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INDEPENDENT ASSESSMENT OF TRADE-OFF DETERMINATION AND
TRADE-OFF ANALYSIS F..(U) XMCO INC MCLEAN VA
J SPERRAZZA ET AL. 30 MAR 83 DAAK10-83-M-0007

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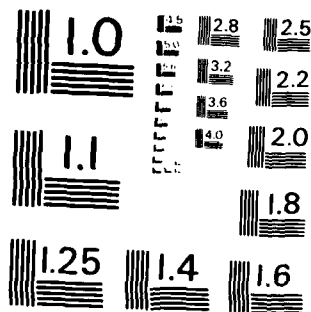
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INDEPENDENT ASSESSMENT OF TRADE-OFF
DETERMINATION AND TRADE-OFF ANALYSIS
FOR DIVISION SUPPORT WEAPON SYSTEM

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30 March 1983

FINAL REPORT FOR PERIOD
February 8, 1983-March 20, 1983

Prepared for:

Project Manager
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AD A 131494
MAR 16 1983

Under Purchase Order Issued by
Department of the Army
U.S. Army Research and Development Command
Attn: DRCM-PRW-ATG, Gorman
Dover, NJ 07801

DTIC FILE COPY

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. REPORTING CATALOG NUMBER
Report DAA10-83-M-0007	AD-A131494	
4. TITLE (and Subtitle)		5. TYPE OF REPORT & PERIOD COVERED
Independent Assessment of Trade-Off Determination and Trade-Off Analysis, For Division Support Weapon System		Final Report, February 2 to March 30, 1983
6. PERFORMING ORG. REPORT NUMBER		
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
Dr. Joseph Sperrazza Mr. Henry Shelton		DAA10-83-M-0007
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
AIAD, Inc. 100 Greensboro Drive Suite 801, McLean, Virginia 22102		6.629A-D008
11. CONTROLLING AGENCY NAME AND ADDRESS		12. DISTRIBUTION STATE
Department of the Army US Army Armament R&D Command Fort, NJ 07001 Attn: DRAA-FW-513		March 30, 1983
13. AUTHOR'S REPORTING AND TRADE DESIGNATION (When Applicable)		14. NUMBER OF PAGES
Independent Manager Division Artillery Weapons System Fort, NJ 07001 Attn: DRAA-FW, (a. Fiscal) (a)		15. SECURITY CLASSIFICATION
		Unclassified
16. ABSTRACT (When Applicable)		17. SECURITY CLASSIFICATION OF ABSTRACT
		Unclassified
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (When Applicable) (When Applicable) (When Applicable)		
Division Support Weapon System (DSWS), Field Artillery, Division Support, Survivability, Vulnerability, Nuclear Hardening.		
20. ABSTRACT (When Applicable) (When Applicable) (When Applicable)		
The following is a summary of the conclusions drawn from review of DSWS T&E and T&E documentation coupled with discussions with representatives of the development and analytical communities. The major concern is predictive margins survivability of the candidate DSWS. Suggested solution to the predicted marginal survivability problem is the use of a unique armor for the chassis of the new DSWS. Additional suggestions to enhance the overall		

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DSWS effectiveness includes: an antiholocauster GRAF round, a flechette round for defense against direct ground attack, improved MET data, replacement of copper rotating bands with plastic ones, and continued high priority emphasis on advanced propellants and remotely settable timed fuzes.

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CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. DSW SURVIVABILITY CONFERENCE	1
3. NUCLEAR SURVIVABILITY/VULNERABILITY	5
4. SURVIVABILITY COMMENTS	7
5. SUMMARY.	12

Appendix 1 - Conference Agenda

Appendix 2 - Bibliography

Distribution

1. INTRODUCTION

This report provides the final results of the Purchase Order DAAK10-83-M-007 task performance requirements to conduct an independent assessment of Trade-Off Analysis and Trade-Off Determination for PSWS.

The purpose of this report is to provide comments resulting from the authors' independent assessment of PSWS draft TOA and TOD, plus the results of extensive conferences, meetings, and conversations with members of the developmental and analytical communities. These comments were formulated primarily by the principal analyst, Dr. Joseph Spornazza, and reflect a perspective gained from many years experience in evaluating major weapons as Director of the U.S. Army Materiel System Analysis Agency (AMSAA).

The report is organized in the five following sections: an introduction which provides background information; a section that addresses the PSWS Survivability Conference, to include observations and follow-on actions; a section that reports a meeting with HQ on nuclear survivability/vulnerability; a section that provides independent comments on survivability made by the principal analyst regarding PSWS and related developments; and, a summary section.

