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SYSTEMS ANALYSIS DIRECTORATE  
ACTIVITIES SUMMARY  
APRIL 1976

MAY 1976

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

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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: The Lightweight Company Mortar, delivery errors, nitrolysis of hexamine, HMX, arsenal security, and Squad Automatic Weapon System (SAWS).		

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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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ARSENAL SECURITY STUDY

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21 APR 1976

## MEMORANDUM FOR RECORD:

SUBJECT: Arsenal Security Study

1. After the meeting with COL Skibbie, 9 Mar 76, an initial, tentative study plan was formulated (Incl 1). Our current efforts have focused on a literature search of studies similar to this one (Incl 2). To date, we have identified four studies (Incl 2, Ref. 12, 13, 14, 15) which contain analysis of security of vital assets, perimeters, and the allocation of resources using the Rodman Laboratory Technical Library keyword, computer terminal.
2. It appears that the Army's Mobility Equipment Research and Development Center (MERDC) has done considerable work on this type of problem. We are requesting reports on Border Security Systems Analysis contracts from MERDC. Similar study efforts by the Army Scientific Advisory Panel Ad Hoc Group on Physical Security are being requested. Past efforts of the New York City Rand Institute will also be reviewed for applicability. A trip to the University of Iowa central library is being planned for the near future to review the general literature and periodicals.
3. After the literature search is completed by 30 Apr 76, a model will be formulated for the problem. This will allow a better definition of what types of data will need to be obtained. A revised study plan will be completed at that time.

2 Incl  
as

*Stuart W. Olson*

STUART W. OLSON  
Operations Research Analyst  
Studies Application Division

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S. OLSON  
16 MAR 76

Title of Study: Arsenal Security Study

Objective: To determine the requirements of providing a maximum level of security protection to designated high interest locations on Rock Island Arsenal (RIA) with the least manpower necessary while providing an adequate level of other routine security police services.

Approach: The RIA security force must perform many functions ranging from guarding entrances to RIA, checking to see if classified material is secure, enforcing traffic regulations, providing escorts, patrolling the perimeters of RIA, and providing security to areas of high interest, to name a few. During any short interval of time the available security force manpower must be split in some fashion to perform some or all of their function. Since the available manpower is assumed to be less than that needed to perform all the necessary functions on a continuous basis, it is desirable to assign manpower to functions during each interval of time to achieve an overall optimal performance of security responsibility.

The key information needed to perform this study is the formulation of a value function in order to distinguish between alternatives. It is, therefore, assumed that each security function assigned to the RIA security force has a certain security value. This approach to assignment of manpower avoids addressing the probability of a breach of a high interest security asset. It is felt that there is little or no experience of the occurrence of this event to permit the estimation of its frequency under various conditions. Interviews will be conducted with RIA security personnel to determine how security can be measured. Depending upon the outcome of these interviews, the problem could be formulated in several conceivable ways from a game theoretic framework to a resource allocation



structure.

Resources Required: Resources required by the Systems Analysis Directorate will depend upon how much data needs to be gathered. Uncertainty in this effort at the present time limits the accuracy of the estimate. A reasonable estimate of from 6 to 12 man-months is made based upon initial discussions with the CO of RIA. This effort will be divided as 10% to problem formulation, 25% to literature search, 30% to data gathering, 25% to model formulation and 15% to analysis and interpretation of results. It is estimated that 10 hours of computer time will be required. There is no requirement for travel.

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Ordered 26 Mar 76

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11. R. C. Larson, Urban Police Patrol Analysis, The MIT Press, Cambridge, Massachusetts, 1972.
12. Physical Security Test Report, Annex A, Appendix 4, Aggressor Synopsis MASSTER AD 515 535 (S).

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13. Army Scientific Advisory Panel Ad Hoc Group on Physical Security, Part II AD-C002811 (C).
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15. Border Security Systems Analysis AD-870 731L Honeywell Inc., Minn, RD Systems Research, B.E. Rice 0065-FR1-Vol-7.

