.2.1 ROD TECHNOLOGY

At this time (June 1990), ROD technology is far from mature. The shortage of funds has reduced the momentum of the efforts to fix a practical dart configuration and determine the aeroballistic coefficient needed for the mathematical modeling and the development of critical dispersal techniques. Even though there appear to be several promising applications, until these milestones are passed, the potential of ROD will remain a question.

2.2.2 SERVICE SUPPORT

Budget constraints continue to tighten in the Services. All have adopted the "show me" attitude toward new starts. The facts that ROD technology is so immature and possible ROD applications have had little fanfare contribute to neutral-to-negative views of ROD on the Services' part.

2.3 PROGRAM OUTLINE

2.3.1 GENERAL

Rough calculations lead to the view that the ROD concept has significant applications in the Army, especially in the antiarmor and counterartillery applications, and possibly the Air Force, the Navy, and the Marines. However, ROD proponents' assertions based on rough calculations will impress none of the Services until these assertions are backed up with a credible set of data gathered from field experiments. Consequently any DARPA effort on behalf of ROD must have two parts: Technology Maturation and Support Generation. The form and focus of the latter must be closely linked to the former.

2.3.2 TECHNOLOGY MATURATION

The technological aspect of the plan can be divided into four phases:

- Phase I - Aeroballistic Evaluation
- Phase II - Dart Dispersal Technology/Effects Evaluation
- Phase III - Missile/Rocket Delivery of ROD
- Phase IV - System Integration.

Note that, in Phase II, the viability of the antiarmor concept of simultaneously detonating tank ERA would be established.

As the technology matures from its currently ill-defined status to a point in which a definite application can be credibly identified, DARPA would phase the responsibility for program management from a fully DARPA responsibility in Phase I and the early part of Phase II, to a joint DARPA/Army responsibility Phase I and the early latter part of Phase II, and, finally, to a fully Army program in Phases III and IV. The layout of the plan allows the program to be canceled early on should the technology not support the aspirations of the developer.

2.3.3 GENERATION OF SERVICE SUPPORT

In the initial phase of the program, DARPA would present the ROD conceptual material to selected Service audiences for informational purposes only. As the technology matures and the effects data are developed, the "leap-ahead" nature of the T-ROD application should be apparent, allowing DARPA to provide briefings and a white paper informing the Balanced Technology Initiatives Office (BTIO) and soliciting Army support. DARPA should be prepared to carry T-ROD to a prototype/concept

though its earlier involvement is desirable. If, at the end of the T-ROD demonstration against a T-80 (with ERA) mockup, the Army is not interested, the program can be canceled. Assuming a positive Army reaction, however, DARPA would continue to participate in the program long enough to stimulate the interest of the other Services. Depending on individual Service reaction to program achievements, DARPA can supplement its verbal and written reports with a Technology Review Panel composed of representatives at the O-5, O-6 level from the development and user communities. The final phases would see the transfer of ROD technology to the other Services for application to their specific needs.

3.0 PHASE I. DART DESIGN OPTIMIZATION/AEROBALLISTIC EVALUATION

3.1 OBJECTIVES

3.1.1 TECHNICAL OBJECTIVES

- Fix dart configuration and dimensions.
- Determine dart performance and aeroballistic coefficients.
- Begin initial modeling of flight dynamics and distribution patterns preliminary to design of fundamental approaches for dart delivery and dispersal.

3.1.2 SERVICE SUPPORT

- Inform the Services of ROD, its operational potential, the supporting technology program, and its progress.

- Inform BTIO of ROD program progress. In meeting these objectives, DARPA should finesse skeptics by identifying the major technical and operational issues facing ROD development.

3.2 ISSUES TO BE ADDRESSED IN PHASE I

Several issues will have to be addressed in this phase of ROD development. The most pressing will be as follows:

- Lack of DARPA/BTI funding support for the program
- Lack of high-level DARPA support
- Lack of Service awareness of ROD potential
- Existence (or lack) of a practical dart
- Availability of repeatable dart performance parameters
- Assurance of effective configuration control
- Question as to whether the ERA detonation experiment should begin in Phase I or Phase II.

3.3 POINTS FOR EMPHASIS

Two main points should be emphasized in conducting Phase I:

- The early fixing of dart design and performance parameters
- Familiarization of the prospective user with the operational potential of ROD.

3.4 IMPLEMENTATION

3.4.1 TECHNICAL AND PROGRAMMATIC

The ROD effort has been under way for approximately 1 1/2 years. The latest round of trial firings of test darts indicates that the dart design is still not correct. Dart design, fabrication, testing, and analysis are being conducted

consecutively, partly because of severe funding problems. The restoration of the original funds would help speed up development and would provide a more timely basis for user support or, if the research so indicates, a basis for stopping work altogether. Concurrence in conducting some of the effects experiments, such as simulated ROD initiation of tank ERA, would also help establish or deny some of ROD's potential operational applications.

Technical issues such as dart dimensions, number of fins, amount of helical twist, ogive shape, and body cross-sectional shape must first be fixed so that the dart's in-flight stability can be ensured and the aeroballistic parameters describing individual and clustered dart flight dynamics and penetration mechanics can be determined. These data will contribute to identifying a suitable dispersal technique for potential direct and indirect fire applications. They will also help define the impact environment that the dart cluster will create at and through the target surface.

The changing dart characteristics caused by the testing environment may introduce problems later in the development process that may in turn have an adverse impact on packing densities, operational effectiveness of the deployment system, and other considerations. The early establishment of program direction and close coordination of ROD configuration control among the concept and design engineers and the effects evaluation personnel would lessen this possibility and should be a part of the program.

3.4.2 SERVICE SUPPORT

As noted in the general discussion of the plan approach, initially DARPA will not have enough credible data to suggest early Service involvement. Phase I should be used by DARPA to introduce the Services to ROD, familiarize them with the program, identify possible technology applications, and provide periodic

identify possible technology applications, and provide periodic progress reports.

3.4.2.1 ROD PROGRAM REPORTING

DARPA's ROD program personnel would present three types of reports:

- Introductory briefing - executive-level briefing covering:

- ROD concept
- Program objectives and milestones
- Potential Service applications
- Likely early opportunities
- Results of computer simulations comparing selected munitions with and without ROD warhead
- Proposed future interactions.

- Routine periodic progress reports - written reports and briefings on request at Action Officer level:

- Provided semiannually
- Covering program progress and identifying successes and remaining hurdles
- Pointing out areas needing Service cooperation.

- Technology "leap-ahead" reports - Briefings to executive offices key to ROD progress:

- Unusual events contributing significantly to achievement of a potential application

- Reports in briefing format to appropriate Action Officers and their principals on request.

3.4.2.2 POINTS OF CONTACT

Located in Appendices A and B are a Point of Contact Participation List and a POC/ROD Awareness List that identify, by report type and Service, personnel who should receive ROD program data. These appendices apply to both Phase I and Phase II.

4.0 PHASE II. DART DISPERSAL TECHNOLOGY/EFFECTS EVALUATION

4.1 OBJECTIVES

4.1.1 TECHNICAL OBJECTIVES

- Understand the physics of dart dispersal, especially in a gun-delivery environment.
- Test and evaluate this understanding in experiments using 105mm and/or 120mm gun-delivered test items.
- Evolve these test items into T-ROD prototypes.
- Examine simulated T-ROD warhead effects on a surrogate Soviet T-80 tank protected by ERA.
- Start analytical work to evaluate T-ROD in the antihelicopter role.
- Determine, based on the results of the above, the advisability of continuing the program.

4.1.2 SERVICE SUPPORT

- Inform the Services of progress in Phase I and aspirations for Phase II.

- Given sufficient success in the dart dispersal work and the T-80 simulations, present to the Army a DARPA interpretation of the operational significance of this part of the program. Solicit from the Army a commitment to participate jointly with DARPA in developing T-ROD prototypes, with the Army in the lead for T-ROD weaponization.