2. PSWS SURVIVABILITY CONFERENCE

The office of the Project Manager, Cannon Artillery Weapon Systems (OP*, CANS) hosted the PSWS Survivability Conference at ARRADCOM Dover, New Jersey, on January 11-12, 1983. This conference brought together both in-house and industry representatives that were interested in PSWS survivability. Detail presentations were made on actions ongoing to provide for a survivable PSWS. The stated objective was to identify "soft" areas where additional efforts should be focused to better prepare for AMRC/PMARC I.

All participants were trained on the four major deficiencies defined in the Mission Element Need document that provided the requirement for BSMS. These stated deficiencies were: responsiveness, terminal effectiveness, RAN, and survivability. Development goals to address the deficiencies were divided into four broad areas: improved design, airframe reduction, improved mobility, and minimum time to repair.

The war community presented a critical case for the need to develop a self-sustained howitzer (SPH) that can rapidly occupy a position, deliver effective munitions on the selected target in a short period of time, and quickly displace to a subsequent firing position. Concurrently, the SPH must be capable of being transported by air, land, or water by vehicle (ARV) that provides protection for ammunition and crew from counterfire or ill-fragments. A prime consideration of the user is reduction in crew size in the forward area.

Many of the users' requirements can be met with a combination of the M109 program, the adoption of new hardware provided by associated programs, and state-of-the-art electronics to the M109.

First, the M109 is being addressed in the howitzer Extended Life Program (ELP), resulting from the NSAW studies, will provide a positive step in increasing RAN, NRE, protection, and survivability.

Noteworthy improvements, responding to the users' requirement for rapid emplacement/displacement, are automatic gun positioning to eliminate the need for survey of each gun position, and remote control for the trail lock and slides. For that survivability improvement, as stated in this phase to fire ammunition inside the vehicle. Second, the adoption of a tailored package of SINGAS, CDS, DSA, and M/FPS equipments will provide the capability for enhanced automatic processing of

technical time control for the SPH. Item 4, the incorporation of an automatic loader and gun laying device in the SPH drastically reduces the time required to convert from manual to automatic firing.

Assuming that these capabilities exist and are used to change in artillery tactics to reduce vulnerability to the enemy's concept of massive counterfires on located batteries. These tactics embody several new ideas. "Spread formation" is firing platoons allow for greater distances (not less than 100 meters) between firing units, thereby decreasing the enemy's ability for precision target location and reducing the overall exposure to counterfires. "Move on incoming" allows for displacement of a platoon or fire unit before enemy rounds are used to destroy effective units allowing continuous or continued firing.

The analysis done to date in support of the new tactics do not consider offsetting factors such as: increased unit maintenance requirements due to increased care of fire and frequent movement; competition for suitable terrain for subsequent firing positions; and, changes in enemy tactics and equipment.

Analysis of these new tactics did not consider changes in countermeasures. For example, the enemy might deem his battery neutralization in favor of using less ammunition to force "move on incoming," and he might selectively use scatterable mines and/or infiltrate small unit ambushes with antiarmor weapons along likely displacement routes. The whole area of countermeasures should be examined to determine their impact on these new tactics.

The above discussion leads to one of the main issues presented to this conference; i.e., what is the threat? The presentation on the threat presented a lengthy catalog of possible enemy systems that had the capability to attack ASWS, but this was not limited down to the most likely threat within the

context of the combined arm: team operating against a postulated force. Of particular concern is disregard of future enemy munitions improvement ("smart" shells or controlled fragmentation) in analyzing effects of counterfires. This type of analysis could lead to the wrong conclusions as to the vulnerability of propellants and the importance of the location for their storage, including compartmentalization and blow-out panels to protect the crew.

A presentation was made on the structure of work for the independent facilitation panel of DSWS. An initial problem area became apparent in reviewing the draft SOV. That is, available information had to be loosely completed studies on related survivability issues. Examples were: AMSAA collection of structural, thermal stress, flight harness, and blow-out panels; "TICOM" vulnerability compartmentalization; blow-out panels, and crew in maintenance; and, vulnerability studies regarding location of critical components and propellants.

The sum of these presentations provided interesting aspects of survivability when investigated by segments, and identified some technical factors that individually should help DSWS to survive. However, there seemed to be lacking any attempt to interrelate all these factors into the overall system survivability within a reasonable scenario that gives credit to the enemy to improve both weapons and tactics during the time frame of interest.

