CONVOY SECURITY UPGRADES

AN ANALYSIS BY
SANDIA LABORATORIES, LIVERMORE,
SYSTEM STUDIES DIVISION I

I. INTRODUCTION

During the past year several evaluative methodologies that address the physical protection provided by road convoys have been developed by Sandia Laboratories, Livermore, for the NRC's SAFER Division. During the months of November and December two of the simulation models, SOURCE and SABRES I (described References 1 and 2 respectively) were used to examine the relative security provided by a spectrum of convoy options. These range from the current system consisting of an armored transporter, an unarmored escort vehicle with a total of five guards up to a system with an armored transporter and three armored escort vehicles with a total of nine guards. This memo summarizes the findings of the study.

The two methodologies used in this study use time-stepped Monte Carlo simulation techniques. The SOURCE code examines the physical protection systems performance during the initial phases of the conflict. This covers the events from the ambush of the convoy up until the point where the guard force could begin returning fire. The SABRES I code simulates the subsequent battle phase. Several of the limitations of this brief study are outlined in the discussion below. This study only examines adversary scenarios involving an external rifle-armed force. The relative benefits of the various convoy configurations in resisting an attack involving insiders, deceit or duress are not examined. Furthermore, the models cannot predict the absolute outcome of an attack. There are too many variables, such as individual performance, that are not quantifiable. However, the models do help identify the relative performance of the alternative configurations and tactics.

II. THE ANALYSIS OF THE INITIAL EVENT

The SOURCE computer model was used to assess the impact on transportation security of the number of vehicles and guards, their deployment and vulnerability, and their tactics after ambush. The model simulates the movement of the convoy down a highway and examines the outcome of an ambush where the adversaries are described by their numbers, deployment, rate and field of fire, and lethality. The underlying approach used in the study was to choose a baseline threat and then find the effect of armor, convoy configurations, and tactics on the number of guards surviving an ambush. Due to the limited time available for the study only limited excursions to the baseline threat were examined. The baseline threat was chosen, based upon our experience,

as one that would be a good strategy for the adversary. The threat consisted of six adversaries armed with M-16 rifles. They were placed in three units: a central team of four to attack the transporter and one individual placed a kilometer up and one a kilometer down the road to cut off any escort vehicles. It was assumed that they could immediately identify the convoy vehicles from other highway traffic.

Two convoy tactics were examined: (1) stop outside the field of fire and (2) close rendezvous about the transporter. The study examined several different convoy configurations. In these the number of guards and escort vehicles are varied from 5 to 9 and 1 to 3 respectively and several different deployments of the escort vehicles are examined. These vehicle deployment variations examined the sensitivity to vehicle placements ranging from fixed position to random locations up to five kilometers removed from the transporter. The SOURCE simulation configuration and results are summarized in Table I: Expected Number of Guards Surviving the Initial Ambush and Table II: The Fraction of Guards Surviving the Initial Ambush. The tables show the advantages of using moderately armored vehicles. Armor generally reduces sensitivity to the convoy configuration. Furthermore, it may permit the use of tactics such as close rendezvous, which otherwise have very low survival figures.

While the study contained little sensitivity analysis to adversary strategies and equipment, some excursions were examined. The use of M-14 rifles with armor-piercing rounds was studied. In the SOURCE results the surviving fraction was not significantly reduced. The comparisons in Tables I and II are based on the expected number of surviving guards. The statistics from the Monte Carlo calculation can be used to examine alternate criteria. For example, the measure of merit could be the number of guards surviving at least 90% of the incidents. Furthermore, the values in Tables I and II must be taken only as a comparative measure because the vulnerabilities and consequences of hits on the crew are extrapolated from military data and they are unverified by any safeguards experimental data. However, while the actual number surviving any engagement cannot be calculated, the SOURCE analysis does provide a framework for comparing the relative benefits of the alternative systems.

III. THE ANALYSIS OF THE POST-AMBUSH BATTLE

The SABRES I computer model was used to investigate the battle effectiveness of the guards, their tactics and equipment. SABRES I simulates an armed conflict in which the participants are in fixed position, i.e., no movement, and each participant knows the location and condition of every other participant throughout the battle, i.e., perfect intelligence. The code contains no terrain, vegetation, barrier penetration or response force model. Two measures of merit were used: the length of the battle and the fraction of battles with total

defender success. In the latter measure the defenders were declared successful if all the adversaries sustained a major wound or death. Furthermore, extended battle time due either to tactics or barrier delays may benefit the defenders if response forces have been summoned to assist.