4.2 ISSUES TO BE ADDRESSED IN PHASE II

The issues requiring response in this phase have to do mainly with (1) the technical feasibility of dispensing the darts in a predictable, uniform, and operationally useful way and (2) the likelihood of the T-80 tank model to respond to the simultaneous or near-simultaneous detonation of its ERA in the manner expected. More specifically, the major issues are as follows:

- The ability to achieve the desired dart dispersal patterns in the gun-delivered mode.

- The validity of the BRL report that infers Soviet tank and crew vulnerability to simultaneous or near-simultaneous detonation of the tank ERA.

- The establishment of the acceptable limits of ERA detonation time interval and weight needed to achieve the desired blast effects on the tank.

- The feasibility of achieving the desired effect using T-ROD.

- The operational viability and required characteristics of an antihelicopter T-ROD.

- The existence and seriousness of collateral troop safety problems caused by using T-ROD in the antihelicopter role.

An internal issue raised in Section 4.2.2 is whether the ERA detonation experiments should be moved up from Phase II to Phase I. The rationale for their being in Phase II is based on the expected availability of funds and time.

4.3 POINTS FOR EMPHASIS

Phase II is the "do or die" phase for ROD. This phase of the technology exploitation effort should result in emphatic conclusions.

- ROD is or is not a viable concept.
- It does or does not have application as T-ROD against tanks and helicopters.
- Dart dispersal technology is understood well enough to expect success in delivering it by missile and rocket.

4.4 IMPLEMENTATION

4.4.1 TECHNICAL AND PROGRAMMATIC

This phase produces the data needed to continue or kill the program and, if the former option is justified, to bring the Army into partnership. Concurrence in the effects and dart dispersal investigations or, preferably, the former leading the latter, will allow the identification of critical capabilities required of the dispersal system, such as critical dart velocities and densities, variability of dart densities, uniformity of the dart cloud, and cloud shape, to name a few. Tests and analyses probing the achievable limits of the dispersal system with these characteristics in mind can help to establish the practicality of the ROD concept by determining if there is a match between dispersal system capabilities and the conditions required for the desired target response. Speculation has it that the darts must

hit the ERA tile array at a minimum velocity ($> 2\text{km/sec}$) and within a very short time interval ($< 2\text{msec}$) to achieve the desired effect. How much explosive must go off simultaneously to cause damage to tank and crew is also subject to speculation. The mechanics of cause and effect of target response must be well understood to justify prototyping and fielding a T-ROD for antiarmor use.

Similar target response analysis must be made in the antihelicopter application of T-ROD. In addition to target response, the questions of adaptability and limitations of M1A1 tank fire control and gun-laying components to antihelicopter engagement should be answered early in Phase II. The operational question of the likelihood of an antihelicopter engagement by T-ROD producing troop safety problems can be addressed later on in the phase.

Assuming that the antiarmor and antihelicopter employment of T-ROD appear desirable, it will remain to be determined what has to be done to the round, if anything, to make it adaptable to both missions.

4.4.2 SERVICE SUPPORT

Phase II reporting will keep the Services informed of ROD program progress and will initiate Army participation. During the latter part of this phase, the formation of an O-5, O-6 Technical Review Panel (as noted in Section 2.3.3) should be considered.

4.4.2.1 PROGRAM REPORTING

The briefings visualized for this phase would be of these types:

- Information briefings consisting of two parts:
 - Phase I results covering:
 - Final configuration of dart
 - Reconciliation of final configuration with initial design
 - Changes in performance, actual versus initial predictions
 - Performance predictability and impact of dart
 - Program performance versus program schedule
 - Funding status.
 - Phase II program covering:
 - Phase objectives and milestones
 - Potential issues and predicted accomplishments
 - Programmatic and operational inferences.
 - Executive-level briefing for interested Service principals.
- Mid-term progress report:
 - Briefing timed to cover completed effects tests and available gun test data and presenting:
 - Program performance versus schedule
 - Experimental and effects test results to date
 - Technical, programmatic, and operational interpretation of the data
 - Projected future results and expected operational and programmatic impact.

•• Briefing for selected senior Army and OSD personnel having potential program involvement.

• Near-End-of-Phase-II report:

•• Briefing format, presented to OSD and Army principals when sufficient data have been accumulated and analysis has been completed to support recommendations for program cancellation or continuation with Army support. Major topics to be covered:

- Program results versus prediction
- Comparison of prototype performance versus impact criteria for achieving desired effects on target
- Explanation of discrepancies, if any
- Interpretation of Phase II results in the context of Army operational requirements and fulfillment of the definition of "leap-ahead" technology
- Work remaining to begin T-ROD Full Scale Development
- Applicability of results to missile and rocket delivery
- Recommendations.

• Phase II Final Report:

•• A briefing and a written report to appropriate Service principals and their interested action officers updating the Near-End-of-Phase-II briefing with the final results of the Phase II effort. Phase III goals and scheduling would be included.

An additional activity will be the negotiations between top-level Army and DARPA leadership needed to obtain full Army participation. The overtures to this end should begin as soon as experimental results warrant it - probably with the mid-phase progress report.

4.4.2.2 POINTS OF CONTACT

The points of contact and their exposure to Phase II reports appropriate to this phase are found in Appendices A and B.

5.0 PHASE III: MISSILE AND ROCKET DELIVERY OF ROD

5.1 OBJECTIVES

5.1.1 TECHNICAL OBJECTIVES

- Apply the technology developed in Phase II to dart dispersal from more complex carriers.
- Develop the technical requirements for dart dispersal that will provide the desired effects on typical targets of interest to the Army. Upon an expression of interest, similar evaluation can be conducted for the other Services.
- Develop MLRS and ATACMS carrier configurations with supporting technology to meet the Army requirements. Consider the compatibility of the Army configurations with the requirements of other Services.
- Demonstrate the operational potential of these configurations in a laboratory environment as a preliminary step to integrating the carriers into the basic weapon system.

5.1.2 SERVICE SUPPORT

During this phase, the Army will have the lead, having put T-ROD into Full Scale Development at the end of Phase II and, in Phase III, starting the weaponization of ROD for MLRS and ATACMS. It is visualized that expressions of interest by other Services will begin during this phase as the result of analyses and experimental success achieved in its early stages. Transfer :

technology for specific Air Force and Navy/Marine Corps applications would be made at their initiative. However, DARPA and the Army can assist by offering to give technical and operational briefings to the other Services at their request.

5.2 POTENTIAL ISSUES IN THIS PHASE

The evolution of the ROD concept from its T-ROD application into a configuration suitable for dispensing from missiles or rockets will be successful as the result of meeting positively a number of issues raised by the Services in early ROD discussions. These issues, by Service, are as follows:

- Army - Indirect Fire Applications (MLRS and ATACMS):

- Attainment of adequate footprint size
- Achievement of expected lethality within the footprint
- Achievement of predicted low warhead costs
- Satisfying the user that the MLRS-ROD and ATACMS-ROD use "leap-ahead" applications
- Convincing the user that ROD weaponization holds no threat to ongoing development such as SADARM.

- Air Force - ARM and Stand-Off Applications:

- Practical minimum range
- Achievement of optimum burnout velocity of carrier
- Tailored flight profiles to maximize advantage of KE warhead

- Suitable warhead initiation device
- Credible dart pack-carrier body separation technique
- Adaptability of HARM guidance to ARM-ROD applications
- Ability to vary pattern density
- Relative cost of missile.

• Navy/Marines - As noted in the forward sections of this paper, because the information about ROD that was available to the Navy and the Marines was so scanty, little interest in ROD applications could be generated. Once the technology has been better defined and understood as the result of work done and data disseminated in Phases I and II, this gap should be filled.