SAW DECISION RISK ANALYSIS

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81 APR 1976

DRSAR-SAS  
MEMORANDUM FOR RECORD

SUBJECT: SAW Decision Risk Analysis

1. On 16 April 76, MAJ Lukens (SAW PM) called me regarding Systems Analysis Input to his IPR package. He indicated that a copy of our DRA had been sent to Frankford and Frankford disagreed with the statement about the high risk associated with produceability of the improved 5.56mm ammunition. Our report cited Frankford as the source of the information.
2. We tried to reverify the source of the information at Frankford without any success. We didn't have any documentation on the subject to determine who the original source was; and now that Frankford management has taken a formal position, I doubt if we ever will.
3. Subsequently, I talked to personnel in Rodman Laboratory (Chuck Rhoades) and also to Mr. Clyde Bradley, who is a recognized expert in small arms. Mr. Rhoades referred me to the NATO AHTAWG meeting at Aberdeen on 29 March 1976.
4. The briefing made by Frankford at the above meeting indicated that the first lot produced at Lake City had excessive yaw at extended ranges and that the tracer did not meet the 800 meter requirement. Also the helmet penetration range was only 770 meters. This production at Lake City was by conventional means and not using SCAMP. Mr. Bradley indicated that in view of the trouble with producing 7.62mm steel core ammunition that he would expect more trouble with 5.56mm. He cited other examples of problems with the 5.56mm. In his opinion until produceability has been demonstrated on the production line the AP-1 ammunition is high risk from a mass production view point.
5. Subsequently, the reference to Frankford was removed from the report. I told MAJ Lukens to replace the reference to Frankford with the following: "Preliminary analysis by DRSAR-SA revealed many areas of uncertainty associated with mass production and therefore, produceability should be labeled high risk at this time."
6. In the description of the performance attribute analysis, reference was made to the fact that TECOM participated in expressing opinions about each weapon. TECOM's participation was by accident rather than by intent. Mr. Chuck Crider was visiting Rodman Labs on the day the interviews with the engineers took place. He sat in on the interview and expressed his opinions as appropriate. He called and wanted us to add a sentence in our report stating that he didn't represent an official TECOM position and that TECOM doesn't necessarily agree with the results of the analysis. It was agreed to add the caveat.



1 APR 1976

DRSAR-SAS

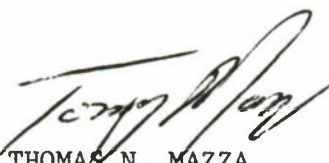
SUBJECT: SAW Decision Risk Analysis

7. MAJ Lukens also questioned the statement in the cost/schedule analysis section concerning the weapon and ammunition development. It was stated that after entry into Engineering Development they would be separate activities. I explained that insofar as the cost/schedule analysis was concerned, that once the SAW program enters Engineering Development, the weapon/ammunition interface will be defined and set. Weapon design activities after that point will not be directed at revising chamber volumes, barrel twist, etc., that would affect the ammunition design and conversely that ammunition design activities will more than likely be directed at production problems. In short, the schedule network describing the program did not depict either the ammunition nor weapon development programs as waiting or depending on the other program.

8. MAJ Lukens also questioned the inclusion of the 7.62mm candidates in the performance analysis. He stated that TRADOC and DARCOM had already decided on the 5.56mm and that the inclusion of the 7.62mm was only mudding the water. I replied that we had conducted the performance analysis prior to the joint decision and felt that our results were significant. Particularly interesting is the fact that the Belgium 7.62mm candidate rated above all other candidates. AMSAA's recent comments on the LOA for SAWS also calls for reconsideration of the M16A1.

9. Our report stated January 1982 as the IOC date for SAW. I originally obtained this date through discussions with MAJ Lukens. The DRA indicates that the program can expect to miss that schedule by 14 months. MAJ Lukens now informs me that he has changed his rationale used to determine the IOC date and would like us to refer to the new date. The new date significantly reduces the expected program delay. When asked for a formal documentation on the IOC date, MAJ Lukens said one does not exist as such. He said it can be implied from the MN. I requested a written response from him stating the IOC date. The response we received did state a date, however, it was subject to approval from higher HQs. I didn't know it would be so difficult to get a clear answer on what would appear to be a very simple question.