One defender tactic examined was that of standing off some distance (a few hundred meters) rather than engaging the adversary at close quarters. Figure 1A shows this has essentially no effect on the chance of defender success if no response forces are involved. But, as Figure 1B shows, it can substantially increase the length of battle. Thus, if response forces are an integral part of the protection system, training and tactics emphasizing stand-off are important.

Another important parameter examined by the SABRES I code was the weapons supplied the guard force. Both the SOURCE and the SABRES analysis showed that the M-16 was most effective when used in the single shot mode. Due to the inaccuracies and rapid expenditure of ammunition, automatic weapons may not be desirable. As an alternative to the M-16, the M-14 was studied. The SABRES I conflict model shows in Figure 2A, M-16's may reduce the size of the guard force required to achieve a given level of effectiveness by about one man compared to a force with M-14's. This corresponds to an uncertainty in the adversary force size of about one man. Thus, the physical protection provided by the guard force is not highly dependent upon the rifle selected. This is further emphasized by the fact that the length of the battle as shown in Figure 2B is fairly independent of the rifle system used.

IV. OBSERVATIONS

The following remarks are derived from the experience accumulated over the past three years at Sandia Laboratories, Livermore, in transportation safeguards analysis as well as through this SOURCE-SABRES convoy configuration study.

A. Guard survival is far more important than enhancing their ability to inflict casualties. Tactics and equipment which lengthen the battle time result in systems which are less sensitive to the adversaries' characteristics and generally have higher probabilities of a favorable outcome than systems designed mainly to achieve high attrition rates against the adversary. Note that the SABRES I results showed that moderate stand-off distances could result in significantly longer battle times. This increases the possibility of support by response forces. Such stand-off distances imply that the convoy can use a "distance" rendezvous rather than a close rendezvous tactic. SOURCE simulations have shown that a "distance" rendezvous tactic by remote unarmored escort vehicles can achieve survival figures close to those given for the all armored stop values.

B. The current system may experience very heavy losses in an ambush, and the capability of the surviving force to maintain possession of the material until response forces can arrive is highly questionable. There are many advantages in going from one to two escort vehicles. The case for three over two is not as strong. The adversary characteristics arguments that result in three vehicles being required can just as easily be extende to argue for four or more escort vehicles.

A system of seven guards with two escort vehicles (2 guards in each vehicl and a convoy commander) where the transporter and one escort are armored and within visual contact and the other may be unarmored but is removed from the convoy by distances from 1 to 10 kilometers, with proper training, communications, and coordination with response forces can provide extensive protectio to the transporation link in the nuclear fuel cycle against a broad range of possible threats.

V. REFERENCES

1. R. J. Gallagher, K. G. Stimmell, N. R. Wagner, "The Configuration of Road Convoys: A Simulation Study, SAND 77-8625, July 1977

2. S. C. Keeton, P. DeLaquil, III, "Conflict Simulation for Surface Transport Systems," SAND 77-8624, July 1977.

TABLE I: EXPECTED NUMBER OF GUARDS SURVIVING THE INITIAL AMBUSH

Rounded to Nearest .5

nfiguration		STOP			RENDEZVOUS		
		All Armored	All Unarmored	Transporter Armored	All Armored	All Unarmored	Transp Armor
3EV	I	5.5	3.5	4.5	3.5	1.5	2
	II	4.5	2.5		3.5	1	
	III	6	4		4	1.5	
	IV	6	4		5	3	
	V	5.5	3.5		5	2.5	
	VI	7	6		3.5	1.5	
2EV	VII	6	4		4	1.5	
1EV	VIII	7.5	5.5	6.5	5	1.5	2.
	IX	6.5	4.5		6	4	
3EV	X	4.5	2.5		3.5	1.5	
2EV	XI	4	2	3	2.5	.5	1
1EV	XII	3	1.5	2.5	1.5	.5	1
	XIII	2.5	1.5	2	2.5	1.5	1.