6.0 PHASE IV. SYSTEM INTEGRATION

The general objectives of this phase would be as follows:

- The integration of the MLRS-ROD and ATACMS-ROD prototypes into their intended Army systems.
- Transferring ROD and ROD-carrier technology to the Air Force and Navy/Marines for applications suitable to their operational needs.

Whether or not this phase comes to pass will depend to a great degree on how well the development program is handled in Phases I and II and how convincing and thorough DARPA and, later, the Army are in passing along to the other Services the technical data in both raw and operational contexts.

APPENDIX A - PCJ PARTICIPATION LIS. FOR ENCLOSURE 2

	PHASE 1			PHASE 2			
	INTRODUCTORY BRIEFING	PROGRESS REPORTS	"LEAP-AHEAD" REPORTS	INFORMATION BRIEFING	MIDTERM PROGRESS	NEAR-END-OF-PHASE II REPORT	PHASE II FINAL REPORT
OSD							
DDR&E: DIRECTOR, LAND WARFARE	X			X		X	X
TEL: (202) 695-9284							
DIRECTOR, DEFENSE SYSTEMS	X			X		X	X
TEL: (202) 697-5385							
DIRECTOR, BALANCED TECHNOLOGY INITIATIVE OFFICE	X		X	X	X	X	X
TEL: (201) 697-4431							
PAE: DIRECTOR OF LAND FORCES	X			X	X	X	X
TEL: (202) 695-0881							
U.S. ARMY							
ASARDA: ASSISTANT SECRETARY	X			X		X	X
TEL: (202) 695-6163							
MILITARY DEPUTY	X			X	X	X	X
TEL: (202) 697-0356							
DEPUTY FOR TECHNOLOGY ASSESSMENT	X			X	X	X	X
TEL: (202) 697-1646							
DIRECTOR FOR RES. AND TECH.	X	X	X	X	X	X	X
TEL: (202) 695-1477							
HQDA, DCS, OPS:							
ASSISTANT DCS OPS, FORCE DEVELOPMENT	X			X		X	X
TEL: (202) 697-5116							
DIRECTOR, REQUIREMENTS, INTEGRATION AND CLOSE OPERATIONS	X			X	X	X	X
TEL: (202) 695-3611							
DIRECTOR, REQUIREMENTS, INTEGRATION AND DEEP OPERATIONS	X			X	X	X	X
TEL: (202) 695-0527							
CHIEF, FIRE SUPPORT DIVISION	X		X	X	X	X	X
TEL: (202) 695-5789							
CHIEF, COMBAT MANEUVER DIVISION	X		X	X	X	X	X
TEL: (202) 695-5612							
HQ, AMC: DCG, RESEARCH, DEVELOPMENT AND ACQUISITION	X		X	X		X	X
TEL: (202) 274-9705							
DCS, DEVELOPMENT, ENGINEERING AND ACQUISITION	X		X	X	X	X	X
TEL: (202) 274-9490							
USA MICOM:							
DIRECTOR, RESEARCH, DEVELOPMENT AND ENGINEERING CENTER	X		X	X	X	X	X
TEL: (205) 876-3322							
USA LABCOM:							
COMMANDER	X			X		X	X
TEL: (202) 394-1600							
DIRECTOR, ANTIARMOR MUNITION TECHNOLOGY OFFICE	X	X	X	X	X	X	X
TEL: (202) 394-6043							
DIRECTOR, BALLISTIC RESEARCH LABORATORY	X	X	X	X	X	X	X
TEL: (301) 298-6244							

	PHASE 1			PHASE 2			
	INTRODUCTORY BRIEFING	PROGRESS REPORTS	"LEAP-AHEAD" REPORTS	INFORMATION BRIEFING	MIDTERM PROGRESS	NEAR-END-OF-PHASE II REPORT	PHASE II FINAL REPORT
PEO, FIRE SUPPORT: TEL: (205) 876-0714 PM, ATACMS TEL: (205) 876-1141 PM, MLRS TEL: (205) 876-1195/6	X X X		X X X	X X X	X	X X X	X X X
PEO, AIR DEFENSE: TEL: (205) 876-8071	X			X		X	X
PEO, STRATEGIC DEFENSE: TEL: (703) 746-0303							
PM, HEDI: TEL: (205) 895-3103	X		X	X	X	X	X
U.S. AIR FORCE: HQ, DAF: DIRECTOR, TACTICAL PROGRAMS (SAF/AQP) TEL: (202) 695-2147 CHIEF, WEAPONS DIVISION (SAF/AQPW) TEL: (202) 697-7715	X X X			X X X		X 	X X
HQ, AFSC: DSC, REQUIREMENTS (AFSC/XR) TEL: (301) 981-2116	X X			X X			X X
MUNITIONS SYSTEMS DIVISION: DEPUTY COMMANDER FOR RD&A (MSD/CZ) TEL: (904) 882-5471 ASSOCIATE DEPUTY, DEVELOPMENT PLANS (MSD/XR) TEL: (904) 882-2880	X X X			X X X			X X
AIR-TO-SURFACE TOC (MSD/XRF, XRM) TEL: (904) 882-8002/8003		X	X		X		
HQ, TAC: DCS, REQUIREMENTS (TAC/DR) TEL: (804) 764-3148 DIRECTOR, ARMAMENTS AND AVIONICS REQUIREMENTS (TAC/DRA) TEL: (804) 764-5201 CHIEF, AIR-TO-SURFACE DIVISION (TAC/DRAS) TEL: (804) 764-7066	X X X X			X X X X		X 	X X
U.S. NAVY: ASN-RE&S: AIR WARFARE DIRECTOR TEL: (202) 694-7794 SURFACE WARFARE DIRECTOR TEL: (202) 694-5090	 X X			 X X			 X X
CNR: CHIEF OF NAVAL RESEARCH (OCNR-00) TEL: (202) 696-4767	 X		X	 X			 X
	X			X			X

	PHASE 1			PHASE 2			
	INTRODUCTORY BRIEFING	PROGRESS REPORTS	"LEAP-AHEAD" REPORTS	INFORMATION BRIEFING	MIDTERM PROGRESS	NEAR-END-OF-PHASE II REPORT	PHASE II FINAL REPORT
ONT: OFFICE OF NAVAL TECHNOLOGY DIRECTOR, ANTI-AIR, ANTI-SURFACE WARFARE AND SURFACE AEROSPACE TECHNOLOGIES (ONT-21) TEL: (703) 696-4771	X		X	X			X
NAVSEA: WEAPON AND COMBAT SYSTEMS ASST DEP COMMANDER, ANTI-AIR WARFARE/SURFACE WEAPONS (NAVSEA-O6A) TEL: (202) 692-4122	X			X			X
NAVAL AIR SYSTEMS COMMAND NAVAL WEAPONS CENTER DIRECTOR, NWC (NWC-03) TEL: (619) 939-1468 HEAD, INTERCEPT WEAPONS DEPARTMENT (NWC-39) TEL: (619) 939-2504 HEAD, ATTACK WEAPONS DEPARTMENT (NWC-35) TEL: (619) 939-3500	X		X	X			X
	X		X	X	X		X
	X		X	X	X		X
USMC: COMMANDING GENERAL, RDA TEL: (201) 696-0921 GROUND WEAPONS PROGRAM MANAGER TEL: (703) 640-2092 AMMUNITION PROGRAM MANAGER TEL: (201) 696-1170	X			X			X
	X		X	X	X	X	X
	X		X	X			X

COUNTERARTILLERY PLUS . . .
APPLICATIONS FOR THE DARPA
HYPERVELOCITY DART TECHNOLOGY

Final Briefing
June 1990

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Los Alamos National Laboratory
Los Alamos, New Mexico 87545
under
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BACKGROUND