10. Our DRA report is being updated to include all of the comments/information discussed.



THOMAS N. MAZZA  
Operations Research Analyst  
Studies Application Division  
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SENSITIVITY OF THE LIGHTWEIGHT COMPANY  
MORTAR TO VARIATIONS OF DELIVERY ERRORS AND  
PROJECTILE FUNCTIONING HEIGHT

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## MEMORANDUM FOR RECORD

SUBJECT: Sensitivity of the Lightweight Company Mortar to Variations of Delivery Errors and Projectile Functioning Height

1. This analysis was requested by the Program Manager for the Lightweight Company Mortar to assist in the development of test plans to be used in testing and evaluation of the LWCM. As requested, the purpose of this analysis was to determine the sensitivity of the LWCM on-target effectiveness to specific variations of projectile height of burst and system delivery errors.
2. The measure of effectiveness used to characterize on-target effectiveness was percent casualties of unprotected prone personnel in the open. The values of range, target size and delivery errors used in the study were suggested by the Program Manager. Casualty estimates were derived for two volley sizes, four burst heights, three system Mean-Point-of-Impact errors, and three precision errors. The JTCG/ME approved ROBM and MATRIX Programs<sup>1</sup> were used to generate effectiveness estimates. Fragmentation data were obtained from Aberdeen Proving Ground Firing Records<sup>2</sup>. Projectile terminal velocities and angles of fall were provided by BRL (DRXBR-EB-FT). Aiming Policies used are those shown by an ARMCOM Study<sup>3</sup> to be the policies necessary to minimize ammunition expenditures.
3. Tables 1 through 4 display the results of this analysis. Each table displays the percent casualties for a specific target and range. Examination of data in Tables 1 through 4 reveals the following:
  - a. Fraction Casualties is sensitive to MPI errors. A reduction of MPI error results in an increase in percent casualties regardless of range, target size, target shape, precision errors, burst height or number of volleys fired. The effect is most pronounced for small targets.
  - b. No consistent trend between percent casualties and precision errors was detected. The amount of precision error desired is a function of target size, height of burst, number of volleys, MPI error, and sheafing policy. In most cases a median precision error provides the highest percent casualties or, a level of casualties within five percent of the highest.

<sup>1</sup>Computer Program for General Full Spray Personnel MAE Computations (JMEM), 25 May 71, (ROBM) and "Expected Target Damage to Computer Program (MATRIX Programs 100-1, 103, 105, and 106)", January 1974, by Seymour Einbinder.

<sup>2</sup>Fragmentation Test Data for 60mm M49A4E1 (XM720), Firing Record FR-B15848, Materiel Test Directorate, Aberdeen Proving Ground, MD.

<sup>3</sup>Report, "Comparative Analysis of the 60mm, XM224 and 81mm M29A1 Mortars", October 1975, R. Fischer. (CONFIDENTIAL).

8 6 APR 1976

DRSAR-SAA

SUBJECT: Sensitivity of the Light Weight Company Mortar to Variations  
of Delivery Errors and Projectile Functioning Height

c. Casualty estimates are based on the assumption that all projectiles in an engagement function at the same height. Of the burst heights investigated, a height of four feet provides the highest casualty level. There is one exception to this generalization. For small targets at 250 meters range and a large number of volleys, the best choice of burst height was ten feet.

4. This study assumed zero target location error. In practice, target location error is greater than zero and increases with range. Inclusion of the target location error would result in significantly higher bias errors and as a result, casualty levels would generally decrease. However, failure to include the target location error does not negate the conclusions concerning the sensitivity of the casualty level to delivery errors. However, over the range of conditions considered, failure to include the target location error does not negate the conclusions concerning the sensitivity of casualty level to precision error.

FOR THE COMMANDER:

SIGNED

1 Incl  
Tables 1-4

R. BLANKERT  
Operations Research Analyst  
Systems Analysis Directorate

TABLE 1. EFFECTIVENESS OF THE LWCMS AGAINST PRONE PERSONNEL IN THE OPEN (250 Meters Range, 5-Minute Assault Casualty Criteria, Target Size 100 Meters Range X 100 Meters Deflection)

