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DRSAR/SA/N-47

SYSTEMS ANALYSIS DIRECTORATE ACTIVITIES SUMMARY MAY 1976

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JUNE 1976

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US ARMY ARMAMENT COMMAND
SYSTEMS ANALYSIS DIRECTORATE
ROCK ISLAND, ILLINOIS 61201

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Foreign Military Sales (FMS)
Army-Navy Guided Projectile
Design tolerances
Physical security simulation
Tank-Antitank Model Implementation
CAMERA analysis
VADS
British L16A3, 81mm mortar
Single round hazard distance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This monthly publication contains Memoranda for Record and other technical information that summarize the activities of the Systems Analysis Directorate, US Army Armament Command, Rock Island, IL.

The subjects dealt with are: pricing of FMS, DARCOM Draft Regulation 11-1, Army-Navy Guided Projectile Comparison Study, overdesign of equipment, physical security simulation study plan, tank-antitank model implementation, CAMERA recommendations for AAP's, VADS PIP application study, British 81mm

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Mortar, L16A3, and single round hazard distance.

CONTENTS

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Section I. GENERAL

1. This monthly publication summarizes the activities of the Systems Analysis Directorate. The purpose of this note is to give wider and more timely distribution on subjects of concern to the command.

2. The most significant Memoranda for Record (MFR's) and other technical information will be published as notes or reports at a later date.

3. In order to assure accurate distribution of this publication, addition or deletion of addresses to/from the DISTRIBUTION LIST are invited and should be forwarded to the address below.

4. Inquiries applicable to specific items of interest may be forwarded to Commander, US Army Armament Command, ATTN: DRSAR-SA, Rock Island, IL 61201 (AUTOVON 793-4483/4628).

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Section II. MEMORANDA AND OTHER TECHNICAL INFORMATION

Memoranda for Record and other technical information are grouped according to subject, where applicable, and in chronological order.

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FMS

"PRICING"

BY

R. D. HUSSON

10 MARCH 1976

US ARMY ARMAMENT COMMAND
SYSTEMS ANALYSIS DIRECTORATE
ROCK ISLAND, ILLINOIS 61201

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PURPOSE:

Report results of investigation regarding the pricing of FMS Cases.

SCOPE:

a. Review of existing system.

b. Areas for action.

c. Study resources and timeframe.

d. Quick-fix.

REVIEW OF EXISTING SYSTEM

a. Flow.

b. Responsibility.

c. Problem areas.

d. Other factors:

(1) Communication.

(2) Validation.

(3) Forecasting.

(4) Stabilized Production.

(5) Regulations.

(6) Disjoint corrective actions.

(7) External Studies.

FLOW/RESPONSIBILITY/PROBLEM

IL - Country Mgr - Est Case | Vol & Quick Turn Around

MM - Item Mgr

Principle Item/Ammo — {AM, RS, RP, CP} — {Customer Avail}

Secondary Item & Tool & Equip — {AM, RS, RP, CP} — {P&A}

PP - PPM

Coordinate PP Input

- PPX

Develop Case Price

(1) Production Availability (PPW)

(2) Support Cost (PPM)

(3) Item Cost History (PPC)

(4) Apply Factors

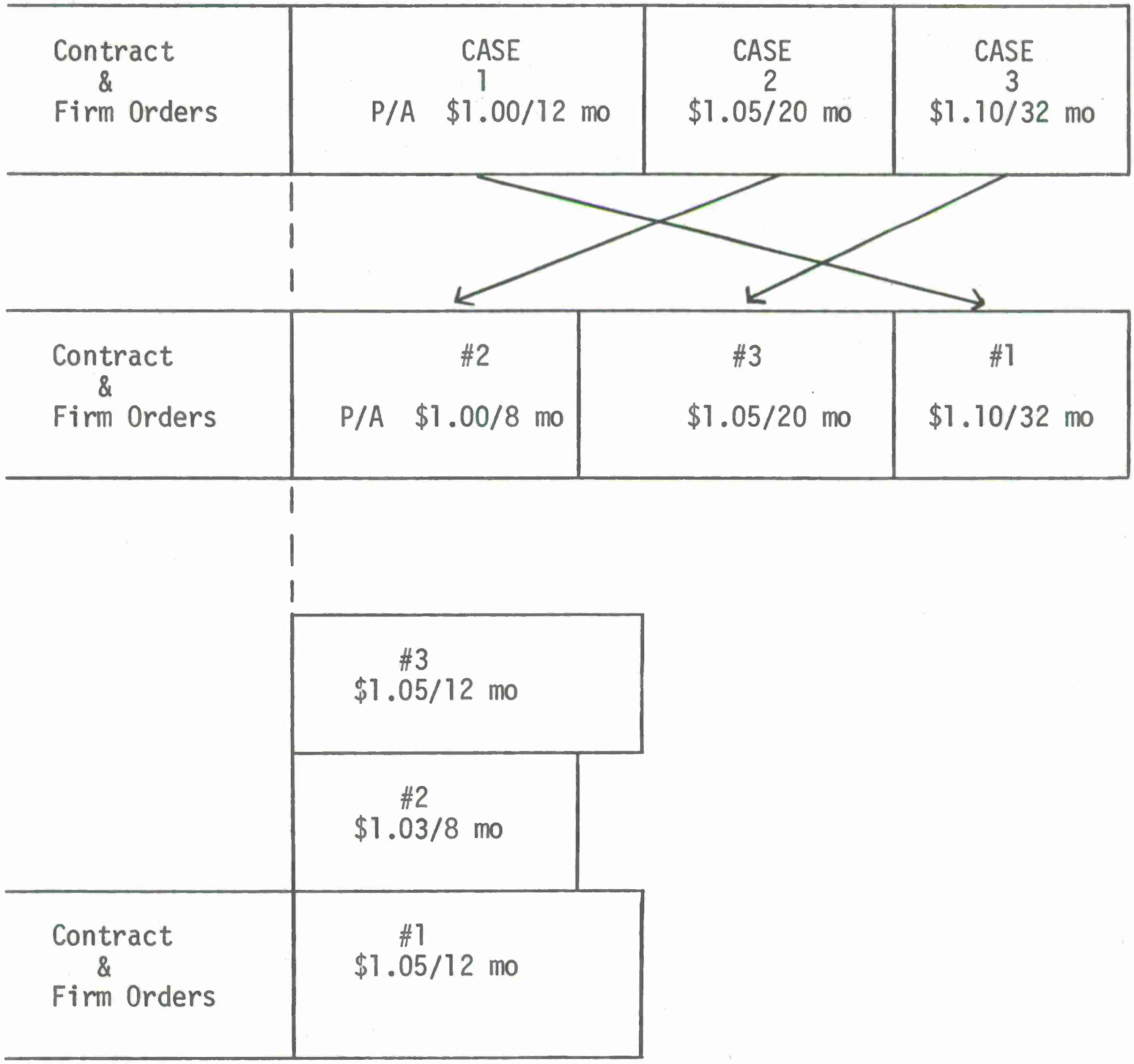
1. Queing/Stacking for Avail.
2. Spt Cost Estimated in isolation.
3. Item Cost History does not give conditions of base for unit prices (item/plt).
4. Omissions.
5. Volume.
6. Communication/Interpretation.

MM - Update Item Record

IL - { Coord/Concur
MM   CP - Cost Validation (Data Base)
PP   AS   as required
TM }

OUT

PROD vs. CUSTOMER AVAIL



↓

Accepted Order

↓

New Problems

a. Customer ques up in new order

b. Reference point for avail has changed

c. Effects of "stacking"

d. Item/Plt workload changes

e. Omissions found

f. Funding/EPA

FMS	1.00	1.02	1.04	[1.05]
PPW	[1.05]	___	___	___

AREAS FOR ACTION

a. Guarantee Price

(1) Stabilize Production

(2) Forecast Requirements

(3) Queing Rules

(4) Time Valid

(5) Predictive Cost Model

(6) Aggregate P/L = 0

b. Not-To-Exceed Price

(1) Min Production Level

(2) Forecast Requirements

(3) Queing Rules

(4) Time Valid

(5) Predictive Cost Model

(6) Contingencies

c. Info System

(1) Std Definitions

(2) Conditions of Input Data

(3) Forecasting

d. Predictive Cost Model

(1) Standardized Input Data

(2) Check List

(3) Queing Rules

(4) Validate Factors

STUDY RESOURCES/TIME

a. Team

SA	PPM	Subject Area Specialist
CP	PPC	
PPW	IL	
PPX		

b. 120 - 150 days lapsed time

c. M/M Effort: 24

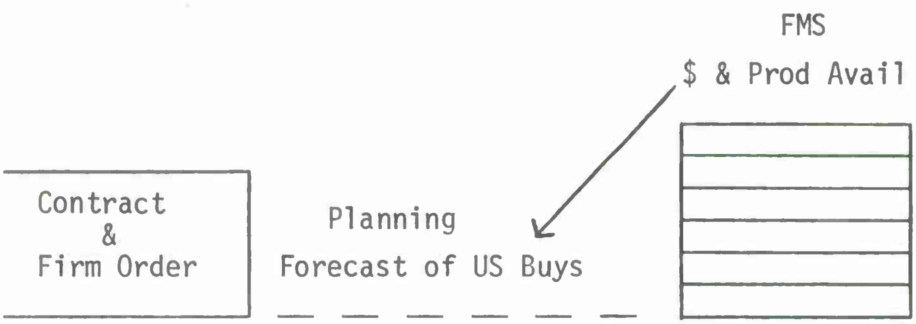
SA, RPX — 5mm Ea

CP, PPW, PPC, PPM, MM, IL — 2.5mm Ea

<u>NO LOSS POLICY</u>

a. Check list.

b. Quote all customers a price under conditions that he is last production in the plant and off the line.



c. Return any savings to customer.

d. Price good for stated period of time.

e. Que up by order of inquiry move to end of line if firm order not received in stated time (120 days).

f. Develop Implementing Instr.

COMMENTS TO DARCOM DRAFT REGULATION 11-1

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DRSAR-SAS

1 2 MAY 1976

MEMORANDUM FOR RECORD

SUBJECT: Comments to DARCOM Draft Regulation 11-1

1. General. An Independent Evaluation (IE) is being used interchangeably with a DRA. This is not correct because an IE is really a function performed by some systems analysis organizations to challenge the position of a project proponent or evaluate similar data to insure agreement in findings. Performing the IE function frequently results in a systems analysis study and probably the DRA, properly prepared, can address a project independently. The goal of the IE function appears to be the same as the goal of a "Red Team." The flexibility of an SA group should not be limited by this concept. All OR/SA techniques should be applied whenever alternatives are compared and an "optimum" or "best" alternative must be selected. The creativity of an SA group is directly related to the freedom available and employed. IE is a normal process when it can function without the success orientation exhibited by a proponent and his functions, particularly his SA function. Discovery of a potential project failure resulting from analysis of some course of action should not be the basis for considering the proponent to have failed. Success is never certain. If one examines Appendix C, it is obvious that a systems analysis study is being redefined again. Every subject listed as an element to be considered in an IE can be specified in a request by a proponent and the SA group should be able to handle every subject named. Perhaps a course in presenting the results of a systems analysis study is in order. Nevertheless, management prerogative should be allowed to select the required analyses. Frequently, a manager/decision maker desires confidence in selecting a course of action and the objective of an SA study is to support valid alternatives and provide some insight into the chance of program success.