A follow-on meeting was held to discuss some of the information presented at the DSWS Survivability Conference. At this meeting, the authors were requested to arrange conferences with AMSAA, FRM, BDI, and ARBACOM to improve analytical data required to support the DSWS ASARC. Appendix A lists the conferences scheduled by location, subject, and attendees. The results of

these conferences will be reflected in the continuing analysis conducted by these agencies in support of DPM.

3. NUCLEAR SURVIVABILITY/VULNERABILITY

A conference was scheduled at Harry Diamond Laboratories (HDL) Adelphi, Maryland to discuss an approach to assist DPM/CSW to address nuclear survivability/vulnerability at ASARC. This conference began with a definition of the basic survivability philosophy that equipment must survive in such a way that elements here are expected to survive and be expected to complete the assigned mission after a nuclear attack. Nuclear survivability requires identification and protection of all essential equipment including command and support equipment needed to establish a critical position or function.

The nuclear threat was divided into two broad categories: the tactical threat (neutrons, gamma rays, blast, thermal, and radio), and the high altitude burst phase (EMP). Emphasis during the remainder of the presentation centered on hardening against electromagnetic pulse because of the magnitude of vulnerability of electronic components in DPM and its command and equipment.

A review of the directives and regulations requiring specific nuclear survivability in material acquisition was conducted. In addition to the basic DODI's 5000.1, 5000.2, and 5000.3 a new DODI 3120.XX, "Acquisition of Nuclear Survivable and Enduring Systems", is currently being drafted and will probably be in effect at the time DPM goes to DSARC review. Concurrently, AR70-60, "Army Nuclear Survivability", will provide the Army's similar requirements expanded to include consideration of force constitution and response to multiple burst. These instructions/regulations will require summaries of plans for nuclear survivability to be included in system concept papers (SCP), decision coordination papers (DCP), and integrated program summaries (IPS).

To assist the project manager in defining the proper specifications for nuclear survivability, the following Data Item Descriptions have been published and should be included as requirements in statements of work presented to hardware contractors:

DI-R-1758 - NUCLEAR SURVIVABILITY PROGRAM PLAN

DI-R-1759 - NUCLEAR WEAPONS EFFECTS TESTS PLAN

DI-R-1760 - NUCLEAR WEAPONS EFFECTS TEST REPORT

DI-R-1761 - NUCLEAR SURVIVABILITY DESIGN PARAMETERS REPORT

DI-R-1762 - NUCLEAR SURVIVABILITY ASSURANCE PLAN

DI-R-1763 - NUCLEAR SURVIVABILITY MAINTENANCE PLAN

One of the positive aspects of the project was the assurance that the associated contractors (TACDAR, AIRCRAFT SINGAPORE, PIR, PIRAS) all have active programs for requirements to harden against EMP. A good example is that the effort to harden the MI rack and to add Vack filters was done for less than 1% of hardware cost. The MI was cited as a good example of a successful nuclear survivability program based on the fact that planning began early and nuclear survivability was a basic consideration in the design of critical components.

The importance of test and evaluation planning, including EMP evaluations of early prototypes and EMP simulator testing of the developed system, was emphasized. This type testing should be included in the DSW master test plan.

HDL representative, Mr. John J.F. Corrigan, offers the assistance of his office and special expertise to advise DPCDM-CWW on all aspects of nuclear survivability. That offer

included a briefing to OPM TAWS on this subject and preparation of an outline of the appropriate briefing for AFALC presentation.

4. SURVIVABILITY COMMENTS

Assessment of the analysis comparing AWS, CO and TOA leads to a conclusion that the BSWSs under consideration cannot meet all critical needs. In particular, neither the current HP, the new version with a ballistic limit or thickness less than or equal to 1/2 inch of aluminum can survive a battle of interest of the 1960's. The threat will consist of a series of old plus new weapons. On the whole, it is likely that the BSWS will be able to produce a very high level of survivability, such as controlled, delayed, and fragmented. Recall that, in the case of the BSWS, Sweden never had a complete record (called "mild") of a battle of interest. With experience and adequate time, a BSWS can be developed now to be able to obtain appropriate survivability results in a forward spray of very effective treatment.