Case <sup>1</sup>	DELIVERY ERRORS <sup>2</sup>			PERCENT CASUALTIES				
	Precision		Mean-Point-of-Impact		Projectile Burst Height Feet			
	Range	Deflection	Range	Deflection	1	4	7.8	10
1	1.875	7.5	15	10	14	18	17	16
	3.75	15	30	20	12	15	14	13
	7.5	30	60	40	7	8	8	7
2	1.875	7.5	15	10	44	52	53	53
	3.75	15	30	20	38	45	45	45
	7.5	30	60	40	24	28	29	28

1. CASE 1 - three mortars spaced 30 meters apart firing parallel sheaf. Center tube is aimed at the center of the target. Four volleys were fired.
2. CASE 2 - three mortars spaced 30 meters apart firing twenty-four volleys in parallel sheaf. Target is divided into four squares 50 meters square. Center tube is aimed at the center of each of the smaller squares for 25 percent of the rounds fired.
3. Delivery errors are the standard deviation in meters.



TABLE 2. EFFECTIVENESS OF THE LWCMS AGAINST PRONE PERSONNEL IN THE OPEN (250 Meters Range, 5-Minute Assault Casualty Criteria, Target Size 25 Meters Range X 25 Meters Deflection)

Case <sup>1</sup>	DELIVERY ERRORS (2)		PERCENT CASUALTIES					
	Precision		Mean-Point-of-Impact		Projectile Burst Height Feet			
	Range	Deflection	Range	Deflection	1	4	7.8	10
1	1.875	7.5	15	10	42	51	51	49
			30	20	19	24	25	24
			60	40	6	8	8	8
	3.75	15	15	10	43	51	48	46
			30	20	21	26	26	25
			60	40	7	9	9	9
2	7.5	30	15	10	35	42	38	35
			30	20	20	25	23	21
			60	40	8	10	10	9
	1.875	7.5	15	10	70	78	81	83
			30	20	38	46	49	51
			60	40	14	18	19	20
2	3.75	15	15	10	73	80	82	83
			30	20	43	50	53	54
			60	40	17	21	22	23
	7.5	30	15	10	76	81	82	81
			30	20	49	55	56	56
			60	40	22	26	27	27

1. CASE 1 - three mortars spaced 30 meters apart, firing converging sheaf at the center of the target. Four volleys fired.

CASE 2 - conditions the same as CASE 1 except 24 volleys fired.

2. Delivery errors are the standard deviation in meters.

TABLE 3. EFFECTIVENESS OF THE LWCMS AGAINST PRONE PERSONNEL IN THE OPEN (3000 Meters Range, 5-Minute Assault Casualty Criteria, Target Size 100 Meters Range X 100 Meters Deflection)

Case <sup>1</sup>	DELIVERY ERRORS (2)			PERCENT CASUALTIES					
	Precision		Mean-Point-of-Impact		Projectile Burst Height Feet				
	Range	Deflection	Range	Deflection	1	4	7.8	10	
1	22.5	7.5	15	10	17	21	19	18	
			30	20	14	17	15	15	
			60	40	8	10	9	8	
	45	15	15	10	13	17	14	14	
			30	20	11	14	12	12	
			60	40	7	9	8	8	
	90	30	15	10	7	9	8	7	
			30	20	6	8	7	7	
			60	40	5	6	5	5	
	22.5	7.5	15	10	58	65	62	61	
			30	20	47	53	51	50	
			60	40	27	31	30	29	
2	45	15	15	10	55	63	59	57	
			30	20	47	55	51	49	
			60	40	31	37	34	33	
	90	30	15	10	35	42	38	37	
			30	20	32	39	36	34	
			60	40	25	31	28	26	

1. CASE 1 - three mortars spaced 30 meters apart firing parallel sheaf. Center tube is aimed at the center of the target. Four volleys are fired.

CASE 2 - same as CASE 1 except twenty-four volleys are fired.