2. Complex Decisions. This should be defined in para 5a. Probably, complex pertaining to alternatives containing complex relationships among many interdependent variables. A systems analysis study should be able to structure the problem and provide the means for the decision maker to comprehend the alternatives and evaluate his decision. Significant decisions (para 6d(2)) should be defined or called complex to insure consistency.

3. Review of all DRAs (para 6d(6)) by an SAO is not necessary. If a proponent desires SAO evaluation, it is within his management prerogative to request SAO support. Resources do not permit SAO to collect data (para 6d(7)) for TRADOC and COEA purposes. This requirement should be eliminated.

DRSAR-SAS
SUBJECT: Comments to DARCOM Draft Regulation 11-1

4. Add to para 6f(2) ....and that a summary of the DRA is placed in Section I of the Development Plan.

5. Para 7e should be deleted. DRAs are reported internally within an MR or MD study program. In addition, they become part of the DP and become a permanent record when published and incorporated in the DDC data bank library. This will meet the requirement to have a means of exchanging information.

6. Replace first sentence in Appendix A, Definition 7 with: "Operations Research is the application of analytical techniques, usually mathematical, to the study and analysis of complex problems, resources, strategy or tactics."

7. Some of the foregoing items were discussed by telecon with Clair Weiss by R. Banash on 7 May 1976. In particular, the inconsistency of the DRA and SA definitions were discussed as well as the role these studies play in the new MR/MD organizations.

M. Netzler Jr.

M. NETZLER, JR.
Operations Research Analyst
Studies Application Division

CRITIQUE OF THE REVIEW OF THE ARMY-NAVY GUIDED PROJECTILE COMPARISON STUDY

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DRSAR-SAM

Critique of the Review of the Army-Navy Guided Projectile Comparison Study

DRCPM-CAWS-TM DRSAR-SA

1 8 MAY 1976

Mr. Schlenker/cl/5075

1. Reference is made to the FONECON between Mr. Fuqua (DRCPM-CAWS) and Mr. Schlenker (DRSAR-SA) relative to the above subject.

2. As requested in the referenced conversation, Mr. Schlenker has read the review of subject study by Navy representatives. His critique is provided in the attached MFR (Inclosure 1).

3. Although Mr. Schlenker has used rather strong language in rebutting the assertions and allegations regarding the conduct of the DRSAR-SA study, his MFR is not abusive or unfair. DRSAR-SA requested an opportunity to review the Navy position in July 1975 when our office entertained the Navy representatives. It is noted that approximately ten months elapsed before we were given that opportunity. Consequently, DRSAR-SA suggests that the position expressed by the inclosed MFR be conveyed to the Navy in an expeditious manner to avoid a similar, inexcusible delay.

1 Incl
as

JAMES C. RICHARDS
Acting Director
Systems Analysis Directorate

CF:
DRSAR-SAM
DRSAR-SA CF
DRSAR-SA RF
DRSAR-SAM (Mr. Schlenker)
DRSAR-SAM RF

DRSAR-SAM

1 3 MAY 1976

MEMORANDUM FOR RECORD

SUBJECT: Rebuttal to Comments Made by the Naval Surface Weapons, Center, Dahlgren on the AMSAR-SA Memo, dated 23 Jul 75, subject: "Army-Navy Guided Projectile Effectiveness Study"

1. References:

a. Letter from Chief of Naval Operations to PM-CAWS, 22 Apr 76, subject: Operational Simulations.

b. Letter from Commander, Naval Sea Command to Chief of Naval Operations, 15 Sep 75, subject: Cost-Effectiveness Comparison of Army 155mm and Navy Sleeved 5-Inch Laser Guided Projectile.

c. Inclosure 1 to (b), a Memorandum on the same subject.

d. Memorandum for Record, AMSAR-SAM, 23 Jul 75, subject: Army-Navy Guided Projectile Effectiveness Study.

e. Memorandum for Record, AMSAR-SAM, 17 Dec 74, subject: Army-Navy Guided Projectile Commonality Study.

2. Reference (a) is a letter of transmittal from the Navy responding to a request for information from PM-CAWS. The information requested is contained in Ref (b). Reference (b) with inclosure 1 represents the opinion of Navy representatives regarding the contents of a study performed in July 1975 by DRSAR-SA. The purpose of this memorandum is to challenge statements made in inclosure 1 of Reference (b) which the author regards as incorrect and/or misleading.

3. The author and his colleagues in DRSAR-SA spent two full days -- 29 and 30 July 75 -- briefing the authors of the subject memorandum -- Perkins and Farley -- (Ref. c.) on the methods and data used in the Army-Navy Guided Projectile Comparison (Ref. d.). We had solicited their response at the time in an effort to encourage a meaningful dialogue. Apparently, the memorandum of Ref. (c) represents that response. Unfortunately, this response has only recently been presented to me, so that approximately ten months has elapsed in the interim.

4. The study on which the Dahlgren authors were commenting represents the most recent of a series of studies by DRSAR-SA on the same subject.

An earlier study was completed in December 1974. A memorandum giving further explanation of the results of that study is found in Reference e. Prior to writing and publishing both of these memoranda, lists of data items, representing characteristics of the Navy 5-inch sleeved guided projectile, were transmitted to Dahlgren for verification. Only one response was received early in 1975, relative to the first study. The suggested changes to the data were made and, as far as DRSAR-SA is concerned, constituted an expression of satisfaction on the part of Dahlgren representatives with the manner in which the ballistics of the Navy were treated in Army studies. No response from any Navy representative was received relative to a similar request for verification of projectile parameters made prior to the study done in July 1975 (Ref. d).

5. The study performed in July 1975 at the request of Dr. Royce Kneece, OASD-PA and E, was intended to extend the earlier work to a set of environmental conditions more nearly typical of the six, worst fall and winter months in Central Europe. Accordingly Dr. Kneece selected, with our concurrence, meteorological visibility ranges of 5, 3, and 2 km and cloud heights of 2000, 1500, and 1000 feet. A full factorial set of computer experiments was performed using these values of experimental variables. Additionally -- a point not mentioned in Ref. c -- a baseline experiment was performed for the condition: 10 km visibility range and 3000 ft ceiling. Reference c incorrectly states that "the average cloud height in Eastern Europe during the winter months is 3000 ft." In fact the median cloud height during the poorest six months in the Fulda area, reported in the CLGP and HELLFIRE COEAs, is 2000 ft. Thus, while indeed adverse, these weather variables are not unrepresentative for a European scenario. Further, taken in the context of the earlier (Ref. e) operational simulations, Reference d completes the values of weather variables under which guided projectile alternatives are compared.

6. In addition to the choice of values of weather variables, Ref. c contested the use of an armor-heavy Red force attacking a Blue force which has occupied a prepared defensive position. The statements in para 4 specifically referred to are: "The scenario appears rather restrictive in that it involves only a defensive posture by Blue and considers only hard targets attacking." ... "Reasons for the choice of such poor weather conditions and such a restrictive battle plan are unclear." In spite of efforts to rationalize the choice of these variables during the visit of Perkins and Farley and in spite of our efforts to promote a dialogue, it appears this issue is still "unclear." It is the policy of the US Government that our military presence in Europe is defensive. It

follows that a single, representative European scenario involving US and Soviet ground forces would pit the Soviet (Red) force as the attacker and the US (Blue) force as the defender. Further, all DA-approved European scenarios place considerable emphasis upon armor-heavy threat forces, ie. tanks, APCs, MICVs, etc. For short-duration, high-resolution battles, such as that used in the CLGP COEA, the preponderance of the targets for Blue are armored vehicles. This is completely consistent with what is known about the Soviet TOE and doctrine. In fact, the scenario treated in the CLGP operational simulation (OSM) was devised in cooperation with US TRADOC FAS to be consistent with the DIA- approved threat. The battle simulated in OSM was fought across a US brigade front (8 km) and represented the largest scale simulation used during the CLGP COEA. Consequently, it is surprising to find Perkins and Farley stating that the attack occurred "across a relatively narrow front by large Red armor units containing primarily tanks and APCs" and that the scenario "appears rather restrictive" to them. Certainly, these authors cannot believe that it is necessary or possible to model the entire Soviet front or combat support system (containing softer targets) to have an adequate operational setting for CLGP.

7. It is also stated in para 4 of Ref c.: "It seems that if the guns could be placed further aft of FEBA [ie, more than 6 km], they would be far less vulnerable, and also the longer range of the sleeved round could be employed in massing fires during a heavy attack." The implications in this statement should be examined carefully. First, it is not the policy of Army artillery to dedicate guns to one projectile. Therefore, the choice of battery position for DS artillery is based upon all the munitions fired, the maneuver elements supported, the posture of the enemy, the terrain and a host of other factors. Under the conditions played, the choice of battery position -- 6 km aft of FEBA -- is consistent with Army doctrine for 155mm DS artillery and was approved by the US FAS. This choice was certainly not prejudicial to the 5-inch sleeved round. The primary ground rule for the comparative evaluation was to play all alternative guided projectiles in an equitable manner, as nearly identical as possible, and consistent with Army operational doctrine. After all, the 5-inch sleeved round is contending for the CLGP, ground-based anti-armor role. And, this is the primary role for CLGP. Other missions and roles were not of concern in the comparison study. The other false implication one may draw from the above statement is that the 21 km maximum range of the Army ED CLGP is not adequate for massing of fires whereas the range of the 5-inch sleeved round is, since the Navy round was mentioned explicitly in this role whereas CLGP was not.

DRSAR-SAM 18 MAY 1976

SUBJECT: Rebuttal to Comments Made by the Naval Surface Weapons Center, Dahlgren on the AMSAR-SA Memo, dated 23 Jul 75, subject: "Army-Navy Guided Projectile Effectiveness Study"

The massing of CLGP fire depends upon the presence of an FO to designate the target in order to be feasible. Unfortunately, this limitation restricts the targets attacked to a zone typically less than 5 km forward of FEBA. Even with large weapon standoff this restriction does not begin to tax the maximum range of CLGP. One must conclude that the issue of maximum range is not pertinent and its introduction in Reference c. is misleading.