TABLE II: EXPECTED FRACTION OF GUARDS SURVIVING THE INITIAL AMBUSH

Rounded to Nearest .05

		STOP			RENDEZVOUS		
iguration		All Armored	All Unarmored	Transporter Armored	All Armored	All Unarmored	Transpo Armore
EV	I	.6	.4	.5	.4	.15	.25
	II	.5	.3		.4	.1	
	III	.65	.45		.45	.2	
	IV	.65	.4		.55	.35	
	V	.6	.35		.55	.25	
	VI	.8	.65		.35	.15	
EV	VII	.65	.45		.45	.15	
EV	VIII	.8	.6	.75	.6	.2	.25
	IX	.7	.5		.7	.45	
EV	X	.55	.35		.4	.15	
EV	XI	.55	.3	.4	.4	.1	.15
EV	XII	.6	.35	.5	.3	.05	.15
	XIII	.5	.25	.4	.5	.25	.3

FIGURE 1A: Sensitivity to Separation Distance

6 Adversaries with M-16s
Defenders with M-14s

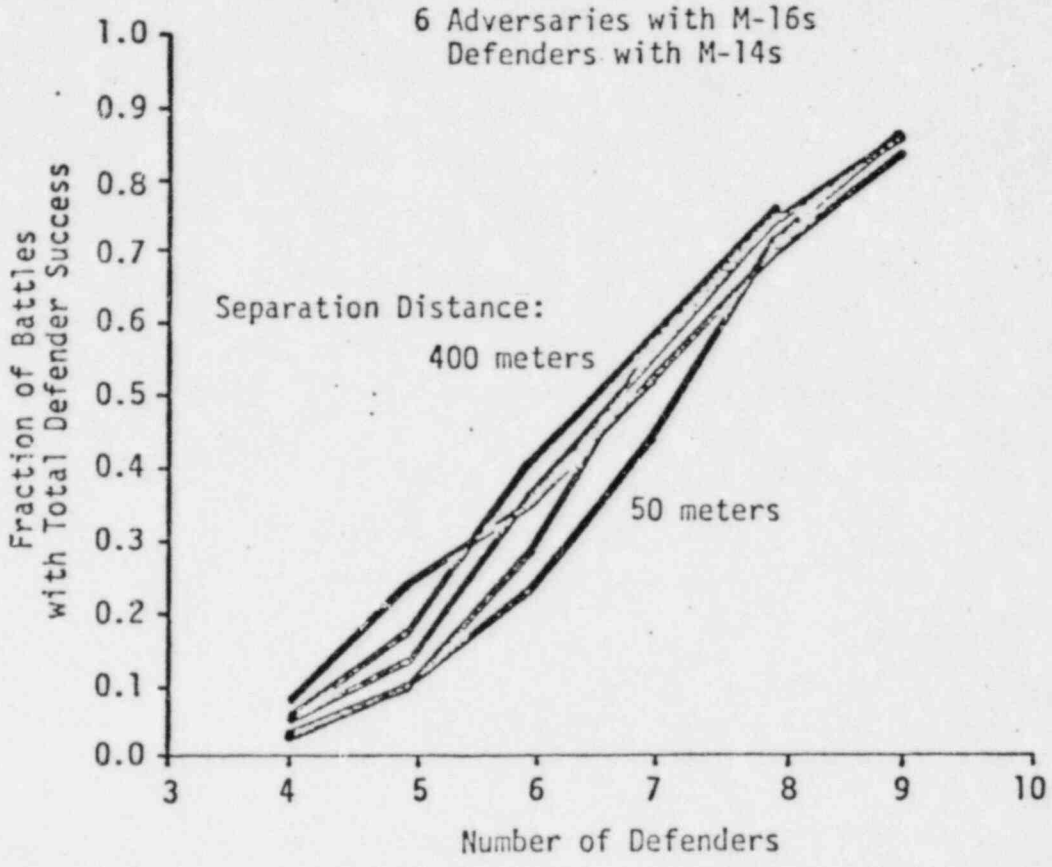
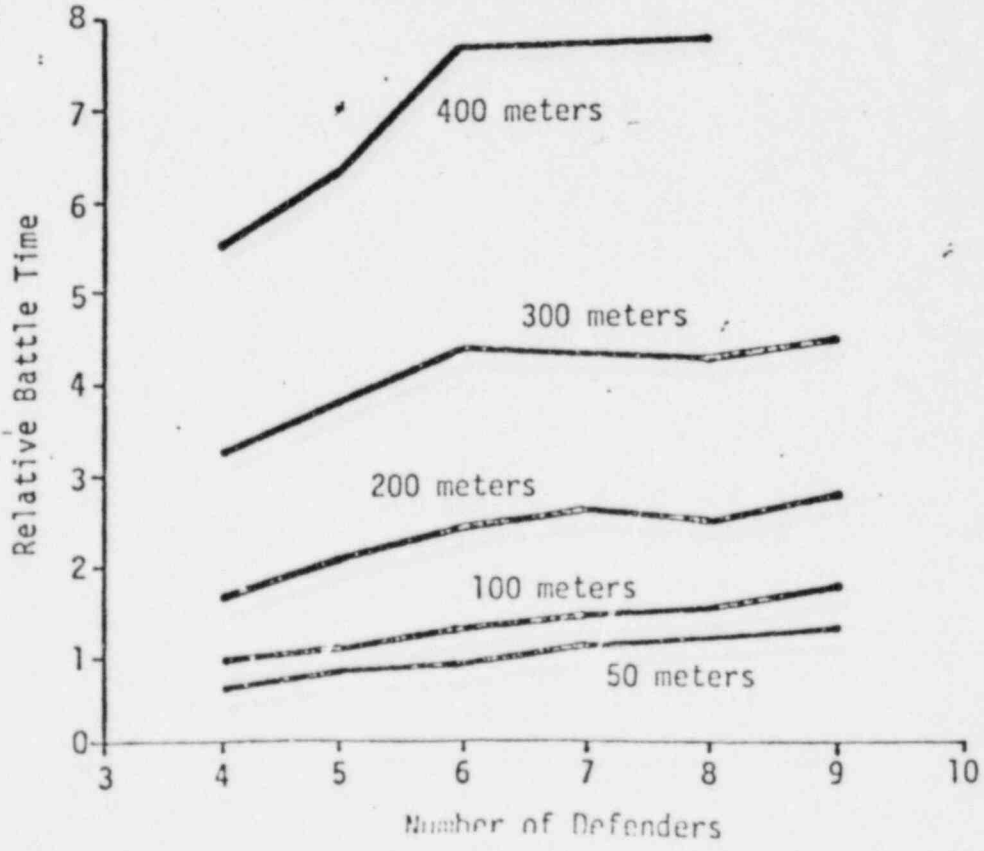