- **1988 DEFENSE SCIENCE BOARD SUMMER STUDY ON COUNTERING
WARSAW PACT FIRE SUPPORT SYSTEMS**
 - **NATO SEVERELY OUTGUNNED, NEEDS TO REDRESS IMBALANCE, RESTORE
CONVENTIONAL DETERRENCE**
- **CHANGING WORLD ENVIRONMENT**
 - **DETERIORATION OF SOVIET CONTROL OF WARSAW PACT NATIONS**
 - **EUROPEAN PERCEPTION OF LESSENERD SOVIET THREAT**
 - **U.S. PERCEPTION OF LESSENERD SOVIET THREAT**
 - **U.S. POLITICAL AND ECONOMIC ASSAULT ON DEFENSE**
 - **SERVICES CAUTIOUS**
 - **SERVICES EXAMINING NEW ROLES**
 - **ARMS CONTROL TREATIES ARE PROBABLE**
 - **CFE**
 - **START**
 - **CHEMICAL**
 - **NUCLEAR UNDERGROUND TESTING, OPEN SKIES, SRNF, ETC.**

OUTLINE

- **BACKGROUND**
- ➔ **THREAT**
- **OPTIONS TO COUNTER THE THREAT**
- **ROD CONCEPT**
- **ROD APPLICATIONS**
- **ORGANIZATIONAL AND OPERATIONAL CONCEPTS**
- **CONCLUSIONS**
- **RECOMMENDATIONS**

THREAT

CENTRAL EUROPE

- POST-CFE, WARSAW PACT WILL HAVE 16,500-20,000 ARTILLERY PIECES BETWEEN ATLANTIC AND URALS (FINAL NUMBER UNDER NEGOTIATION)
- TODAY, BY SOVIET COUNT, THEY HAVE AN 11.8:1 SUPERIORITY IN SHORT-RANGE ROCKET AND BALLISTIC MISSILE LAUNCHERS WEST OF URALS
- SOVIETS HAVE MORE THAN 1,600 ROCKET AND MISSILE MOBILE LAUNCHERS EAST OF URALS

WORLDWIDE

- TREND TO ARMORED SELF-PROPELLED ARTILLERY IN 27 DEVELOPING NATIONS
- PROLIFERATION OF MISSILES IN THIRD WORLD ARMIES
- SPREADING NUCLEAR, CHEMICAL, BIOLOGICAL CAPABILITIES
- MULTIPLICITY OF SMALL CONFLICTS; POTENTIAL FOR LARGE WARS.

MANY THIRD WORLD CONFLICTS

... ALL CAPABLE OF GROWING LARGER

PROLIFERATION OF MISSILES AND ATTACK CAPABILITIES

Ballistic Missile System/Warhead	Argentina	Brazil	China	Cuba	Egypt	India	Iran	Iraq	Israel	North Korea	South Korea	Libya	Pakistan	Romania	Saudi Arabia	South Africa	Syria	Taiwan	Yemen
Short Range		X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X
Intermediate Range	X	X	X		X	X	X	X	X			X		X	X	X	X	X	
Chemical		R	W	W	W	R	W	W	W	W	R	W	R			W	W	R	W
Biological	R	R	R			R	W	W	R	R	R	R	R			R	R	R	
Nuclear	R	R	W		R	W	R	R	W	R		R	W			R	R	R	

R = Research and Development (R&D)
W = Stockpiled or Suspected Weapons

Source: Jane's: Weapon Systems 1989-1990
ISS: The Military Balance 1989-1990
Unclassified Testimony: CIA Director Webster, Others

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OPTIONS TO COUNTER THE ARTILLERY SYSTEM THREAT

"As They ..."

<i>We Must..</i>	<i>Move</i>	<i>Shoot</i>	<i>Communicate</i>	<i>Acquire Targets</i>	<i>Sustain Selves</i>
<i>Acquire Them By ...</i>	JSTARS UAVs OV-1D OH-58D REMBASS	TPQ-36/37 IPB SHELLREP OH-58D UAVs	GUARDRAIL V ASAS QUICKFIX	ASAS QUICKLOOK REMBASS OH-58D F-4G WILD WEASEL TACIT RAINBOW	UAVs IPB REMBASS JSTARS OH-58D OV-1
<i>And ...</i>					
<i>Suppress Them With ... (Mission Kill)</i>	MINES APAM DPICM CEM	DPICM APAM HE CEM	JAMMERS APAM ABN EW HE DPICM CEM CBU	STINGRAY APAM HE DPICM JAMMERS CBU	MINES DPICM APAM HE CBU
<i>Or ...</i>					
<i>Destroy Them</i>	TGW TGSM SADARM CEM APGM (?) NLOS-FOG-M	SADARM TASM CEM HE DPICM NLOS-FOG-M	APAM DPICM HE CBU	APAM HARM TACIT RAINBOW DPICM HE TASM IRON BOMBS ROCKEYE CBU	APAM DPICM HE CEM ROCKEYE CBU

AIR FORCE OPTIONS TO COUNTER THE ARTILLERY THREAT

- COUNTERARTILLERY, PER SE, IS NOT AN AIR FORCE PRIORITY UNTIL THE SUPPORTED GROUND COMMANDER MAKES IT ONE
- THE AIR FORCE PLACES A HIGH PRIORITY ON FIELDING MUNITIONS CAPABLE OF EFFECTIVELY ATTACKING SEMIHARD TARGETS, SUCH AS, ENEMY ARTILLERY SYSTEMS

TO ATTACK

EXISTING

PROGRAMMED ACQUISITION

PERCEIVED ADEQUACY

MOVING HOWITZERS

MINES
CEM
ROCKEYE
MAVERICK

SATISFACTORY
SATISFACTORY
SATISFACTORY
SATISFACTORY

HOWITZERS IN POSITION

IRON BOMBS
CEM
MAVERICK

SATISFACTORY
SATISFACTORY
SATISFACTORY

COMMUNICATIONS

IRON BOMBS
CEM
ROCKEYE
CBU

SATISFACTORY
SATISFACTORY
SATISFACTORY
SATISFACTORY

TARGET ACQUISITION

IRON BOMBS
ROCKEYE
CEM
HARM

SATISFACTORY
SATISFACTORY
SATISFACTORY
SATISFACTORY

LOGISTICS SUPPORT

IRON BOMBS
CEM
ROCKEYE
MINES
CBU

SATISFACTORY
SATISFACTORY
SATISFACTORY
SATISFACTORY
SATISFACTORY

**CURRENT SPECTRUM OF MUNITIONS ARE ADEQUATE
FOR ATTACK OF THE FIELD ARTILLERY SYSTEM**

ARMY OPTIONS TO COUNTER THE ARTILLERY THREAT

CLOSE COUNTERARTILLERY MUNITIONS: 5-35 KM

<u>TO ATTACK:</u>	<u>EXISTING</u>	<u>PROGRAMMED ACQUISITION</u>	<u>PERCEIVED ADEQUACY</u>
MOVING HOWITZERS	HE DPICM MINES	TGW TGSM WAM	SATISFACTORY
HOWITZERS IN POSITION	HE DPICM APAM	SADARM	SATISFACTORY
COMMUNICATIONS	HE DPICM APAM	EXJAM	SATISFACTORY
TARGET ACQUISITION	HE DPICM APAM	TACIT RAINBOW	SATISFACTORY
LOGISTICS SUPPORT	HE DPICM APAM		SATISFACTORY

**ABILITY TO COUNTER
CLOSE ENEMY ARTILLERY SYSTEMS
IS HIGHLY DEPENDENT
ON PROCURING EXPENSIVE
SMART MUNITIONS IN QUANTITY**

ARMY OPTIONS TO COUNTER THE ARTILLERY THREAT (CONT.)