8. In para 6 of Ref c. the authors repeat the reasons given them for the choice of firing quadrant elevations in the CLGP zoning solution. Then, they state: "The other reason, not mentioned by the Army, is that this provides a compatible initial trajectory for their 20 deg glide phase. The CLGP round ballistics were therefore well optimized for this study. Unfortunately, the same cannot be said for the Navy round." This statement is simply not true. The choice of these QEs is based upon a compromise between competing considerations of minimum time of flight, maximum available footprint, and most favorable target aspect. This compromise was made for the AD CLGP during the CLGP COEA (1974) at ARMCOM and, independently, at the USA FAS (Ft. Sill). The firing solution is only approximately optimal for the ED CLGP and would apply equally well to the Navy round as it was played with the early rocket thrust option (1.6 sec ignition delay). Incidentally, this was the only ignition-delay option known to Army analysts at the time the comparison study was done. Althought DRSAR-SA did employ the midcourse, glide option within OSM, it was not a consideration in the zoning solution. Every effort was made to be fair to the Navy candidate. Two additional firing zones were provided the 5-inch sleeved round. Army studies supporting the CLGP COEA determined that a targeting procedure in which the ballistic range is less than the intended range of engagement is optimal for all ballistic CLGPs. (The midcourse glide option was not available at that time.) By using a ballistic range offset earlier acquisition is permitted, initial heading error is minimized, and the useful footprint is maximized. The optimal offset changes somewhat with range and cloud height, however, departures from the optimum by ± 100 meters do not significantly affect the single-shot kill probability. Consequently, a nominal ballistic range offset of 250 meters was used for CLGP throughout the COEA. Since the field of view, detection sensitivity, and endgame ballistics for the 5-inch sleeved round are quite similar to the AD CLGP, it was considered reasonable to use a targeting procedure which is approximately optimal for that system. In view of the above considerations, I do not understand why Perkins and Farley object to the use of this targeting procedure.

9. In para 7 of Ref c., the authors state that the guidance accuracy computer program (ZOT.14) uses "an ideal second order airframe, perfect controls, and a linear seeker response." They further state that "...one must recognize that this simplified model cannot be used to compare the accuracy of two systems in the presence of error sources which affect seeker tracking performance, since seeker dynamics are not adequately modeled." These statements represent a misunderstanding of the seeker-and pitch-dynamics as modeled in ZOT.14. The input-output response of the detector represented in ZOT.14 is handled by a series of straightline segments. The response of the detector over the entire instantaneous field of view which is determined in this way is distinctly non-linear. The only linear part of the detector field of view for the 5-inch sleeved round is a region of ± 0.5 degrees about null. This "function-generator" approach to modeling the detector transfer function is quite general and applies equally well to the Army CLGP. The allegation that "an ideal second-order airframe" is modeled in ZOT.14 again misses the point that the parameters in the second-order transfer function depend upon Mach number, angle of attack, and control surface deflection, making the transfer function distinctly "nonideal" and capable of describing aerodynamic non-linearities. Whereas perfect controls are assumed in ZOT.14, it is entirely reasonable to do so. Both Army and Navy control-actuator systems have essentially flat input-output dynamic response over a bandwidth from zero to beyond ten hertz. Since the frequency content of autopilot signals to the actuators is essentially devoid of content above ten hertz, the approximation of a perfect actuator is reasonable. In fact, during the meeting at ARMCOM in July 1975, Farley agreed that this assumption was not actually a significant consideration.

10. In the latter part of para 7 of Ref c., one finds the statement: "It is important to note that the Army didn't even model the midcourse guidance portion of their trajectory; but assumed a nominal ballistic path." This statement is surprising in view of the remarks of para 6 concerning the choice of firing zones providing "a compatible initial trajectory for their 20 deg glide phase." The latter statement implies an exploitation of a feature which para 7 states was not employed. In fact, the (midcourse) glide option was employed during the July 1975 comparison study (Ref d.) and updates the earlier commonality study of Dec 1974 (Ref e.) performed on the AD CLGP, which did not employ the glide option.

11. To the best of my knowledge, the 5-inch sleeved projectile does not possess a consistent and/or significant roll during guidance. Further, the normal body forces computed by ZOT.14 for the sleeved projectile agree closely with published wind tunnel data. As noted above, the Navy was given an opportunity to comment on the values of aerodynamic parameters

used to describe the sleeved projectile in out study and did not do so. In view of the above, the following comment in para 7 of Ref c. is simply gratuitous: "The Army also assumed the Navy projectile did not roll thus reducing the average maneuverability by 15%."

12. As a small point, it is noted that neither the CEP nor the equivalent linear standard deviation σ_e of the guidance error -- mistakenly called the circular normal error -- is a linear function of designation range, as asserted in para 7 of Ref c. In fact, it required a third degree polynomial to obtain a good fit to simulation data, a point also noted in para 7 and 8 of Ref c. A more significant point is the following. The guidance accuracy simulation did not consider only laser spot motion and target motion, as asserted by Perkins and Farley, even though these are the dominant error sources. Actually, gyro drift and pitch-yaw coupling are modeled for the Army CLGP within ZOT.14. In an effort to avoid controversy wherever possible, these error sources were assumed absent for the Navy 5-inch sleeved round. This "neglect" can only be preferentially favorable to Navy and should strengthen the conclusions of our accuracy analysis. In Reference e. I discussed in detail the reasons for the poorer accuracy of the Navy round. This discussion regarding the greater sensitivity of the Navy projectile to spot motion and pulse dropout is still valid. In summary the reasons for the poorer accuracy for the 5-inch sleeved projectile are:

(1) This round uses a significantly larger navigation ratio than the Army's CLGP -- 6 versus 3.5 to 4 for CLGP. Sensitivity to noise increases with navigation ratio.

(2) The Navy projectile has no gravity bias, so that pitch-plane impact bias occurs in the presence of large, apparent spot motion, ie, 1 to 2 ft standard deviation.

(3) The Navy projectile does not employ synthetic damping using gimbal rates and relies instead only on the relatively small aerodynamic damping. As a consequence, this projectile is constantly correcting for over-response to line-of-sight errors.

Although the Army CLGP is faced with identical exogenous errors, its guidance-error sensitivity to these is substantially smaller. Obviously, given an extremely low-noise environment, there would not be a significant difference in the accuracy of these systems. Clearly, it is necessary to evaluate the systems under comparable and realistic levels of exogenous spot-motion noise for guidance accuracy comparisons to be meaningful. I believe that we have done this in the study of Reference d. If an error has been made with respect to characterizing the exogenous noise, it is likely to be in the direction of underestimating the severity of the noise. The stochastic process which describes spot motion in ZOT.14 is based upon the OT 1 laser designation tests performed at WSMR under conditions more favorable to designation than those likely to occur in combat. These data, therefore, may understate the spot motion noise in combat. This possible understatement of exogenous noise is differentially favorable to the Navy system because of greater sensitivity to this type of noise. All of the in-house Army studies -- at ARMCOM and MICOM -- as well as the guidance error analyses performed by MMA have consistently shown that spot motion versus moving targets at designation ranges in excess of 2 km is the dominant error source over the ensemble of acquisition conditions and is not "masked" by the effect of initial heading error, due to target prediction error and ballistic dispersion, as was asserted by Perkins and Farley.

13. On the subject of warhead lethality, the authors of Ref c. suggest that the ARMCOM study underestimated the lethality of the 5-inch sleeved projectile. For comparable impact conditions, our study did assume that the Navy projectile was 10% less lethal than CLGP against all targets in the Red force being treated in OSM. This force consisted of 54 tanks, 2 ZSU 23-4s (on a tank chassis), and 16 armored assault infantry combat vehicles. There are no trucks or softer targets in the first wave. In view of the nature of these targets, it is our opinion that the treatment given warhead lethality is fair. Furthermore, it is anticipated that the future armored threat will generate a larger percentage of harder targets (with spaced-or array armor) than played in our scenario. Should this occur, the result would be differentially unfavorable to the smaller Navy warhead.

14. The present Navy draft specification -- Draft 5 of Jan 76 -- requires a seeker detection sensitivity which is less (or better than) any experimental value measured by MICOM. The lowest detection threshold for the 5-inch seeker measured by MICOM (and witnessed by Dahlgren engineers) prior to July 1975 was the basis for the detection threshold actually used in OSM to represent the Navy seeker. In fact, we used the present Navy specification during all of the guidance accuracy studies. To be consistent we used the best measured detection threshold for the Army CLGP which is lower by a factor of 1/2 than present Navy specified threshold. This treatment of detection threshold seems quite fair to me and certainly is not in accord with the allegations made by Perkins and Farley.

15. Perkins and Farley have implied that guidance-accuracy estimation procedures have been predjudicial to the 5-inch sleeved round. They correctly pointed out that accuracy estimates were not obtained for the Navy round at a gun-to-target range of 4 km. In the same context they

neglected to point out that the use to which these estimates were put within the operational scenario did not require gun-to-target ranges less than 7 km. Consequently, this "neglect" is irrelevant to the results obtained from OSM. In this connection one should mention that Ref d. also neglected the accuracy estimates obtained at 15 km for both systems. The guidance accuracy estimate which was obtained at 10 km for both systems was the basis for the summary guidance accuracy model used in OSM. This gun-to-target range was selected for these estimates because the OSM engagements are located close to that range, ie, within two to three footprint lengths.

16. In para 11 of Ref c. the authors state: "ARMCOM indicated 4 km was not evaluated because they couldn't model the guided portion of flight during motor burn." What ARMCOM representatives actually said in this regard is that accuracy estimates for the Navy projectile during thrust could not be made without computer program modifications and that the values of the additional error sources necessary for faithful modeling of guidance error under thrust were unknown to us. Furthermore, as indicated above, this aspect of the performance of the 5-inch sleeved round was not pertinent to our study. Neither one of the ARMCOM studies (Refs d. and e.) neglected the rocket motor propulsion employed by the sleeved round and, in fact, used trajectories similar to those selected by the Navy in the WSMR tests done prior to the July 75 study. The allegation that ARMCOM neglected advantages accruing from use of a rocket is simply false.

17. The Navy representatives have used an apparently reasonable argument to assert that the sleeved round should be more reliable than the Army CLGP. Electronically and optically CLGP is more sophisticated and complicated than the Navy 5-inch projectile. However, it is in precisely these areas that CLGP has demonstrated a significantly better test record than the sleeved round. At the present time, the Navy has completed 8 of the 12 competitive test shots at WSMR. Only one of these has been successful. During Advanced Development, the MMA version of CLGP achieved 8 hits out of 12 shots at moving and stationary targets at WSMR. Thus, the record belies the alleged greater reliability of the Navy projectile.

George J. Schlenker

GEORGE J. SCHLENKER
Operations Research Analyst
Methodology Division
Systems Analysis Directorate

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OVERDESIGN OF EQUIPMENT - AMCPA-S TASK #75-58A

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Mr. Mazza/jls/6370

DRSAR-SAS (30 Mar 76) 1st Ind
SUBJECT: Overdesign of Equipment - AMCPA-S Task #75-58A

HQ, US Army Armament Command, Rock Island, IL 61201 14 MAY 1976

TO: Commander, US Army Material Systems Analysis Activity, ATTN: DRXSY-RX, Aberdeen Proving Ground, MD 21005

1. As best as can be determined, the original intent of this task was to look at DARCOM design of equipment across the board to determine if design tolerances are unrealistic. This task had its initiation on the basis of a statement, from a person at Martin Marietta to General Deane, that the cost of CLGP warhead could be reduced significantly by a relaxation of tolerances. (See page A7, Volume II.)