FIGURE 1B: Sensitivity to Separation Distance

6 Adversaries with M-16s
Defenders with M-14s



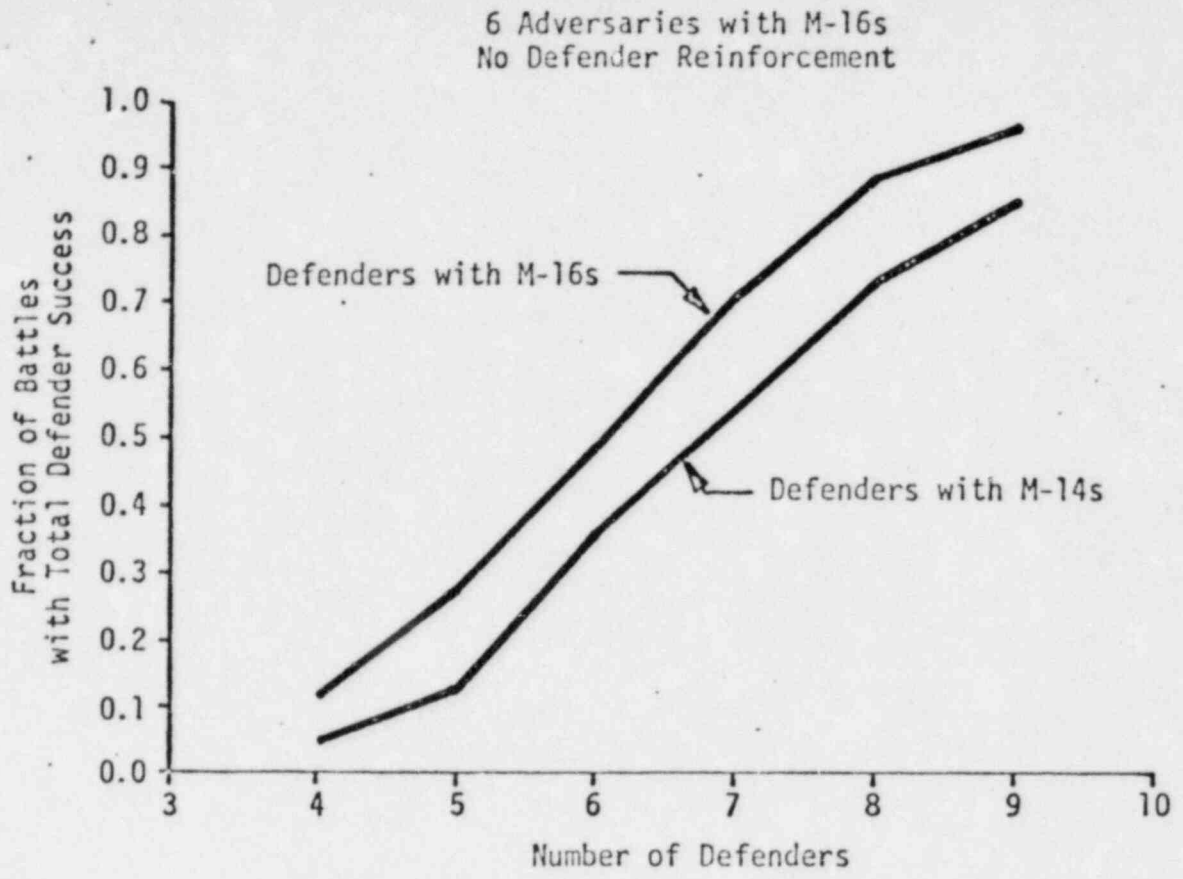
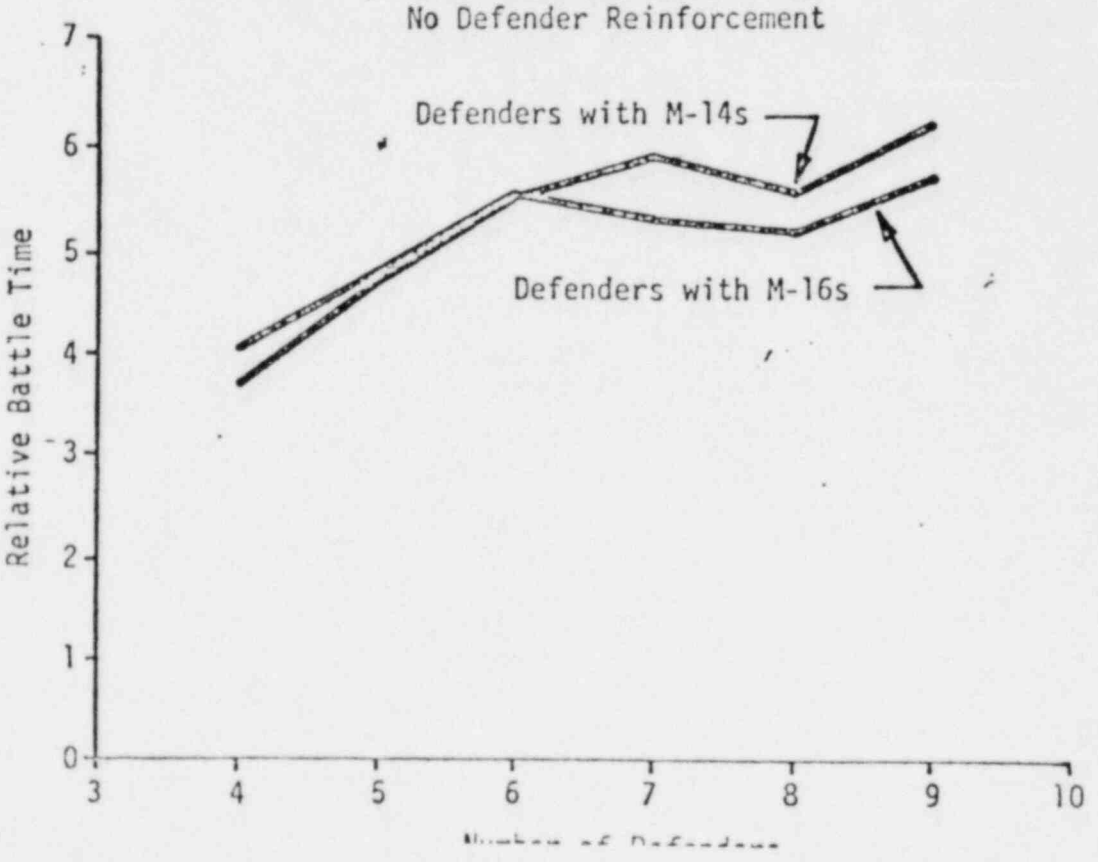