DEEP COUNTERARTILLERY MUNITIONS: 35-150KM

<u>TO ATTACK</u>	<u>EXISTING</u>	<u>PROGRAMMED ACQUISITION</u>	<u>PERCEIVED ADEQUACY</u>
SECOND ECHELON ARTILLERY ADVANCING FOR EMPLOYMENT	APAM	TGSM	SATISFACTORY
TACTICAL BALLISTIC MISSILES MOVING	APAM	TGSM	SATISFACTORY
TACTICAL BALLISTIC MISSILES IN POSITION	APAM		MARGINAL
TBM LOGISTIC SUPPORT	APAM		SATISFACTORY

**ABILITY TO COUNTER
DEEP ENEMY ARTILLERY SYSTEMS
HIGHLY DEPENDENT ON PROCURING
SMART MUNITIONS**

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RAIN OF DARTS (ROD) CONCEPT

6.5 GRAMS

$\beta = 12000 \text{ KG/M}^2$

36 MM PENETRATION RHAE @ 2 KM/SEC

- HIGH PACKING DENSITY - HONEYCOMB STYLE
- TIP-TO-TAIL PACKING AND DISPENSING OF PACKS
- HIGH β , LONG RODS
- AERODYNAMICALLY STABLE - HYPERVELOCITY
- SPIN DISPERSED TO ACHIEVE CONTROLLED DENSITY, DISK PATTERN

DART DEPLOYMENT

**LOW IMPACT ANGLES PROVIDE
COVERAGE MAGNIFICATION**

POTENTIAL TARGETS

- LIGHT ARMOR TARGETS
 - SELF-PROPELLED HOWITZERS
 - AIR DEFENSE SYSTEMS
- TACTICAL MISSILE LAUNCHERS
- COMMAND SITES AND COMMUNICATIONS
- REACTIVE ARMOR STRIPPING
- AIRFIELD ATTACK
- ANTISHIP MISSILE DEFENSE
- TERMINAL BALLISTIC MISSILE DEFENSE
- SHORE BOMBARDMENT
- RAIL YARD ATTACK
- FUEL/SUPPLY AREAS

ATACMS ROD SYSTEM CONCEPT

- PAYLOAD - (4) ROD SUB PROJECTILES
- LAUNCH WEIGHT - 1,350KG (2,790 LBS)
- ΔV MAIN BOOSTER - 1,876 M/SEC
- ΔV PAYLOAD BOOSTER - 335 M/SEC

ROD - A UNIQUE MUNITION

IT COMBINES THE FOLLOWING ATTRIBUTES -

- COUNTERMEASURES IMMUNITY (SPEED, DUMBNESS DEFEAT CM)
- +
- TAILORABLE FOOTPRINT AND DART DENSITY (ADAPT TO THE TARGET)
- +
- UNIFORM DART DISTRIBUTION (PREDICTABLE/ASSURED COVERAGE)
- +
- HIGH P_H (HUNDREDS TO THOUSANDS OF CLOSELY SPACED DARTS FLYING A "MAXIMUM TARGET ENCOUNTER" PATH)
- +
- HIGH P_K (PENETRATION OF UP TO 35MM RHA VIRTUALLY ENSURES MISSION KILL; PROBABLE CATASTROPHIC KILL)

INTO A SIMPLE, USER-FRIENDLY, LOW-COST, HIGHLY EFFECTIVE MUNITION FOR EMPLOYMENT AGAINST A WIDE SPECTRUM OF SOFT TO SEMIHARD TARGET SYSTEMS

AND - ITS USE NEED NOT BE LIMITED TO COUNTERARTILLERY

OUTLINE

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- **RECOMMENDATIONS**

VERSATILE ROD APPLICATIONS

COUNTERARTILLERY

- DESTRUCTION OF ENEMY CANNON SYSTEMS
- DESTRUCTION OF ENEMY SSM SYSTEMS ON ENEMY-HELD TERRAIN
 - DETERRENT AGAINST USE OF CHEMICAL, BIOLOGICAL, NUCLEAR WARHEADS
- DESTRUCTION OF ENEMY TARGET ACQUISITION, TRACKING RADARS
- SUPPRESSION/DESTRUCTION OF ENEMY AIR DEFENSE SYSTEMS

HIGH-PRIORITY MISSIONS

- DESTRUCTION OF LIGHT ARMOR FORMATIONS

DIRECT ATTACK

(GOOD TARGET LOCATION)

- ENABLES RAPID RESPONSE
- POSSESSES LONG RANGE
- PRESENTS LONG RANGE
- PRESENTS LARGE FOOTPRINT
- OBTAINS HIGH LETHALITY
- FREES SCARCE AIR ASSETS

DEFENSE SUPPRESSION

(DUBIOUS TARGET LOCATION)

- ATTACKS AIR DEFENSES, COMMAND AND CONTROL
- ENABLES ASYMMETRICAL ATTACK - AIR PENETRATION, LOCATION, ATTACK OF TARGET OF INTEREST TO ARMY

VERSATILE ROD APPLICATIONS (CONT.)

SPECIAL OPERATIONS - LOW-INTENSITY CONFLICT (SO/LIC)

- TO EXECUTE SURGICAL STRIKES
 - CONTROL SIZE, SHAPE OF LETHAL FOOTPRINT
- TO MINIMIZE COLLATERAL DAMAGE
 - CONTROL SIZE, SHAPE OF LETHAL FOOTPRINT
 - ELIMINATES EXPLOSIVE EFFECTS, FIRES
 - NO "DUDS"

OTHER ATTRIBUTES

- MANY "STOWED KILLS" IN SINGLE WARHEAD
- A FEW DEPLOYED MLRS OR ATACMS WILL COVER LARGE AREA, LARGE RANGE OF TARGETS

VERSATILE ROD APPLICATIONS (CONT.)

OTHER CONCEPTS, CAPABILITIES

- TANK SELF-DEFENSE AGAINST HELICOPTERS, FIRED MISSILES
 - TANK GUN DART CLOUD COMPENSATES FOR POINTING ERRORS, HELO-TANK MOVEMENT, ENGAGES INCOMING MISSILES
- POTENTIAL ANTIARMOR APPLICATION
 - TURNS DEFENSIVE, EXPLOSIVE, REACTIVE ARMOR INTO ARMOR-DEFEATING MECHANISM
- PLUS GENERAL PURPOSE EMPLOYMENT
 - ANTIPERSONNEL, C3, LOGISTIC APPLICATIONS

ROD IS VERSATILE, LETHAL, AND DEPLOYABLE

ANTI-HEAVY ARMOR POTENTIAL

- IF ROD CAN DETONATE EXPLOSIVE REACTIVE ARMOR TILES, IT MAY BE POSSIBLE TO TURN THE EXPLOSIVE REACTIVE ARMOR DEFENSE INTO A WEAPON AGAINST THE HOST TANK

EXPLOSIVE FORCE IS DEPENDENT ON DART DENSITY

DENSITY (DARTS/M ²)	RADIUS ROD CLOUD (M)	EXPLOSIVE DETONATION (LBS)	155 HOW BN TOT EQUIV (BN 3X8)
10.4	4.8	520	1
38.0	2.5	1,900	4
60.0	2.0	3,000	6

THIS APPLICATION DESERVES CAREFUL EXAMINATION

OUTLINE

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- CONCLUSIONS
- RECOMMENDATIONS

COUNTERARTILLERY - SP HOWITZERS

PLACE:
CHORWON VALLEY, S. KOREA

TIME:
EARLY SPRING, 1995

TERRAIN:
ROLLING, FLANKED BY LOW MOUNTAINS

VEGETATION:
RICE PADDIES IN VALLEY, LOW TREES AND SCRUB, HEAVIER VEGETATION IN MOUNTAINS

WEATHER:
COOL, CLEAR. EARLY MORNING FOG

ATTACKING RED FORCE:
2 MOTORIZED RIFLE DIVISIONS IN ATTACK

DEFENDING BLUE FORCE:
INFANTRY DIVISION (REINF)
2 REGTS ON FLOT
1 TK AND 1 INF REGT IN RES

DEFENDING FORCE MISSION:
DEFEND DMZ AGAINST RED ATTACK, DEFEAT 1ST ECHELON

RSTA TASKS:
DIV CG DIRECTS G-2 TO FOCUS ON HOSTILE ARTILLERY AND MOVEMENT OF ARMOR

G-2 ASSETS:

- OV-1 (SLAR)
- SMALL AEROSTAT SURVEILLANCE SYSTEM (SASS)
- UAV-CLOSE

BATTLE ACTION:

- OV-1 DETECTS ENEMY MOVEMENT INTO ATTACK POSITIONS ACROSS CHORWON VALLEY. COLUMNS MOVING TOWARD DMZ. LEAD ELEMENTS INTO LIKELY ARTILLERY AREA
- SASS MTI RADAR FOCUSED ON SUSPECTED POSITION AREAS. CONFIRMS AND LOCATES SEVERAL ARTILLERY BATTERIES IN POSITION
- MLRS/ROD* BATTERY TARGETED AGAINST HOSTILE DS/GS UNITS
- COUNTERBATTERY RADARS PICK UP FIRST ROUNDS OF ENEMY PREPARATORY FIRES AGAINST 21ST INF DIV DEFENSIVE POSITIONS.
- MLRS/ROD UNITS FIRE ON MULTIPLE TGTS AT 4 ROCKETS PER TGT

BATTLE RESULT:

- INTENSE HOSTILE FIRE ABATED. UAV-TV CONFIRMS CONSIDERABLE DAMAGE TO SPHs AND SUPPORT VEHICLES. SASS CONFIRMS ENEMY HELICOPTER "DUST-OFF" INDICATING NUMEROUS CASUALTIES. SIGINT REPORTS SHUTDOWN OF BATTERIES' RADIO TRAFFIC CONFIRMING EFFECT AGAINST ENEMY ARTILLERY C3
- FINAL RESULTS: 18 HOSTILE BATTERIES ENGAGED IN ELAPSED TIME OF 5 MINUTES WITH 60%-80% ARTILLERY DESTROYED AND 30%-50% PERSONNEL CASUALTIES

CONTINUOUS FOLIAGE 7m HIGH

- **TYPICAL LINEAR BATTERY FORMATION IN WOOD LINE IS HIGHLY VULNERABLE TO ROD-TYPE MUNITIONS**
- **FOUR MLRS/ROD ROCKETS WILL EFFECTIVELY COVER A BATTERY**
- **LENGTH OF BEATEN ZONE CAN COMPENSATE FOR TLE, DELIVERY ERRORS ALONG ROCKET FLIGHT AXIS**

- CITED BATTLE RESULTS ARE CONSERVATIVE; ALL MISSION-ESSENTIAL COMPONENTS OF SP ARTILLERY BATTERY ARE VULNERABLE TO ROD
- ON NONLINE AR BATTLE FIELD PERMITTING FLANK SHOT, ESSENTIALLY THE SAME BATTLE RESULTS COULD BE ACHIEVED WITH ONE MLRS/ROD ROCKET

COUNTERARTILLERY - MISSILE BATTERY

PLACE:
CENTRAL EUROPE

TIME:
LATE SPRING 1998

TERRAIN:
45% FORESTED, ROLLING
HILLS, GOOD ROAD NET

WEATHER:
COLD, RAIN, FOG

ATTACKING RED FORCE:
COMBINED ARMS ARMY,
CONSISTING OF THREE
MOTORIZED RIFLE
DIVISIONS AND TWO TANK
DIVISIONS, EACH WITH
SS-21 SSM BN WITH 4 TEL

DEFENDING BLUE FORCE:
NATO (U.S.) CORPS,
CONSISTING OF 1
ARMORED, 1 MECH
INFANTRY DIVISION

DEFENDING FORCE MISSION:
DEFEND FORWARD TO ENABLE REINFORCEMENT
FROM U.S., U.K., AND GENERATION OF NATO
RESERVE FORCES

CORPS ATACMS MISSION:

- COUNTERARTILLERY
- SEAD
- DESTRUCTION OF HIGH-VALUE TARGETS

BATTLE ACTION

- 2 CORPS ATACMS/ROD PLT'S WITH 1 LAUNCHER PER PLT IN HIDE POSITION READY TO FIRE ATACMS IN 7 MIN.
- UAV LOCATES 2 OF 20 ENEMY SS-21 LAUNCHERS IN FIRING POSITION; TLE = 50-100M
- LAUNCH POSITION SIZE = EACH 150M x 90M CONTAINING:
 - ~ 1 TEL ~ 1 RELOAD VEHICLE
 - ~ METEOROLOGICAL SOUNDING TEAM
- EACH SS-21 FIRING POSITION TARGETED, ATTACKED BY 1 ATACMS/ ROD MISSILE FIRED FROM 1 ATACMS LAUNCHER WITHIN 8 MIN. OF SIGHTING
- BDA FOLLOW-UP BY UAV OVER BOTH FIRING PSNS

BATTLE RESULT

- BOTH SS-21 MISSILES, TEL FUNCTIONALLY DESTROYED; FIRES IN AREA
- LITTLE PERSONNEL, NO VEHICULAR MOVEMENT, NO RECOVERY OPNS IN AREA
- ONLY METEOROLOGICAL SUPPORT UNIT PREPARING TO EVACUATE POSITION

COUNTERARTILLERY - ASYMMETRIC ATTACK

PLACE:
PAKISTAN

TIME:
SUMMER 1995

TERRAIN:
DESERT; IRRIGATION DITCHES; WIDE,
SHALLOW RIVERS

WEATHER:
HOT, DRY

ATTACKING RED FORCE:

INDIA

2 ARMORED DIVISIONS
1 INFANTRY DIVISION
2 INDEPENDENT ARMORED
BRIGADES SUPPORTED BY
TACTICAL BALLISTIC MISSILES
WITH CHEMICAL WARHEADS

DEFENDING BLUE FORCE:

PAKISTAN

1 ARMORED DIVISION
2 INDEPENDENT ARMORED BRIGADES

U.S.

JTF COMPOSED OF
2 MECH BRIGADES
1 MARINE REGIMENT
2 AIR SQUADRONS (36 F-16)
2 MLRS/ATACMS BNS

DEFENDING FORCE MISSION:

EJECT INVADERS; OBTAIN PEACE
TERMS FAVORABLE TO PAKISTAN

RSTA TASKS:

LOCATE, DESTROY SSMs BEFORE
THEY FIRE; LOCATE AIR DEFENSES

RSTA ASSETS:

- U.S. JSTARS
- PAK SPECIAL SERVICES GROUP
(HUMINT)

BATTLE ACTION:

- JSTARS DETECTS MOVEMENT OF MISSILE SYSTEMS TO NEW FIRING LOCATIONS
- IMPRECISE LOCATION OF NEW POSITIONS RULES OUT ATACMS EMPLOYMENT
- DENSE AIR DEFENSES LOCATED BY PAK SPECIAL SERVICES GROUP IN AREA INDICATE THAT AIR RECCE AND BAI ARE HIGH RISK
- ATACMS/ROD IS EMPLOYED AGAINST PRECISELY LOCATED AIR DEFENSES
- F-16s RECCE PRESUMED POSITION AREAS; LOCATE, ATTACK MISSILES AND LAUNCHERS WITH CEM

BATTLE RESULT:

- ATACMS/ROD DESTROYS 1 SAM GROUP (4 BTRY) MISSILES, RADARS, POWER SOURCES, 65% OF OPERATORS
- CEM FUNCTIONALLY DESTROYS 2 PRITHVI SSM BTRIES

COUNTERARTILLERY - ASYMMETRIC ATTACK (CONT.)