2. It appears from Appendix 1c that AMSAA then assumed, a priori, that overdesign is a major problem within DARCOM and set about to prove the assumption. Only two projects (TOW and COPPERHEAD) were investigated into any depth; however, the report makes broad statements about the entire DARCOM engineering community and most of the statements are conjecture on the part of the author and are not substantiated by information and facts found elsewhere in the report. In the case of the COPPERHEAD (CLGP) almost all of the statements about overdesign are based on statements by Martin Marietta in areas which are causing them design problems. Each of the examples cited (i.e., 9000g's, 5 min at 400°F, etc.) represent realistic design requirements for the CLGP system and, if anything, border on being underdesigned.

3. The report repeatedly makes reference to the fact that sufficient data is not available for the contractor to determine the minimum tolerances required for each design, and that it should be the responsibility of the major commands to provide the information to the contractors for unique military equipment. The author proposes that the Army Laboratories and Commodity Commands build up a new area of expertise to provide this data; however, the report did not address the cost to get this data. In order to determine the sensitivity of performance to tolerances, costly test programs may be required for each item to be examined. While it is conceded that some tolerances can be relaxed by this type of analysis, the expected savings are unknown.

4. It is implied that all design tolerances should be minimized to reduce the cost so design and produce an item. One point overlooked completely is the possible life cycle savings obtained through overdesigns which result in fewer parts replacement and maintenance actions. Here is where the biggest difference occurs between the commercial and Army world. The commercial developer does not have to incur the maintenance cost for the life of the item and is primarily concerned with reducing his production cost; the Army must incur cost for the life of the item.

1 4 MAY [redacted]

DRSAR-SAS
SUBJECT: Overdesign of Equipment - AMCPA-S Task #75-58A

5. The conclusions and recommendations section (pgs. 45-47) does not answer or address the basic task, i.e., are design tolerances unrealistic. The recommendations in essence say that the Commodity Commands should do their jobs. The author proposes that design trade-off data should be supplied by the government. Another alternative is to require the contractor to make cost vs. performance trade-offs and offer these as choices to the government prior to proceeding with the hardware program. However, before exploring all the possible alternatives, the government must first decide a criteria for selecting a preferred design. Attached is one concept (Incl 2) which suggests minimal lifetime cost of ownership as a criterion.

6. Specific Comments (Incl 3) pertaining to the report are attached.

FOR THE COMMANDER:

SIGNED

JAMES C. RICHARDS
Acting Director
Systems Analysis Directorate

2 Incl
wd incl 1
Added 2 incl
2. Concept paper
3. Specific Comments

DETAILED STUDY PLAN PHYSICAL SECURITY SIMULATION

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DRSAR-SAS 1 8 MAY 1975

MEMORANDUM FOR RECORD

SUBJECT: Detailed Study Plan Physical Security Simulation

1. Objective. The physical security simulation will be constructed to allow rapid comparative evaluation of alternative means of providing protection under a wide variety of circumstances.

2. Approach. The basic approach is to assume an attack by force is made on a fixed facility with the intent to remove certain materials or perform sabotage of some portion of the facility. A fixed facility may be an arms room, an ammunition storage area, a computer room or a payroll cage. The attackers are characterized by their number, method of entry on government property, means of mobility and equipment brought with them to carry out their mission. It is assumed the attackers have some knowledge of the facility in order to choose a point of entry, select a method and route of advance to the facility and determine a proper set of tools and equipment to make an intrusion at the facility.

3. The facility security system is characterized by several parameters. It may be composed of various types of barriers and automatic sensors connected to alarms. The barriers may consist of locked doors and windows, fences and gates. The facility location, as well as the location of roadways and natural concealment are also important. These data will be needed to describe the speed of penetration of the attackers as well as the speed of arrival of the security force.

4. The security force will consist of automatic alarms and a guard force distributed at fixed sites and in patrols assigned to various routes. There will also be a backup force of auxiliary guard forces that can be called upon if necessary to help prevent the successful completion of an attack. The security guard force is assumed to have reliable communication to alert and mobilize at the facility from whatever location they happen to be in.

5. Discussion. The simulation will be event-oriented. The driving event will be an intrusion by the attack force at one of the several permissible points of entry to the arsenal appropriate to the size of force and its mode of mobility. The event triggers subsequent events marking the arrivals and departures of the attack force at various checkpoints at which they may delay and prepare to advance to the next point. These checkpoints may be used to describe a transition over some type of terrain by the choice of appropriate time between checkpoints. For example, the time between three

successive checkpoints may represent travel through thick brush from the point of entry on the arsenal to a road and then along the road to a fence. The method of selection of routes is to take the shortest path to minimize detection while maintaining maximum speed suitable to conditions.

6. Arrival at the fixed facility is the final event in the entry and travel sequence. The next sequence of events describes the penetration of barriers at the fixed site facility. This may be an arms storage room in a building with locked doors and windows and external barriers consisting of fences and/or security guards. A sequence of events from encounter of the first barrier at the facility until successful removal of assets or the act of sabotage of assets is accomplished is next. These events describe the times it takes to breach the barriers using the tools and equipment brought along. For example, if a concrete wall or a chain link fence is the barrier, the attack force may try to scale it or pass through it by cutting a hole. The type of barrier will be specified as a simulation parameter, as well as the tools and equipment to be used to breach it. Typical distributions of times to accomplish this set of tasks will be required input data for the simulation. The repetitive selection of random times from these distributions will simulate the variations perceived in the real world.

7. If part of the fixed facility barrier consists of one or more guards, Lanchester-dual combat description could be used. In this formulation, rates of attrition and force strengths will be used to determine the time the guard is defeated.

8. After the mission of the attack force is successfully completed at the fixed facility, the attack force must escape from the arsenal, if possible, undetected. If they have not been detected by this time, they will retrace their route back through the traveling checkpoint sequence to the point of entry at maximum speed.

9. In this study, however, successful intrusion and successful escape from the arsenal is the objective of the attack force. The physical security system must be designed to function so as to minimize the objectives of the attack force. In the simulation, this is accomplished by a sequence of events starting with detection. Detection of the presence of the attack force can occur if a patrol guard encounters the attack force on a road either in its agress or egress. Detection can also occur if the fixed facility is checked periodically by guards. Finally, detection occurs if an alarm occurs as a result of the breach of a barrier or the sound of an explosion in the case of a violent entry. Conditions which constitute detection will have to be specified in some manner by experts for the simulation. Simulation logic from a border security study done for MERDC will likely also be used.

10. Given detection, a sequence of events constituting a reaction begin. A reaction force is mobilized for stopping the intrusion by notification of all available units on patrol and standby within a short time to account for communications, command and control. The locations of patrol and standby units is determined from distribution functions and state probabilities obtained empirically. Given their locations and type of mobility available, arrival events can be determined for each at the fixed facility. At the option of the analyst, they may choose to wait until their number reaches a certain value before any further events can occur or Lanchester attrition events may commence as the guards arrive. In either case, if the attack force has already left, no Lanchester attrition events will begin. Instead, the guard force may wish to determine their direction and method of escape. In the simulation, it will be assumed that this readily is known and a pursuit sequence begins with the guards pursuing the attack force to its point of entry at maximum speed (faster than the attackers).

11. The simulated intrusion is repeated many times so as to generate a spectrum of sequences with the characteristic conditions of attacker and defender and operating policies fixed. Statistical estimates are made from this large number of repetitions of quantities of interest. Some of these are the probability of success of the attacker force, the length of time from entry to defeat when the intrusion was unsuccessful, the number of attackers and guards attrited, and the extent of penetration into the fixed facility, to name only a few.

12. <u>Data Required</u>. The arsenal must be structured into a grid configuration to enable simulation entities to be located according to some common reference point. A fine grid of squares no greater than thirty meters on a side is desirable based on past experience. If intervisibility, for the purpose of visual detection is desired, the altitude of the terrain and height and type of vegetation at each grid intersection point is required. Furthermore, all significant intervening visual barriers, such as buildings, must be completely specified. Areas of concealment should be determined. The patrol routes of guards and the travel times between various checkpoints must be specified. Convenient checkpoints might be places the guard must stop to check something. The time he spends there, as well as the time he is out of earshot of his radio, is also required.

13. The time it takes to mobilize a given force needs to be determined. At certain times, guards are patrolling inside buildings. The time it takes to get them from the building, to the police station for arms and transportation is required.

14. If severe intrusions of very large attack forces are of interest, the time to mobilize a reinforcing security team from off the arsenal should be specified.

DRSAR-SAS
SUBJECT: Detailed Study Plan Physical Security Simulation

15. All possible points of entry to the arsenal for various types of attack forces for each mode of transportation must be determined. This should include both overt and covert entry by a motorized vehicle, by foot, by boat or by air. Possible types of equipment carried should be specified.

16. The fixed facilities, which constitute the target of the attack force need to be specified in great detail. The types of barriers they possess and the time it takes to penetrate them for various types of tools should be determined. The barrier locations around the facility and the possible location of guards, if present, are required. The specification of an intrusion alarm system must include the conditions under which the alarm functions, the chances of defeating the alarm by an intelligent attacker, and the probability that the alarm will function when it is supposed to.

17. The frequency of inspection of the facility by a patrol guard will be a policy parameter.

Stuart Olson
STUART OLSON
Operations Research Analyst
Studies Application Division
Systems Analysis Directorate

CF:

DRSAR-SA Monthly MFR Report File

LETTER TO MOCA-WG (COL. J. B. MURPHY) FROM DRSAR-SA

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DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY ARMAMENT COMMAND
ROCK ISLAND, ILLINOIS 61201

REPLY TO
ATTENTION OF:

DRSAR-SA

1 9 MAY 1976

Commander
US Army Concepts Analysis Agency
ATTN: MOCA-WG/COL J. B. Murphy
8120 Woodmont Avenue
Bethesda, MD 20014

Dear Colonel Murphy,

One of the functions of this Directorate is to ensure that the results of ARMCOM studies are compatible with the results of studies conducted at higher headquarters and by other Army agencies. To accomplish this function we have worked closely with other agencies, including yours, to acquire the models and data bases used in their studies of ARMCOM commodities. Specifically, during the past six months, we have acquired from CAA all of the AMMORATES models and most of the supporting data. We have converted these programs from your UNIVAC 1108 to our IBM 360/65 S&E System, and in this process we have received extraordinary assistance, counselling and advice from members of your War Gaming Directorate. Therefore, I take this opportunity to express our gratitude to Messrs Van Albert, Tucker, and Major R. Hill for their willing cooperation and enthusiasm.

Most recently we have been concentrating our effort on implementing the Tank-Antitank model, since it may be used in a Systems Analysis Directorate study. Because there are differences between our computer systems, this implementation has not been straightforward. We found it necessary to use a diagnostic-debugging FORTRAN compiler to help us to discover certain coding and execution errors which might otherwise never have been found. The analysis of the results obtained using this aid has revealed some errors that can not be attributed to machine differences. These errors, together with suggestions for their corrections, were discussed with Mr. Tucker (CAA) earlier this year. Since he has already taken action to correct those errors, Inclosure 1 is forwarded only for your information and for record purposes.