2. Delivery errors are the standard deviation in meters.



TABLE 4. EFFECTIVENESS OF THE LWCMS AGAINST PRONE PERSONNEL IN THE OPEN (3000 Meters Range, 5-Minute Assault Casualty Criteria, Target Size 200 Meters Range X 200 Meters Deflection)

DELIVERY ERRORS (2)			PERCENT CASUALTIES						
Case <sup>1</sup>	Precision		Mean-Point-of-Impact		Projectile Burst Height Feet				
	Range	Deflection	Range	Deflection	1	4	7.8	10	
1	22.5	7.5	15	10	9	11	10	9	
			30	20	8	11	9	9	
			60	40	7	8	7	7	
	45	15	15	10	8	11	10	9	
			30	20	8	10	9	9	
			60	40	6	8	7	7	
	90	30	15	10	6	8	7	7	
			30	20	6	7	7	6	
			60	40	5	6	5	5	
	22.5	7.5	15	10	29	34	33	32	
			30	20	29	34	32	31	
			60	40	23	27	26	25	
2	45	15	15	10	34	41	38	36	
			30	20	32	39	35	34	
			60	40	26	31	28	27	
	90	30	15	10	27	33	30	29	
			30	20	26	32	29	27	
			60	40	21	27	24	23	

1. CASE 1 - three mortars spaced 30 meters apart firing five volleys parallel sheaf. Center tube aims at the center of the target for the first volley, second and third volleys are aimed 30 meters up and down range from the center of the target. Fourth and fifth volleys are fired 60 meters up and down range from the center of the target.

CASE 2 - same as CASE 1 except twenty-five volleys are fired.

2. Delivery errors are the standard deviation in meters.

NITROLYSIS OF HEXAMINE TO HMX

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22 APR 1976

DRSAR-SAS  
MEMORANDUM FOR RECORD

SUBJECT: Nitrolysis of Hexamine to HMX

1. Holston Army Ammunition Plant (HAAP) was visited on 13-14 April 1976 to discuss data requirements for the HMX DRA (HMX DRA Scope of Work, 3 Mar 76). While there, I learned that the nitrolysis buildings planned for two modernization/expansion continuous Composition B production lines, HAAP Line 2 and Facility X Line 1, were designed for single product capability (RDX). They are modeled after HAAP's D-1 building.
2. HAAP's D-7 building, combined with features of HAAP's D-1 building, is the general model for the nitrolysis building of Facility X Line 2, which is to have the dual product capability of 4,500,000 pounds/month RDX or 500,000 pounds/month HMX.
3. I asked if the capital cost difference between a D-7 type nitrolysis building and a D-1 type nitrolysis building would be small for an expansion facility and what were the differences in RDX production costs. The informal reaction of Holston Defense Corporation (HDC) personnel was that the incremental capital cost required for dual product capability is relatively small and that discrimination cannot be made between the use of D-7 and D-1 nitrators for the continuous production of RDX on the basis of operating economics.
4. Although the HMX DRA effort has not yet identified a requirement for additional crude HMX manufacturing capacity for the time frame of the introduction of these lines, these lines are expected to be operable, and in particular the nitrolysis buildings and equipment usable, into the 2000 time frame. There appears to be a chance, albeit small, that by 2000 nitramine propellants may come into use for large caliber cannon propellants, and that this nitramine may be HMX. If this should occur, the volume of HMX requirements could increase tremendously. Perhaps a need for HMX for deep space probes or space shuttle follow-ons may arise.
5. Although it is recognized that HMX production capability for the nitrolysis buildings of HAAP Line 2 and Facility X Line 1 would, of itself, be unable to provide the finished HMX required for cannon propellant, at least the future option of providing for recrystallization and classification would be meaningful if the crude capacity were available.
6. With the present state of uncertainty concerning the volume of HMX requirements for the 2000 time frame, it would appear to be a well worth-while hedge to provide dual product capability (RDX and HMX) for the nitrolysis buildings of HAAP Line 2 and Facility X Line 1 in a manner similar to planning proceeding for Facility X Line 2, if further examination of the cost impacts of providing this dual capability are anywhere

DRSAR-SAS

SUBJECT: Nitrolysis of Hexamine to HMX.

near HDC personnel's initial informal reaction. If their initial reaction is correct, implementation of this hedge could be accomplished at an incremental cost of about \$100,000 per line. Expansion of crude HMX capacity, for two lines, would amount to 1,000,000 pounds per month.

7. I recommend that the Director, P&P, be made aware of the contents of this memorandum and that he be urged to consider the provision of both RDX and HMX capability for all modernization/expansion facilities for RDX production before making any commitment to an RDX-only nitrolysis building.



GLENN H. WALDRON  
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