EMPLOYMENT CONSIDERATIONS:

- DESTRUCTION OF AIR DEFENSES BY ATACMS/ ROD COORDINATED WITH F-16 FLIGHT
- CEM SUITABLE FOR ATTACK OF SS-21. MAVERICK OR AIR-TO-GROUND ROD COULD ALSO BE EMPLOYED

BATTLE RESULTS CONSIDERATIONS:

- COMPONENTS OF ONLY ONE AD, SSM BATTERY SHOWN
- LETHAL AREA FIRE WEAPONS ENSURE DESTRUCTION OF BOTH AD, SSM BATTERIES

ARM/ROD IN AIR DEFENSE SUPPRESSION

PLACE:

HAS LITTLE INFLUENCE ON
WEAPON EMPLOYMENT

TIME:

SAME

TERRAIN:

SAME

WEATHER:

VISIBILITY FAIR

ATTACKING RED FORCE:

TANK BATTALION ON ROAD WITH
TWO SA-11/2S6 TEAMS PROVIDING
COLUMN COVER

DEFENDING BLUE FORCE:

AIRCRAFT	ORDNANCE
2 F-16C	4 MAVERICK EA.
1 F-4G	2 ARM/ROD EA.
1 F-16C	2 ARM/ROD EA.

DEFENDING FORCE MISSION:

INFLECT MAXIMUM DAMAGE ON
ENEMY ARMOR TAKING MINIMUM
LOSSES FROM HOSTILE AIR DEFENSE

BATTLE ACTION:

- JSTARS ALERTS
ATTACKING
FORCE TO ENEMY
MOVEMENT
- F-4G DETECTS SSNR
ACQUISITION RADAR
- HUNTER-KILLER TEAM
POSITIONS AND
ATTACKS SA-11/2S6
COUNTER AIR
TEAM

BATTLE RESULT:

- ARM/ROD DESTROYS
RADAR; KILLS AIR
DEFENSE SYSTEMS,
PERSONNEL
- ATTACK TEAM RENDERS
TANK BATTALION
INEFFECTIVE WITH
MAVERICK

HIGH VALUE TARGET ATTACK - MOTORIZED RIFLE BATTALION

PLACE:
KUWAIT

TIME:
WINTER 1995

TERRAIN:
DESERT
• TRAFFICABLE EXCEPT FOR
FEW WADIS

WEATHER:
COOL

ATTACKING RED FORCE:
TWO IRAQI MECHANIZED
DIVISIONS

DEFENDING BLUE FORCE:
• 3 KUWAITI BRIGADES
• U.S. JTF (1 LIGHT BDE; 1 MEB;
1 MLRS BATTERY; TACAIR)

DEFENDING FORCE MISSION:
• DELAY IRAQI ADVANCE UNTIL ARRIVAL
OF HEAVY FORCES (SEALIFT) FIRE
SUPPORT ASSETS (LT BDE):
• 105MM HOWITZER BN
• MLRS BATTERY
• ATK HELICOPTER BN
• FIRE SUPPORT AERIAL OBSERVER (FSAO)

MLRS MISSION:
• COUNTERFIRE - DPICM,
SADARM
• COUNTER LIGHT ARMOR - ROD

BATTLE ACTION:

- 2 MLRS PLATOONS - COUNTERARMOR (ROD)
- 1 MLRS PLATOON - COUNTERARTILLERY
- 1 LAUNCHER PER PLATOON IN HIDE POSITION, READY TO FIRE (4 MINUTES)
- FSAO DETECTS IRAQI MR BATTALION (36 VEHICLES) IN STATIONARY POSITION EACH COMPANY (11 VEHICLES) OCCUPIES 50,000 M2
- FSAO ENTERS THREE COMPANY TARGETS INTO FIRE CONTROL SYSTEM
- ONE MLRS LAUNCHER ENGAGES EACH COMPANY TARGET WITH 4 ROCKETS

BATTLE RESULT:

- 70% OF VEHICLES IN MR BN ARE DAMAGED OR DESTROYED; 35% PERSONNEL CASUALTIES

FERA

- **EVEN WITH LARGE TLE AND DELIVERY ERRORS, THE MAJORITY OF BATTALION'S RESOURCES WOULD BE AT RISK**
- **AGAINST TYPICAL SOVIET DOCTRINAL MOTORIZED RIFLE ARRAY SEEN IN MANY ARMIES, ONE LOAD OF MLRS/ROD (12 ROCKETS) IS CAPABLE OF DESTROYING ONE BATTALION**

20km

MLRS IN READY
POSITION

The diagram shows a simple electrical circuit. On the left, there is a battery represented by two cells, each with a long vertical line (positive) and a short, thick vertical line (negative). A wire connects the positive terminal of the battery to the top terminal of a light bulb. The light bulb is represented by a circle with a cross inside. Another wire connects the bottom terminal of the light bulb to the right terminal of a switch. The switch is represented by two small circles connected by a horizontal line. A dashed line indicates the switch is currently open. A final wire connects the left terminal of the switch back to the negative terminal of the battery, completing the circuit.

- **CITED BATTLE RESULTS ARE CONSERVATIVE**
- **RESULTS WOULD NOT BE REDUCED APPRECIABLY BY LIGHT BRUSH AND VEGETATION FOUND IN THIS PART OF THE WORLD**

FEB

OUTLINE

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- ➔ **CONCLUSIONS**
- **RECOMMENDATIONS**

CONCLUSIONS

THERE ARE A WIDE RANGE OF THREATS WORLDWIDE THAT THE U.S. COULD BE REQUIRED TO DEFEAT

- **ARTILLERY - CANNONS AND MISSILES - ARE AMONG THE MOST MENACING TO U.S. FORCES**
- **ROD HAS THE POTENTIAL TO BE A HIGHLY LETHAL, INEXPENSIVE COUNTERARTILLERY WEAPON**
- **ROD IS VERY VERSATILE AND CAN BE USED AGAINST A WIDE RANGE OF NONARTILLERY TARGETS, TO INCLUDE LIGHTLY ARMORED TARGETS**
- **ROD MUNITION VARIATIONS FOR SPECIAL PURPOSE MISSIONS - ANTIHELICOPTER/ ANTIREACTIVE-ARMOR EQUIPPED TANK, ALTERNATIVE WARHEAD FOR HARM - APPEAR ATTRACTIVE**
- **ROD TECHNOLOGY SHOULD BE DEVELOPED TO THE POINT THAT IT DEMONSTRATES THAT IT MEASURES UP TO ITS POTENTIAL IN ONE OR MORE OF THE WEAPONS APPLICATIONS DISCUSSED**

ROD TECHNOLOGY SHOULD BE DEVELOPED

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RECOMMENDATIONS

- CONDUCT FURTHER DARPA DEVELOPMENT, THROUGH SEVERAL PROOF-OF-PRINCIPLE FIRINGS
 - GUN: ANTI-REACTIVE ARMOR, ANTIHELICOPTER
 - ROCKET: MLRS
 - OR MISSILE: ATACMS
- FORM A TECHNOLOGY REVIEW COMMITTEE WITH SERVICE MEMBERSHIP
 - TO DEVELOP THE REMAINING TECHNOLOGY ISSUES OF INTEREST TO DARPA AND THE SERVICES
 - TO FURTHER INFORM AND INTEREST THE SERVICES IN ROD; EXAMINE OTHER APPLICATIONS
 - TO DEVELOP SERVICE SPONSOR(S), FUNDING SUPPORT
- OBTAIN SERVICE PARTICIPATION ON TECHNOLOGY REVIEW COMMITTEE TO INCLUDE MEMBERS OF REQUIREMENTS COMMUNITY AS WELL AS R&D MEMBERS