Sincerely yours,

M. RHIAN
Acting Director
Systems Analysis Directorate

1 Incl
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DRSAR-SA
COL J. B. Murphy

19 MAY 1976

CF:
MOCA-WGT, MAJ R. Hill, III
MOCA-WGT, J. Tucker
MOCA-WGT, C. Van Albert

DRSAR-SAM

21 APR 1976

MEMORANDUM FOR RECORD

SUBJECT: Tank-Antitank Model (TAT-M) Implementation

1. In recent months the Systems Analysis Directorate has obtained the CAA Combat Rates computer models and much of the supporting data. However, because of the differences in computer systems, the implementation of these models on our computer system has not been straightforward. Therefore, to expedite the process, a detailed diagnostic-debugging FORTRAN compiler has been used to uncover not only the obvious coding errors but also those logic errors which could cause the program to abnormally end during execution.

2. Because of its possible immediate application to an SA study, the Tank-Antitank Model (TATM) has received particular attention. A sample run made with data from the P78-82 study was obtained from CAA for comparison purposes. Using the same input data the model was executed but the outputs of the preliminary runs did not match the sample case. Therefore, the model was re-compiled and re-executed using the WATFIV FORTRAN diagnostic compiler. The analysis of these results revealed several basic errors. These errors and the changes required to correct them are listed in inclosure 1. After applying these corrections to the model, the results of our runs closely matched the CAA sample case.

3. Mr. John Tucker at CAA, was informed of these findings and he made the suggested program changes. A new sample case run at CAA matches ours exactly.

Richard A Fischer

RICHARD A. FISCHER
Operations Research Analyst
Methodology Division
Systems Analysis Directorate

1 Incl
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PROGRAM CHANGES TO TANK-ANTITANK MODEL

(1) Delete data statements - Data KHAR/···/, DATA IBPS/···/, and DATA ACTL/···/ - in main program at statement numbers TAT00500-550, and move them into a BLOCK DATA subroutine as shown below:

```
0001  BLOCK DATA
0002  COMMON/DATA/KHAR(39),IBPS(3),KORE,ACTL(6),IACTL
0003  INTEGER ACTL
0004  DATA KHAR/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H9,1HA
      *,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HM,1HN,
      *1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ,1H ,
      *1H,1H*/
0005  DATA IBPS/1H,3HPRI,3HAUX/
0006  DATA ACTL/4HA-T-,4HK-A-,4HP-A-,4HS-0-,4H2-1,4H2-2/
0007  END
```

This was necessary since arrays in labeled common cannot be initialized in a main program using standard FORTRAN IV.

(2) Delete statements - WPNIA='EMTY',WPN2A='EMTY', and ITABNO = 'EMTY' - in main program at statement numbers TAT00860-880 and substitute the following:

```
READ (IN, FORMAT) WPNIA, WPN2A, ITABNO
FORMAT (3A4)
```

This was done to resolve a conflict in initializing blank common variables as literals, which is not allowed in standard FORTRAN IV.

(3) Add the following at statement TAT02030

```
PD(I,J) = 0.0
```

Array PD(I,J) is used at a later stage but was never initialized or defined.

(4) Change the array subscript (I) in array IWPNO (3,I,1) to subscript (J) at statement numbers TAT06530, 6570, 6580 and 6590. This change is required since the driving DO-Loop index is J not I.

(5) Change the array subscript (I) in array DRATE(I) to subscript (J) at statement numbers TAT06620 and 6630. This change is required since the driving DO-Loop index again is J not I.

(6) Add the following statements at statement number TAT09270:

```
JJX4 = JJ
NPQ  = IIA
```

Also change the CALL FIRE (···JJ,IIA···) to CALL FIRE (···JJX4,NPQ···). The variables JJ and IIA are common variables and should not be transferred in a subroutine call statement.

(7) Statement numbers ON2211 and ON2213 in subroutine SCRTCH should be changed to the following:

```
WRITE(      ) (I,I=1,IZ)
WRITE(      )(VECT(L),I=1,1Z), RTOT
```

The redundant parenthesis as used are not required and not valid forms in FORTRAN IV

(8) Change data statement DATA IP/···/ in Subroutine DETECT to DATA IZW/···/ and change all references to IP to IZW. Further IZW must be dimensioned in the subroutine. This change is necessary since IP was previously defined as an undimensioned common variable and not as an array.

Further Suggestions

(1) Array IBLK (1601) could be eliminated since it is never referenced.

(2) The blank common statements used in each subroutine are not the same length as the original ones in the main program. Those variables not included in the subroutine common block should be added to avoid possible inconsistencies in memory allocation.

(3) The compatibility of the TAT model could be improved by changing the "NTRAN" routines to standard FORTRAN direct access read-write statements. The general form of these is discussed in the UNIVAC 1108 FORTRAN V manual under the DEFINE FILE statement. Only minor changes are required, since the substitution for the NTRAN statements is one-for-one. A listing of our IBM-360/65 version is attached and the DEFINE FILE statements have been flagged.

PRODUCTION FACILITIES CAMERA NO. 9-76

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DRSAR-SA
DRSAR-PP
DRSAR-CP

Production Facilities CAMERA No. 9-76
DRSAR-SA

2 1 MAY 1976
Mr. Mazza/jls/6370

1. A review of the financial recommendations of the subject CAMERA has been completed. The attached MFR (Incl 1) describes the analysis conducted by this Directorate. The CAMERA recommendation addressed was "to establish goals and monitor indirect overhead expenses at each individual plant level and at the total Army Ammunition Plant level, ARMCOM.

2. The CAMERA team looked at the percentage of indirect overhead as a function of total dollars among the AAPs in FY75 and the change in indirect overhead vs. the change in total dollars at several individual AAPs over a five-year period. A wide variation in results lead to the CAMERA recommendations.

3. Before indirect overhead can be analyzed on a plant by plant basis or among plants, certain critical ground rules must be established. Effective comparative analysis requires assurance that the cost of the base year is reasonable and that the same methodology was used to arrive at the cost for the subsequent years. Specific costs must not be reclassified as direct or indirect, the variable and non-variable cost components should be analyzed separately and the same operating procedures should have been applied from year to year. The same ground rules are even more critical when making comparisons among plants. These conditions were not met in the CAMERA analysis.

4. Incl 1 cautions that implementation of the CAMERA recommendation verbatim would do little to fulfill the intent of the recommendation and may be counterproductive to reducing total cost. It is suggested that the terminology "indirect overhead" be replaced with another broader term (e.g., cost efficiency index) and that the ARMCOM action be directed toward fulfilling the intent of the CAMERA recommendation.

5. In order to make comparison among the plants or within individual plants, the framework or method of determining the classification of cost accounts for the base year and future analysis must be established. It is suggested that DRSAR-PP and DRSAR-CP analyze specific data to be obtained through UCARS and other periodic information made available to the command and arrive at a definition of the "cost efficiency index" that would be meaningful for setting goals, monitoring, and improving management at the AAPs. DRSAR-SA could assist in completing this first critical step. Separate indices may have to be developed for within plant analysis as opposed to among plant analysis. Incl 1, paragraph 8 provides additional details in this regard.

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SIGNED
M. RHIAN
Acting Director
Systems Analysis Directorate

SA-CF

DRSAR-SAS 1 9 MAY 1976

MEMORANDUM FOR RECORD

SUBJECT: Production Facilities CAMERA No. 9-76 - Indirect Overhead Review

1. Systems Analysis was tasked to review and validate the recommendations of the subject CAMERA. The financial recommendations have been reviewed. In particular, the recommendation to "establish goals and monitor indirect overhead expenses at each individual plant level and at the total Army Ammunition Plant level, ARMCOM" has been examined and analyzed to determine the validity of the recommendation.

2. The first step in the analysis consisted of gathering all of the information that was furnished to DARCOM for the CAMERA. This information was obtained from DRSAR-CPR. Apparently, DARCOM didn't feel the information as reported to ARMCOM (ARMCOM Forms 167-R, 168-R, 169-R) was appropriate to determine indirect overhead and designed a new, one-time form to obtain this information. This one-time form is similar to Section XII (Base Operations) of AR 37-100-74 with the addition of Tenant (COR Staff) cost (AR 37-100-74 establishes official accounting codes for classifying financial data). It is interesting to note that ARMCOM Regulation 37-21, which governs how the AAPs report and separate their costs, does not specifically include an indirect overhead line item. Total overhead is reported (line 75 of ARMCOM Form 167-R) and total direct overhead is reported (line 69 of ARMCOM Form 167-R) and one can assume that the difference must be the indirect overhead. However, the information reported into each overhead category is not consistent among the AAPs.

3. Inclosure 1 presents how several AAPs separated 24 overhead cost categories of ARMCOM Form 169-R into direct or indirect overheads during FY75. Each plant was consistent in reporting Direct Material to direct overhead; however, this was a mandatory entry. Also, each plant was consistent (indicated by an *) in reporting six other overhead categories: Roads and Grounds; Fire and Security; Safety and Medical; Purchasing; Payroll, Account, and Budget; and Executive Administration. The plants were not consistent in reporting the other 17 categories of overhead. For example, cost of utilities was considered direct overhead by Badger; Indiana, Iowa, Lake City and Longhorn considered utilities indirect overhead; Kansas and Lone Star considered utilities both direct and indirect. Joliet did not enter utilities cost on the ARMCOM Form 169-R but entered the cost as direct overhead on ARMCOM Form 167-R. In addition, variations in reporting occurred at some AAPs from year to year and as contractors changed. It must be concluded that DARCOM was correct in determining that the information as reported to ARMCOM is useless to compare indirect overhead among the AAPs.

Incl 1

4. The DARCOM form divided indirect overhead into 10 areas:

1. Supply Operations
2. Maintenance of Material
3. Personnel Support
4. Base Services
5. Utilities
6. Maintenance and Repair of Real Property
7. Minor Construction
8. Other Engineering Support
9. Administration
10. Tenant Support

These areas reflect the basic "Z" accounts as described in AR 37-100-74. (The Z accounts supposedly represent indirect overhead.) It has been difficult to determine the exact guidance or instructions furnished to the plants when the information was requested. However, after reviewing the information provided by the AAPs to DARCOM, it must be concluded that the AAPs again did not report the same information in each category. Inclosure 2 is a breakout of the information provided to DARCOM by the AAPs. An X indicates that no information was provided for that category and an "0" indicates that zero cost was reported. This chart shows some of the inconsistencies between plants. Joliet, for example, reported a negative value for administration costs and no costs for personnel support. Except for Ravenna and Sunflower, each of the plants was active at the time and logically should have been consistent in the categories reported.

5. Part of the CAMERA analysis pointed out the difference in percentage of indirect overhead vs. total dollars among the AAPs (Viewgraph 7 of the CAMERA presentation). There are basically two types of costs that contribute to indirect overhead: costs which do not vary proportionately with the base and costs which do vary directly or proportionately with manufacturing direct cost. These two types of costs should be analyzed separately. The first type can be compared with similar historical costs; however, changes in plant volume must be considered (e.g., construction of new facilities). The variable costs should always be compared to similar historical costs by means of ratios. For example, if an indirect cost, such as manufacturing supplies, has been found to vary directly and proportionately with manufacturing direct labor, it should be expected that the cost will bear the same relationship as prevailed during the past year. However, reclassification of accounts as direct or indirect costs, changes in operating methods, or the effects of inflation can affect the comparability of ratios. A few variables related to indirect

overhead are shown in Inclosure 3. This data (FY75) further emphasizes the differences among plants: the operating procedures and methods of manufacturing differ considering the type of production; maintenance and grounds keeping differ considering the value of buildings and equipment and the size of each reservation; and the personnel support cost differ considering the size of the work force. The differences in classification of accounts among AAPs was shown in Incl 1 and as pointed out in the CAMERA briefing, there are different levels of modernization among the AAPs. It must be concluded, therefore, that the information collected by the CAMERA team is as useless as that reported to ARMCOM for comparing indirect overhead among the AAPs.