Costs and analysis should be integrated to provide a useful survivability model. The most important consideration must be the need for detailed consideration of the effects of the various types of weapons and their effects (e.g., fragments, bullets, rockets, etc.). Each damage type must be estimated in order to determine the resulting damage (e.g., speed and direction) of every fragment including spall and the damaging effects on each fragment, etc., on the various components. Then one can intelligently relocate internal components and/or provide appropriate armorability. The vehicle must be tough enough to withstand some of the major threat weapons. It appears that none of the candidate BSWSs are tough enough.

To provide a convincing and timely service for modeling, it is suggested that the project hire the services of an outside

contraction. His services should be made available to all interested parties (governmental, commercial) seeking data on CWS.

The idea of autonomous operations makes sense, but a serious vulnerability is apparent. Spread configuration will make it difficult to provide local security, especially in a host and sensor team. When air is used to deliver a sensor, the sensor can be put away with the host during a tactical pause.

It is suggested that a similar situation could arise in particular, a plane crash should be considered as a possible event. That aircraft would render a very interesting article that which have not been specifically addressed in the previous article. Aerial elements of survival, including the possibility of a fall-back to a place to take refuge, and the possibility of the aircraft being shot down.

On August 1, 1961, I learned that the Yee Hing Kwoon was involved in a conflicting case over the importance of balls thrown at the altar, and, early after, several members of the Yee Hing Kwoon were charged with destroying a walling altar. Another member was charged with allowed to be a member of the Yee Hing Kwoon, and was charged with, especially with the position of a member of the Yee Hing Kwoon in the Yee Hing Kwoon, and was charged with the Yee Hing Kwoon--and it was not.

With a service life of 100,000 hours, a low maintenance level and low cost, only a single.

Unsurprisingly, this will entail a re-examination of the FLAT bid, at least at ranges, deliver some pre-identified with intended round. Moreover, it would be possible to look for special "guided" rounds such as, improved HARP projectiles,

penetration, p is

$$p = \sqrt[2/3]{\rho_p} / V$$

where ρ_p is penetrator density.

Thus it is recommended that the war reserve should be replaced with tungsten cored rounds. Present rounds should be used for training and for FMS (foreign military sales).

The use of a flechette round equipped with a remotely settable fuse (coupled with a knowledge of muzzle velocity and range to target) can provide good effects against helicopters and enemy ground troops.

Improving Accuracy

The studies to date ignore the reasons for inaccuracy of improving the accuracy of fire. Ammunition failure occurred in World War II as to the reasons why it occurred fall into two categories: as far as 1000 yards to 7000 yards range still contain problems today. Those problems lay mainly in shell design tolerance.

- a. Poor exterior finish
- b. Exceptionally low dimensional tolerances
- c. Loose rotating bands
- d. Coppering/de-coppering effects

An associated program should be carried out to minimize these errors. In particular, serious consideration should be given to replace the present copper bands with a plastic one. Such replacements will virtually eliminate velocity spread within a tube and minimize tube-to-tube errors. Of importance is that one need not fire "warmer" rounds.

Further improvement of accuracy of fire is the knowledge of the velocity of every shell. With today's state-of-the-art it is possible to develop a simple, nonrotating, velocimeter to do this. The proposed techniques are piezoelectric strain gages mounted on the gun muzzle to measure the velocity of each round. These data can be fed directly to a ballistic computer and thereby provide improved fire. The use of this simple velocimeter can provide recalibration with a virtually new round. Moreover, by combining the velocity into the existing trajectory computer, there can be achieved excellent accuracy for both heavy and flexible rounds.

The problem of minimizing the number of rounds fired in the field is a continuing one. A solution of this problem can be achieved by expansion of lot size reductions of propellant, its formulation and elimination of the effects of large lot-to-lot variations. This also is achieved.

The current Meteorological Data System (MDS) development should enhance field artillery accuracy, and, consequently, enhance the terminal effects of conventional munitions. Thus, with precise ammunition, velocimeters, remotely settable fuses and accurate and timely MDS messages, it is possible to deliver conventional ammunition that could perform some missions now assigned for terrainally guided munitions.

Programs that could lead to the improvements just enumerated should be started now as the results are beneficial to all howitzers.

Automatic Fire

Technical problems at developing and fielding an effective and reliable automatic loader would be ameliorated considerably with a larger and more survivable vehicle. That automatic fire

is needed is without question. During battle situations autonomy is akin to taking one's hands off the wheel of fate. The tough APB would enjoy a much higher level of availability during battle and thereby reduce the requirement of supplying a high maintenance force.

A second desired program of research compellants suitable for autonomous control is concerned with high accuracy.