GLOSSARY

ABN EW	AIRBORNE ELECTRONIC WARFARE
AD	AIR DEFENSE (GUNS, MISSILES)
APAM	ANTI-PERSONNEL, ANTI-MATERIEL (BOMBLET MUNITION FOR ATACMS)
APGM	ARTILLERY-FIRED PRECISION GUIDED MUNITION
ARM	ANTI-RADIATION MISSILE (TO ATTACK RADARS)
ASAS	ALL-SOURCE ANALYSIS SYSTEM (INTELLIGENCE COMMAND AND CONTROL SYSTEM)
ATACMS	ARMY TACTICAL MISSILE SYSTEM
BAI	BATTLEFIELD AIR INTERDICTION
BDA	BATTLE DAMAGE ASSESSMENT
BN, BNS	BATTALION, BATTALIONS
C ³	COMMAND, CONTROL, AND COMMUNICATIONS
CBU	CLUSTER BOMB UNITS (BOMBLETS CONTAINED IN LARGER BOMB)
CEM	COMBINED EFFECTS MUNITION (ANTIPERSONNEL, ANTIMATERIEL)
CFE	CONVENTIONAL FORCES EUROPE (FORCE REDUCTION AGREEMENT)
CP	COMMAND POST
DMZ	DEMILITARIZED ZONE
DPICM	DUAL-PURPOSE IMPROVED CONVENTIONAL MUNITIONS (ANTIPERSONNEL, ANTIMATERIEL)
DS	DIRECT SUPPORT (A DEDICATED, IMMEDIATELY RESPONSIVE UNIT)
DUST-OFF	MEDICAL EVACUATION HELICOPTER
EXJAM	ARTILLERY-DELIVERED EXPENDABLE COMMUNICATIONS JAMMER
FDC	FIRE DIRECTION CENTER (FIELD ARTILLERY FIRING DATA CALCULATION CENTER)
GS	GENERAL SUPPORT (NONDEDICATED SUPPORT FROM A UNIT)
GUARDRAIL V	AIR-GROUND COMMUNICATIONS INTELLIGENCE SYSTEM TO LOCATE ENEMY TRANSMITTERS
HARM	HIGH-SPEED ANTI-RADIATION MISSILE (TO ATTACK RADARS)
HE	HIGH EXPLOSIVE
HUMINT	HUMAN INTELLIGENCE (FROM PATROLS, SPIES, POW INTERROGATION, ETC.)
IPB	INTELLIGENCE PREPARATION OF THE BATTLEFIELD (MAP, ORDER OF BATTLE ANALYSIS, ETC.)
JAMMERS	DEVICES TO INTERFERE WITH RADIOS, RADARS
JSTARS	JOINT SURVEILLANCE AND TARGET ATTACK RADAR SYSTEM (AIRBORNE SENSOR AND DOWNLINKS)
JTF	JOINT TASK FORCE (MULTISERVICE COMBAT FORCE)
LT BDE	LIGHT BRIGADE (COMPOSED OF LIGHT COMBAT FORCES, VICE ARMOR FORCES, ETC.)
MAVERICK	AIR-TO-GROUND PRECISION GUIDED TACTICAL MISSILE FOR USE AGAINST HARD TARGETS
M, M ²	METER(S), SQUARE METER(S)
MEB	MARINE EXPEDITIONARY BRIGADE
MET	METEOROLOGY UNIT (DETERMINES METEOROLOGICAL CONDITIONS FOR FIELD ARTILLERY, MISSILE UNITS)
MLRS	MULTIPLE LAUNCH ROCKET SYSTEM (SURFACE-TO-SURFACE ROCKETS)
MR	MOTORIZED RIFLE (WARSAW PACT UNIT; E.G., MR DIVISION)
MTI	MOVING TARGET INDICATOR (A SENSOR UNIT)
NLOS-FOG M	NON-LINE OF SIGHT FIBER OPTIC GUIDED MISSILE (AIR DEFENSE MISSILE)
OH-58D	KIOWA WARRIOR HELICOPTER WITH MAST-MOUNTED SIGHT

GLOSSARY (CONT.)

OV-ID	MOHAWK AIRCRAFT WITH SLAR, PHOTOGRAPHIC, OR INFRARED SENSORS
PAK	PAKISTAN, PAKISTANI
PLT	PLATOON (A SMALL MILITARY SUBUNIT OF A COMPANY/BATTERY/TROOP)
PRITHVI	INDIAN SURFACE-TO-SURFACE MISSILE
PSN	POSITION
QUICKFIX	TACTICAL ELECTRONIC JAMMING, INTERCEPTION, AND DIRECTION -FINDING AIRCRAFT)
QUICKLOOK	MOHAWK AIRCRAFT WITH LOCATION SENSORS FOR RADARS, OTHER NONCOMMUNICATION EMITTERS
RECCE	RECONNAISSANCE
REMBASS	REMOTELY EMPLACED BATTLEFIELD ACOUSTIC AND SEISMIC SENSORS
RHA, RHAE	ROLLED HOMOGENEOUS ARMOR, RHA EQUIVALENT
RISTA	RECONNAISSANCE, INTELLIGENCE, SURVEILLANCE, TARGET ACQUISITION
ROCKEYE	AIR-DELIVERED BOMB WITH ANTIPERSONNEL, ANTI-LIGHT ARMOR CBU's
ROD	RAIN OF DARTS (DEVELOPMENTAL AREA DESTRUCT WEAPONS SYSTEM)
RSTA	RECONNAISSANCE, SURVEILLANCE, TARGET ACQUISITION
SA-11/2S6	SOVIET AIR DEFENSE MISSILE AND GUN SYSTEM
SADARM	SENSE AND DESTROY ARMOR ("SMART" MLRS OR 155mm HOWITZER MUNITION)
SASS	SMALL AEROSTAT SURVEILLANCE SYSTEM (TETHERED BALLOON WITH SENSORS)
SEAD	SUPPRESSION OF ENEMY AIR DEFENSE
SHELLREP	SHELL REPORT (ANALYSIS OF SHELL CRATER THAT MAY HELP PINPOINT ENEMY ARTILLERY LOCATION)
SIGINT	SIGNALS INTELLIGENCE
SLAR	SIDE-LOOKING AIRBORNE RADAR
SP, SPH	SELF-PROPELLED; SELF-PROPELLED HOWITZER
SRNF	SHORT RANGE NUCLEAR FORCES
SS, SSM	SURFACE-TO-SURFACE; SURFACE-TO-SURFACE MISSILE
SS-21	SOVIET SURFACE-TO-SURFACE MISSILE
START	STRATEGIC ARMS REDUCTION TALKS
STINGRAY	LASER BEAM CAPABLE OF DAMAGING OR DESTROYING ENEMY FIRE CONTROL OPTICS, NIGHT VISION EQUIPMENT
TACAIR	TACTICAL AIRCRAFT
TACIT RAINBOW	ANTIRADAR MISSILE (EITHER AIR- OR GROUND-LAUNCHED)
TASM	TACTICAL AIR-TO-SURFACE MISSILE
TEL	TRANSPORTER ERECTOR LAUNCHER (MAJOR GROUND-LAUNCHED MISSILE-HANDLING COMPONENT)
TGSM	TERMINALLY GUIDED SUB-MUNITION ("SMART" MUNITION DELIVERED BY ATACMS
TGT	TARGET
TGW	TERMINALLY GUIDED WARHEAD ("SMART" MUNITIONS DELIVERED BY MLRS)
TLE	TARGET LOCATION ERROR
TPQ36, 37	MORTAR- AND ARTILLERY-LOCATING RADARS
UAV	UNMANNED AERIAL VEHICLE (SMALL, UNMANNED AIRCRAFT WITH SENSORS)
WILD WEASEL	AIRCRAFT WITH MISSION OF DETECTING, DESTROYING ENEMY RADARS