6. In addition to examining the ratio of indirect overhead to total cost among the AAPs, the CAMERA team also examined the change in indirect overhead vs. the change in total dollars at several individual AAPs (Viewgraphs 8 and 9 in the CAMERA presentation) over a five-year period. This type of comparative analysis is a widely used method of evaluating costs. However, effective comparative analysis requires assurance that the cost of the base year, with which comparisons are made, is reasonable and that the same methodology was used to arrive at the cost for the subsequent years. The failure to make this critical step is severely crippling attempts to analyze indirect overhead at individual AAPs. When overhead costs are compared, specific cost must not be reclassified as direct or indirect between years, the non-variable and variable components should be analyzed separately and the same operating procedures should have been applied from year to year. It is doubtful if any of these conditions were met, as most AAP's production schedules have changed substantially between FY70 and FY75, modernization activities are changing with the implementation of UCARS.

7. DARCOM stated in the CAMERA briefing that one of the most common methods utilized to measure efficiency is through the analysis of indirect overhead expense. It must be assumed that the intent of the CAMERA recommendation was to monitor and to establish goals for management efficiency via indirect overhead. It should be pointed out that the ultimate aim is to lower total cost. Therefore, when total cost reduction can be achieved by efforts that increase overhead, there should be no difficulty in recognizing the wisdom of incurring increased overhead in such circumstances. Using indirect overhead as a measure of management efficiency can be misleading and may be counterproductive to reducing total cost. It is suggested that the terminology "indirect overhead" be replaced with another broader term (e.g., cost efficiency index) and that specific cost categories be identified which are more appropriate for determining how well the management at each plant is performing its mission.

8. As pointed out, implementation of the CAMERA recommendation verbatim would do little to fulfill the intent of the recommendation. It is suggested that the actual recommendation be disregarded and that the ARMCOM action be

directed toward fulfilling the intent of the recommendation. In order to make comparison among the plants or within individual plants, the framework or method of determining the classification of accounts for the base year and future analysis must be established. The implementation of UCARS is an attempt to standardize reporting among the AAPs. Therefore, the milestones for completing this recommendation should be keyed to the implementation of UCARS at the individual plants. DRSAR-PP and DRSAR-CP should form a team to analyze the specific data to be obtained through UCARS and other periodic information made available to the command and to arrive at a definition of the "cost efficiency index" that would be meaningful for setting goals, monitoring, and improving management at the AAPs. Most likely, separate indices would have to be developed for within plant analysis as opposed to among plant analysis. DRSAR-SA could assist in completing this first critical step. Since UCARS primarily affects active plants, the first effort should address the within-plant type of analysis. Consideration should be given to the Zero Base Fixed Cost analysis that is currently going-on. Attached (Incl 4) is the first estimate of the resources required to maintain each AAP in a non-productive, high readiness status. If the goals of this exercise are implemented, these costs will be separately funded and could significantly change overhead computed through UCARS.

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THOMAS N. MAZZA
Operations Research Analyst
Studies Application Division
Systems Analysis Directorate

DIRECT AND INDIRECT OVERHEAD AS REPORTED

IN CONTRACTORS PLANT COST STATEMENT - ARMCOM FORM 169-R

(As reported in FY75)

CATEGORY	Badger	Ind	Ia	Joliet	Kansas	Lake City	Lone Star	Lghorn
Direct Material*	D	D	D	D	D	D	D	D
Indirect Material	D	NA	D/I	D/I	D/I	D	D/I	I
Tooling	NA	NA	D	NA	NA	D	D	NA
Plant Line Operations	D	D	D	D	D	D	D	D/I
Other Plant Oper Support	D	I	I	D/I	I	I	I	I
Maintenance	D/I	I	I	I	D/I	I	D/I	I
Internal Transportation	D/I	I	I	I	I	I	D/I	I
Utilities	D	I	I	NA	D/I	I	D/I	I
Janitorial	I	I	I	I	NA	I	I	NA
Stores, Receiving and Ship	D/I	I	D/I	D/I	I	I	D/I	D/I
Quality Assurance	I	I	I	I	I	D/I	I	I
Roads and Grounds*	I	I	I	I	I	I	I	I
Fire and Security*	I	I	I	I	I	I	I	I
Safety and Medical*	I	I	I	I	I	I	I	I
Purchasing*	I	I	I	I	I	I	I	I
Engineering	D/I	I	D/I	I	D/I	D/I	D/I	D/I
Data Processing, Communications, Ofc Svc	I	I	I	I	NA	I	I	I
Payroll, Account, Budget*	I	I	I	I	I	I	I	I
Executive Administration*	I	I	I	I	I	I	I	I
Other (Direct)	D	NA	NA	D	D	NA	D/I	D
Adjustments (Direct)	D	NA	NA	I	NA	NA	NA	NA
Other	D/I	I	D/I	I	D/I	D/I	I	I
Adjustments	D/I	NA	D/I	D/I	I	D/I	NA	I
Fee	D	I	D	D	NA	D	D	D

Incl 1

D-Charged to direct overhead, I-Charged to indirect overhead, D/I-Charged to both direct and indirect overhead, NA-Not applicable or charged.

Incl 1

COMPARISON OF INDIRECT OVERHEAD COMPONENTS REPORTED TO DARCOM

AAP	Supply Opns	Maint Of Mat'l	Personnel Support	Base Services	Utilities	Maint & Repair of Real Prop	Minor Constr	Other Eng Support	Admin	1st Tenant Breakout	2nd Tenant Breakout
Badger	X	X	X	X			-0-				-0-
Holston		X								X	X
Indiana							-0-				
Iowa											
Joliet		-0-	-0-				-0-		(-$)	X	X
Kansas							-0-				X
Lake City							X	X			-0-
Lone Star		X					X				X
Longhorn		X					X	X			X
Louisiana							X			X	X
Milan		-0-					-0-				
Ravenna (I)	X	X	X	X			-0-		-0-	X	X
Scranton	X	X		X			X	X			X
Sunflower (I)	X	X	-0-	X			-0-		X		
Volunteer					X	X	X	X	X	X	X

X - Nothing Reported

0 - Zero Dollars Reported

VARIABLES RELATED TO INDIRECT OVERHEAD

(Data extracted from Dec 75 DIPR/NIPR)

AAP	PRODUCTION Type	PRODUCTION Status	WORK FORCE Govt	WORK FORCE Contractor	Acres	Industrial Floor Space (KSF)	REPLACEMENT COSTS ($\bar{M}$) Bldgs $M	REPLACEMENT COSTS ($\bar{M}$) IPE $M	REPLACEMENT COSTS ($\bar{M}$) OPE $M	ANNUAL Maint Cost $M	ANNUAL Opers Cost $M
Badger	P&E	A	21	371	7,417	3,189	702.6	3.2	128.2	1.895	22.1
Cornhusker	LAP	I	4	81	11,963	1,293	154.5	2.9	11.9	1.23	.078
Gateway	MP	I	2	13	14.9	288	60.2	22.1	14.6	.264	.302
Hays	MP	I	1	11	7.9	224	24.1	34.8	1.4	.150	.150
Holston	P&E	A	43	1,504	6,024	1,118	505.6	99.9	135.3	.236	64.15
Indiana	P&E/LAP	A	56	2,622	10,649	3,315	779.6	8.4	349.3	.871	58.2
Iowa	LAP	A	74	1,576	19,257	1,202	602.6	67.2	74.4	.015	28.7
Joliet	P&E/LAP	A	50	1,087	23,544	1,017	720.8	24.1	361.2	1.27	35.4
Kansas	LAP	A	37	1,040	13,727	928	202.7	9.6	24.0	.412	26.2
Lake City	LAP	A	114	2,443	3,909	2,209	252.6	165.4	29.	.179	82.2
Lone Star	LAP	A	123	1,859	15,546	1,208	271.2	29.4	30.7	.140	47.3
Longhorn	LAP	A	49	1,026	8,493	702	100.4	10.4	46.	.112	29.1
Louisiana	MP/LAP	A	55	966	14,974	1,506	174.3	58.8	92.9	1.35	23.3
Milan	LAP	A	112	3,135	22,861	816.6	327.3	32.2	40.	.083	56.9
Newport	P&E/LAP	I	18	204	6,990	565.	173.8	7.6	71.6	.593	8.78
Radford	P&E	A	72	3,015	7,102	2,964	446.	61.8	75.5	.332	90.3
Ravenna	LAP	I	5	260	21,419	1,749	479.6	271.2	9.9	4.627	6.59
Riverbank	MP	A	31	679	172	558	55.9	103.9	18.5	.798	10.2
Scranton	MP	A	20	640	15	313	26.1	136.2	8.2	.048	38.4
St Louis	MP	I	1	16	21	405	49.1	71.2	19.3	.291	NA
Sunflower	P&E	I	5	204	9,067	2,444	623.6	1.8	49.2	2.73	7.7
Twin Cities	SA/MP	A	36	735	2,389	2,825	334.3	133.2	29.6	2.21	39.8
Volunteer	P&E	A	30	468	7,285	108	156.5	3.0	45.0	.174	18.1

P&E - Propellants & Explosives; LAP - Load Assembly & Pack; MP - Metal Parts; SA - Small Arms.

ZERO-BASED FIXED COST ESTIMATES
FOR GOCO PLANTS IN FY77

GOCO PLANT	MANPOWER REQUIREMENT	DOLLAR REQUIREMENT
BADGER	193	$4,406,000
CORNHUSKER	74	1,363,703*
GATEWAY	15*	322,946*
HAYS	11	167,900
HOLSTON	97	2,263,545
INDIANA	251	6,585,377
IOWA	157	2,450,000
JOLIET	237	6,957,900
KANSAS	158	2,647,200
LAKE CITY	233	8,989,929
LONE STAR	139	2,353,329
LONGHORN	188	4,400,000
LOUISIANA	238	6,000,000
MILAN	369	5,893,964
NEWPORT	111	3,091,376
RADFORD	236	8,227,200
RAVENNA	194	4,076,859
RIVERBANK	53	1,139,374
ST. LOUIS	15	262,000
SCRANTON	66	1,834,530
SUNFLOWER	211	5,132,824
TWIN CITIES	148	4,922,400
VOLUNTEER	131	4,437,666
PHOSPHATE DEVELOPMENT WORKS	(Unknown)	76,650*
WELDON SPRINGS	(Unknown)	58,800*
TOTAL	3,525	88,061,472

*Staff-developed data based on best available information.