FIGURE 2B: Impact of Defender Weapon Systems



SECY 78-185

Enclosure E

IE COMMENTS

IE concurs with the upgrade rule in general. However, IE offers the following comments on two aspects of this Commission Paper.

1. Conspiracy from Two Cleared Insiders

The current version of the threat statement limits the conspiracy to uncleared persons or to such persons in concert with one cleared individual.

IE believes that a conspiracy between two cleared individuals to steal bomb grade nuclear material is a likely enough occurrence to warrant protection under NRC regulations. We base this belief on (a) the existence of espionage cases or other criminal acts involving conspiracy between cleared persons (see examples in footnote a/), and (b) a judgment that the clearance process cannot guarantee that individuals, once cleared, will not for whatever reason subsequently conspire to commit a criminal act such as theft of SSNM. The possibility of such a conspiracy between cleared individuals cannot be "defined away".

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a/
-- Martin and Mitchell, National Security Agency employees, with Top Secret/Crypto/SI Clearances, conspired to commit espionage and subsequently defected to USSR in early 1960's.

-- Staff Sgt. T. J. Safford and Sgt. U. L. Harris, both with clearances, convicted in December 1967 of conspiracy to commit espionage (KGB-USSR)

-- Sgt. R. L. Johnson and Sgt. J. Mintkenbaugh, both with clearances, conspired in Germany beginning in 1955 to commit espionage (KGB-USSR).

-- Other instances of cleared personnel conspiring to commit criminal acts could be developed from government files.

Because of the above, we feel it is necessary that the upgrade rule explicitly require high assurance protection against covert theft by two cleared insiders. Once this requirement is established, the safeguards measures needed to obtain the desired protection can then be determined. For example, there are techniques such as (a) remote surveillance of two persons by a third party, (b) random assignment to process and control points or other critical positions, (c) personnel compartmentalization, or (d) a form of "three-man rule". Such techniques, when combined with clearances and other safeguards measures in place at fuel facilities, could provide high assurance protection.

Accordingly, IE prefers the wording of the April 3, 1978 draft staff paper which stated a requirement for preventing, with high assurance, the theft of strategic special nuclear material by the following: . . . "A conspiracy between insiders or employees in any position who do not have an NRC or DOE material access authorization or two employees who have such authorization." (Page 36, §73.20 (a)(3)). As indicated in earlier portions of the April 3 version, protecting against two conspiri individuals offers some measure of protection against three or more by generally increasing the difficulty of conspiracy.

2. Publish the Rule Now vs Delay

A principal benefit of not publishing the rule now but instead seeking more public comment appears to be allowing the staff more time to finalize guidance on the preparation, review, and implementation of security plans to satisfy the rule. Public comment is not a legal requirement according to ELD.

IE does not believe the additional delay (on the order of 6 - 9 months) offers sufficient benefits, either in terms of added public comment or better guidance, to warrant slipping an already lengthy safeguards upgrade program even more. Given sufficient priority, we believe the staff can complete the preparation of guidance in time to have it ready when the rule is ready for publication. The intensive review and approval process of licensee revised security plans, to include NRC team visits to each site, should provide the necessary regulatory structure to assure licensees can meet the intent of the upgrade rule.

Accordingly, IE recommends Alternative A of the Commission Paper, supplemented by a Commission endorsement that assures priority staff attention to the prompt development of guidance.