Accuracy

Operational requirements for the new APB: i.e., rate of fire, automation, increased range, and enhanced availability. It can be said that beyond the initial capabilities of the CII line craft, therefore, the minimum requirement, as a design goal, the requirements for the new APB will be the envelope of weight, dimensions and cost of the craft.

7. SUMMARY

The following is a summary of the conclusions drawn from review of the DWS and the APB development, and the various findings with respect to the status of the new APB and the DWS.

The major concern is predicted marginal survivability of the candidate DWS's. There is need in the current analyses to not address controlled fragmentation, B.I. ammunition or scatterable mines. Some of these types of munition are within the enemy's capability in the time frame of interest, and appear to be likely countermeasures to a DWS using the proposed tactics (i.e. "spread formation" and "move or inactivate").

A suggested solution to the predicted marginal survivability problem is the need to optimize armor for the chassis of the new DWS.

(The extent of engineering required in the suggested modification has not been addressed.) This approach appears to correct the essential shortfalls in survivability including NBC protection. An alternative to this suggested solution would be the use of the M1 tank chassis. This alternative offers potential for: R&D cost reductions (i.e., no requirement to develop a new power plant, suspension, and hull); production cost savings as a result of larger procurement quantities; and, standardization of components.

Additional suggestions to enhance the overall DPM's effectiveness include: an antiballistic STAFF round; a flechette round for defense against direct ground attack; improved MET data; replacement of copper rotating bands with plastic ones; and, continued high priority emphasis on advanced propellants and smart, retable timed fuses.

APPENDIX A

Conferences arranged to improve analytical data compiled to support the DSWS ASAW review.

Location	Subject	Attendees
USARPADCOM Dover, NJ	Description of the problem. Provided copy of TOB.	1. Sperrazza, Consultant M. Hinton, CNA
USARPADCOM Alexandria, VA	Army Product Improvement Program including the M109, 155mm etc.	1. Sperrazza, Consultant G. W. Roberts and staff
USARPADCOM Dover, NJ	Participation in DSWS Survivability Conference and follow-up meeting and discussions.	H. Shelton, XMC D. Menke, CAS T. Koss, CWS M. Fisetto, CWS M. Della Torre, CAS
USARPADCOM Dover, NJ	Description of survive ability data and analysis. Provided copy of TOB. Request for J. Sperrazza to visit BSL, CMMA, GHL, and review support work for DSWS.	J. Sperrazza, Consultant H. Shelton, XMC M. Fisetto, CWS M. Della Torre, CAS
BSL, AFG, ME	Conference on improving methodology for predicting survivability of the M109 SPH.	1. Sperrazza, Consultant D. Kinsler, BLV-F W. Kokinakis, BLV-F
AMBA, AFG, ME	Conference on Survivability measures for M109. Protection of projectile, by compartmentalization and blow-out panels.	J. Sperrazza, Consultant R. Bailey
BSL, AFG, ME	Follow-on to previous conference with an emphasis on how to improve M109 SPH survivability data.	J. Sperrazza, Consultant J. Zeller, ASI W. Kokinakis, BLV-F

APPENDIX A (Con't)

Conferences arranged to improve analytical data required to support the DSWS ASARC review.

<u>Location</u>	<u>Subject</u>	<u>Attendees</u>
HDL Arling, MD	Nuclear vulnerability survivability data required for the DSWS program.	J. Sperrazza, Consultant H. Shelton, XMOO G. Corrigan, LW-P
USARSDCOM Dover, NJ	Reviewed system analy- sis concern of DSWS: rate of fire, delivery precision, quick MET message, large lot size for propellants, elimin- ation of copper rotation wands.	J. Sperrazza, Consultant J. Brooks, LIS-A S. Bin Jaber

APPENDIX B
BIBLIOGRAPHY

U.S. Army ARRADCOM, PM CAWS. Analysis of DSW Requirements and Alternatives. December 1982.

U.S. Army ARRADCOM, PM CAWS. Division Support Weapon System (DSWS) Trade-off Analysis (TOA). Draft #2, December 1982.

U.S. Army ARRADCOM, PM CAWS. Division Support Weapon System Best Technical Approach. Draft, November 1982.

U.S. Army ARRADCOM, PM CAWS. Division Support Weapon System (DSWS) Industry Briefing Demonstration/Validation Phase. August 1982.

Department of the Army, Harry Diamond Laboratories. Letter, DFLPD-NW-P with enclosed vignettes from briefing "Nuclear Survivability/Vulnerability of Army Materiel." March 1983.

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