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Incl 4

VADS PRODUCT IMPROVEMENT PROGRAM APPLICATION SCHEDULE

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DRSAR-SAS

2 0 MAY 1976

MEMORANDUM FOR RECORD

SUBJECT: VADS Product Improvement Program - Application Schedule

1. Attached (Incl 1) is the application schedule which was presented to DCG, ARMCOM during a briefing by DRSAR-ASV on 11 May 1976, subject: Briefing--VADS Update for the DCG.

2. This MFR has four objectives:

a. To surface some apparent discrepancies in the subject schedule (Incl 1).

b. To present Frankford Arsenal's estimation of the capability of a radar mod team.

c. To show a possible correlation between the subject schedule (Incl 1) and Frankford Arsenal's estimates.

d. Present an alternative application schedule.

Before addressing these objectives, some background information is provided.

3. The Vulcan Air Defense System (VADS) is undergoing a Product Improvement Program (PIP) with many of the improvements awaiting Material Release (MR) following A-1 configuration approval at the scheduled IPR on 27 July 1976. A sole source contract was awarded to General Electric (GE) for production and application of the mod kits. Production is continuing, and several kits (including the radar reliability kit) which are not dependent on the July IPR are currently being installed at Ft. Bliss and Ft. Campbell. The proposed application schedule (Incl 1) was drawn up by GE. DRSAR-PPC (contracting officer) said that GE was allowed to draw up the application schedule since they would best know their own capabilities. Therefore, the validity of the proposed application schedule was never challenged.

4. The mods will be applied by contractor mod teams, with the radar mod teams applying the radar mod kits and the armament mod teams applying all other mods. According to DRSAR-MAC, each armament mod team is capable of completely modifying either 2 M163s or 3 M167s per week on the average. DRSAR-MAC also stated that each radar team is capable of modifying 2.5 to 3 radar systems per week on the average. (There are four radar units per radar system which are being modified, therefore, each team is capable of modifying 10 to 12 units per week on the average.) It also follows that since the Maintenance Work Order (MWO) allows 80 man-hours application time

SA CI

for the radar mod kit and assuming that each of the 5 to 6 members on a radar mod team applies the modifications, each radar team should be capable of modifying 2.5 to 3 radar systems per week (1 team X 6 man/team X 40 man-hrs/wk/man ÷ 80 man-hrs/radar system = 3 radar systems/wk). It should also be noted that GE estimated that only 70 man-hours application time would be required.

5. Considering the worldwide distribution of M163s and M167s, the per weekly average of scheduled modifications at the locations shown in Incl 1 for each radar and armament team was calculated. It was found that the average workload for radar teams fluctuated from 0.7 to 2.5 radar systems per week (e.g., 33.5 radar systems at Ft. Carson are scheduled to be modified by 1 radar mod team in 17 weeks, a per weekly average of 2.0 radar systems). For the armament teams, the average workload fluctuated from 0.9 to 1.9 M163s per week and was 4.7 M167s per week at Ft. Bragg. When analyzing this data, it appears that the scheduled workload for both the radar and armament mod teams fall far short of their estimated capability (2.5 to 3 radar systems per week for a radar team and 2 M163s or 3 M167s per week for an armament team). The one exception was at Ft. Bragg where the estimated capability of the armament team was exceeded. Furthermore, the proposed schedule shows one armament mod team working at Ft. Campbell from May 1976 to the middle of July 1976. Since this is before the 27 July 1976 IPR, the armament mod team must return to Ft. Campbell at some point of time to install the IPR related mods. This is not shown on the proposed schedule. In addition, the proposed schedule shows that only 78 radar systems (312 radar units) are to be modified at Ft. Bliss. This is incorrect. The schedule should show a total of 163.25 radar systems (653 units) to be modified at Ft. Bliss, since the radar systems from Hawaii, Korea, and MMCS are also to be modified at Ft. Bliss.

6. The estimated time of 80 man-hours to apply a radar mod kit to a radar system has been met with some opposition. Representatives from Frankford Arsenal have witnessed and documented the modification of 3 radar systems by GE personnel at GE. The modifications were applied under ideal conditions, i.e., in air-conditioned rooms with all parts available which would be required to correct deficiencies caused by human error in application of the modification. The application time for the first set, without inspection and tests, was 130 hrs, the time for the second set was 110 hrs, and the time for the third set was 100 hrs, for a total of 340 hrs. Again, it should be noted that those times were without inspection and tests. The total time to modify, inspect and test the 3 systems at GE was approximately 980 hours (756 man-hours for modification, inspection and repair, and 224 man-hours for test and trouble shooting). It was later estimated by Frankford Arsenal that with adequate inspection and test procedures utilizing the TPM-22 Radar Test Set, the time for the MWO will be approximately 160 man-hours. This is quite a difference from the stated 80 man-hours in the MWO and GE's estimated 70 man-hours.

7. With the above considerations, the following assumptions were made to show a possible correlation with the attached schedule (Incl 1) and Frankford Arsenal's estimates:

a. that 160 man-hours are required to apply the radar mod to an operable radar system and return the radar system to the user in an operable state,

b. that 70 man-hours are required to apply the radar mod (without inspection and testing) to an inoperable radar system and return that system to the user in an inoperable state,

c. that GE's mod teams modify only 78 radar systems at Bliss as shown in Incl 1 (and not the 163.25 systems which should have been scheduled and was pointed out in paragraph 5),

d. that one-third of the radar systems (545 are scheduled to be modified) will be in an inoperable condition when given to the radar mod teams. (This means that 182 systems would be inoperable and 363 systems would be operable.)

With these assumptions, the total man-hours needed would be 363 operable systems times 160 man-hours per operable system plus 182 inoperable systems times 70 man-hours per inoperable system, or 70,820 man-hours. This is roughly equivalent to the number of man-hours scheduled in Incl 1.

8. In view of the above scheduling problems, the undersigned laid out a schedule which is attached as Incl 2. This schedule was based on DRSAR-MAC's estimates that each radar team can modify 2.5 to 3 radar systems per week on the average and that each armament team can modify either 2 M163s per week or 3 M167s per week on the average. Some time was allowed for annual and sick leave (approximately 2 weeks annual leave and 2 weeks sick leave) as well as travel time. It is recognized that the success of any modification program greatly depends on management, and coordination with the user. The schedule (Incl 2) shows that only 4 armament mod teams (not 5) and 4 radar mod teams are needed to apply the mods, and that they could finish near the end of Oct 77 or the early part of Nov 77.

9. Neither schedule (Incl 1 and 2) meets the DA deadline of July 77, but Incl 2 better utilizes the resources available. In addition, if the Frankford Arsenal estimated application time for a radar mod kit (160 man-hours) is correct, then 43,600 additional man-hours effort would be required if all systems were supplied to the mod teams in an operable state. This would extend the schedules of all 4 radar teams approximately 50 weeks. One alternative solution would be to increase the number of personnel on the radar mod teams. At most, 4 additional personnel on each radar team would be required (totaling 16 additional personnel) in order to meet the schedule (Incl 2).

DRSAR-SAS 25 MAY 1976
SUBJECT: VADS Product Improvement Program - Application Schedule

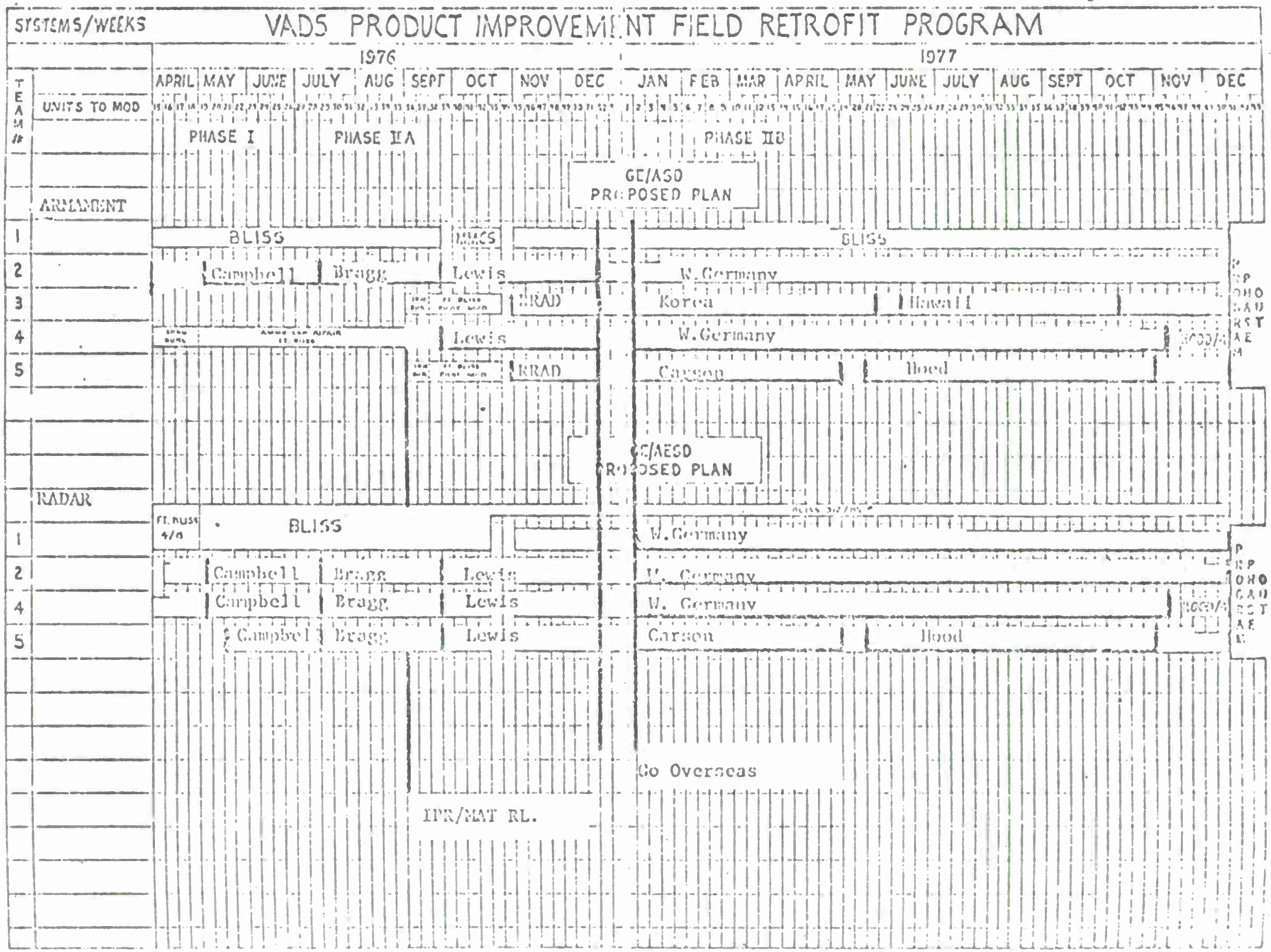
10. The above considerations could solve the scheduling problems, but, unfortunately, it will not solve the Army's problem of what to do with as many as 182 inoperable, but modified radar systems which will be costly and time consuming (if at all possible) to bring to an operable state. Maybe this problem will receive more attention once the operational readiness of VADS starts dropping from 80% to 70% to 60%...

2 Incl
as

NORMAN H. TRIER
General Engineer
Studies Application Division
Systems Analysis Directorate

CF:
DRSAR-ASV
DRSAR-PPC
DRSAR-MAC
SARRI-LW
DRSAR-SA MFR Report File

Incl 1



* INCLUDES 51 UNITS FROM MMCS AND 126 UNITS FROM KOREA

Incl 2

VADS PRODUCT IMPROVEMENT FIELD RETROFIT PROGRAM

1976: APRIL MAY JUNE JULY AUG SEPT OCT NOV DEC — 1977: JAN FEB MAR APRIL MAY JUNE JULY AUG SEPT OCT NOV DEC

PHASE I | PHASE IIA | PHASE IIB

ARMAMENT

78 M163s and 30 M167s

	Apr–Jun 1976	Jul–Dec 1976	1977	
TEAM 1	Bliss	Campbell 47 M167s-20 wk	Lewis 24 M163s-24 wks; Bliss	Program Phase-Out
TEAM 2	Campbell	38 M163s + 13 M167s Hood 24 wks	GERMANY: 26 M163s; 26 M163s; 26 M163s	
TEAM 3		Training At Burl&Bliss; Hood 7 wks	Korea 24 M163s 12 wks; Hawaii 26 M163s 13 wks; Carson 26 M163s 13 wks	
TEAM 4	Ammo can repair at Bliss	Bragg 47 M167s 20 wks	GERMANY: 26 M167s; 26 M167s; 24 M163s; 26 M163s	
70 TEAM 5	Not Needed			

RADAR

	Apr–Jun 1976	Jul–Dec 1976	1977	
TEAM 1	Bliss 653 units*			Program Phase-Out
TEAM 2	Campbell 74 units 10 wks	Hood 178 units - 23 wks	Germany 396 units 44 wks	
TEAM 3	Campbell 74 units	Hood 70 units; Bragg 70 units	Germany 128 units 32 wks; Lewis 111 units 32 wks; Carson 134 units 13 wks	
TEAM 4	Campbell 64 units	Bragg 162 units 23 wks	Germany 397 units 44 wks	

*4 units equate to 1 radar system.

COST ESTIMATE OF TESTING THE BRITISH L16A3, 81mm MORTAR

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FACT SHEET
(ARMCOMM 340-1)

DATE	
25 May 1976	

TO:	FROM:	WRITER PHONE EXT
DRSAR-CG	DRSAR-SAA	R. Blankert 5626

SUBJECT: Cost Estimate of Testing the British L16A3, 81mm Mortar

PURPOSE: To provide the CG with an independent estimate of the cost of testing the British L16A3, 81mm Mortar

FACTS:
1. TRADOC has formally expressed an interest in an improved 81mm Mortar. No official requirements exist. The British L16A3, 81mm Mortar may fill the improved 81mm "requirement."

2. An early version of the L16 was tested and performed poorly in stability and rate of fire portions of the test. Testing was conducted at TECOM under Mr. Trumbore (Autovon 283-3674), in 1964. The L16A3 Mortar is an improved version of the weapon tested. It is not known if improvements addressed deficiencies.

3. Testing costs are dependent upon the level of effort (LE) desired. Summary of costs with associated LE are:

LE I - technical assessment only	$ 15K
LE II - proof testing, rate of fire and stability	180K
LE III - fragmentation and operational testing plus LE II	222K

4. A technical assessment (low level of effort) of the L16A3 could be accomplished with four man-months of effort at a cost of approximately $15K. Assessment would consist of reviewing test reports on the L16 and determining if the L16A3 improvements addressed earlier deficiencies. The technical assessment would involve ~~virtually~~ no firing tests. The assessment could only determine if the L16A3 has the potential to fill the improved 81mm Mortar "requirements" based on expert judgement.

5. A higher level of effort could determine the potential of the L16A3 weapon. The testing would consist of Proof Acceptance, Rate of Fire tests and Stability tests. Cost would include Watervliet support of TECOM Test. Estimate of costs range from a low of $130.4K to a high of $228.2K (TAB A, Part I).

6. In addition to tests previously described, a more extensive test would include a fragmentation test and a operational test. Estimate of cost ranges from a low of $160.4K to $283.2K (TAB A, Part II).

7. Cost estimates are based on data obtained on the Engineering Design, Test I, for the Lightweight Company Mortar (TAB B) and a Watervliet program submission to test the Finnish Tampella 81mm Mortar (TAB C). Cost estimates are based on weapons and ammunition being supplied by the British at no cost.

8. A brief description of the tests is in TAB D.

4 Incl
TABS A-D

M. Rhian
M. RHIAN
Acting Director
Systems Analysis Directorate

SAAF

AMSAR FORM 7, 1 JUL 73

L16A3 TEST COST ESTIMATE+

PART I BASIC TEST OF WEAPON

ACTIVITY	ESTIMATED COST+ (Thousands of Dollars) LOW	HIGH
Rate of Fire Tests	12.2	20.6
Stability Tests	33.0	41.3
Maximum Design Range Tests	28.9	53.7
Precision Error Tests	41.3	82.6
Watervliet Support	15.0	30.0
TOTAL	130.4	228.2

PART II BASIC TEST OF WEAPON, FRAGMENTATION TEST & OPERATIONAL TESTING

ACTIVITY	ESTIMATED COST+ (Thousands of Dollars) LOW	HIGH
Rate of Fire Tests	12.2	20.6
Stability Tests	33.0	41.3
Maximum Design Range Test	28.9	53.7
Precision Error Tests	41.3	82.6
Fragmentation Test	30.0	40.0
Operational Test	0	15.0
Watervliet Support	15.0	30.0
TOTAL	160.4	283.2

+Estimated cost derived by DRSAR-SAA from ED Test I for LWCM and Watervliet Program for Finnish Tampella 81mm Mortar Test.

TAB B

ENGINEERING DESIGN TEST I FOR LIGHTWEIGHT COMPANY MORTAR*

TEST SECTIONS

1. Rate of Fire
2. Stability
3. Simulated Fire Mission
4. Human Factors
5. Bore Residue Test
6. Adverse Conditions
7. Rough Handling
8. Maximum Design Range
9. Precision Errors
10. Adequacy of Propellant
11. Firing in Hand-held Mode
12. HE Cartridge Functioning
13. Fire Control

Cost ('73$) = $329K

Cost ('76$) = (1.255)($329K) = $413K

PORTION OF TEST TO BE PERFORMED ON L16A3	ESTIMATED PERCENT OF TOTAL TEST COST		ESTIMATED COST IN THOUSANDS OF $	
	LOW	HIGH	LOW	HIGH
Rate of Fire	3	5	12.2	20.6
Stability	8	10	33.0	41.3
Maximum Design Range	7	13	28.9	53.7
Precision	10	20	41.3	82.6
TOTAL	28	48	115.4	198.2

*Test sections and cost of tests obtained from Validation IPR Package for the Lightweight Company Mortar dtd 13 Dec 73.

TAB B

TAB C

ESTIMATED COSTS FOR L16A3 MORTAR TEST*

A. PHASE I

		COST (Thousands $)
1.	Engineering Support by Watervliet	30
2.	Proof Acceptance	3
3.	Rate of Fire & Stability Tests	100
	Sub-Total	133

B. PHASE II

1.	Range/Accuracy Tests	9
2.	Compatibility of our M374A2 Ammo with the L16 weapon	12
3.	Fragmentation tests for British round**	40
	Sub-Total	61
	TOTAL	194

* Costs based on Watervliet program submission to test Finnish Tampella 81mm Mortar.

** Estimated by Material Test Directorate, APG, MD.

TAB C

PROOF FIRING

The objective of proof firing is to determine the material soundness of the mortar. The proof firing procedure consists of first determining physical characteristics and inspection of the weapon, then firing the weapons under stress conditions and then measuring physical characteristics to determine unusual wear, malfunction or physical damage such as tube cracks etc. This test is required prior to any subsequent tests.

RATE OF FIRE

The objective of the rate of fire test is to determine the sustained and maximum physical rate of fire capabilities of the mortar system. Maximum physical rate of fire is determined by firing thirty rounds through the weapon limited only by the physical capability of the mortar crew.

Sustained rate of fire is limited by the maximum temperature of the barrel at which the weapon can be safely fired. Tube temperatures are recorded for various sustained rates of fire. Testing at any sustained rate of fire is terminated when temperature equilibrium is reached or when the temperature reaches the limiting tube temperature.

SYSTEM STABILITY/PRECISION

The objective of this test is to determine the interaction between mortar and soil and to determine that portion of system delivery error due to the weapon and ammunition. The tests are conducted on three soil types, two rates of fire and several ranges. Tube and sight throw-off, baseplate displacement, muzzle velocity and impact coordinates are recorded for each round. Soil conditions and meteorological data are recorded throughout the firings.

TAB D

RANGE/ACCURACY

The objective of this test is to determine the range and deflection probability errors. Ten round groups are fired at each of four representative ranges. Weapon is relayed between each round. All rounds fired during a short period of time. Coordinates of impact points are recorded. Using this data range probable error and deflection probable error are calculated.

COMPATIBILITY OF OUR M374A2 AMMO WITH THE L16 WEAPON

An extreme limit study of ammunition and weapon would be conducted to determine if potential problem exists. Testing would consist of a repeat of the range/accuracy test and a comparison of the results.

FRAGMENTATION

The objective of this test is to determine the lethality of the British round. Five rounds would be fragmented and average fragmentation characteristics would be determined. This data would then be utilized to determine lethal areas for various angles of fall, posture and burst heights.

SINGLE ROUND HAZARD DISTANCE

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DRSAR-SAM 26 MAY 1976

MEMORANDUM FOR RECORD

SUBJECT: Single Round Hazard Distance

1. References:

a. FONECON between Mr. Bailey, DRACOM-SF-C and Mr. Haase, DRSAR-SAM, 1 Mar 76, subject as above.

b. FONECON between Mr. Kneasy, SAREA-DE-N and Mr. Haase, DRSAR-SAM, 2 Mar 76 and 26 May 76, subject as above.

2. Reference 1a requested the single round hazard distance using the 1% lethality criteria as defined in DDESB Tech Paper No. 10 for burstered and non-burstered munitions. The requested meteorological parameters to be used for agent GB were (1) a temperature of 90°F, (2) a windspeed of 2 mph, and (3) a decontamination time of 10 minutes. The same parameters were used for agent VX non-burstered rounds. For the VX burstered rounds, a windspeed of 20 mph was used in calculating hazard distances. No temperature is considered for VX.

3. These results are presented in the following table. Conformation of these results were made in ref 1b.

Table 1. Hazard Distance for Single Rounds

Munition	Agent	Distance With Burster (meters)	Distance Without Burster (meters)
105	GB	450	110
	HD	55	<25
155	GB	935	220
	VX	1660	<25
	HD	100	<25
8"	GB	1400	320
	VX	2440	<25
M55	GB	1250	300
	VX	2135	<25
M23	VX	275	<25

Otto F Haase Jr

OTTO F. HAASE, JR.
Operations Research Analyst
Methodology Division
Systems Analysis Directorate

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