

CONFIDENTIAL

COMMANDER U.S. NAVAL FORCES, VIETNAM
OPERATIONS ANALYSIS BRANCH

155204

AN ANALYSIS OF INTERDICTION
BARRIER OPERATIONS AND EFFECTIVENESS
ON SEALORDS OPERATIONS
TRAN HUNG DAO, BARRIER REEF
AND GIANT SLINGSHOT

155204

811

3

DR. ROGER A. SHORACK
NAVY ELECTRONICS LABORATORY CENTER
SAN DIEGO, CALIFORNIA

JULY 1970
RESEARCH NOTE RN-28

RECEIVED
Center for Naval Analyses
IDC

AUG 27 1970
AM 7, 8, 9, 10, 11, 12, 1, 2, 3, 4, 5, 6 PM

035585
CONFIDENTIAL

CNA Cy# 1 = Encl. (3)

1582

JB

ROUTING CATEGORY
RIVERINE WARFARE

COPY NO.

TYPE

CONTROL NUMBER

COPY NO.

00

155204.00

001

WHEN YOU HAVE FINISHED WITH THIS DOCUMENT, PLEASE PLACE YOUR INITIALS AND THE DATE IN THE SPACES PROVIDED,

NAME	INTL	DATE	NAME	INTL	DATE
GOLDSCHMIDT JX OEG SEA S					
10173 TO/FROM					
FREEMAN HB OEG SEA SURF					
10161 TO/FROM					
MINTZ J INS P3					
10346 TO/FROM					
KAPOS E O OEG					
10260 TO/FROM					

IF THIS DOCUMENT IS NOT IN YOUR IMMEDIATE AREA OF INTEREST, PLEASE ADD LIMITATIONS TO YOUR ROUTING REQUEST FOR THIS CATEGORY, THIS WILL ELIMINATE YOUR RECEIVING MATERIAL WHICH IS OF NO VALUE TO YOU, NOTIFY JEAN CLARKE EX 407 OF CHANGES.



DEPARTMENT OF THE NAVY
U. S. NAVAL FORCES, VIETNAM
FPO SAN FRANCISCO 96626

~~CONFIDENTIAL~~

FF5-16/022B:mt
5215
Ser 0713
21 AUG 1970

CONFIDENTIAL--Unclassified upon removal of enclosure

From: Commander U. S. Naval Forces, Vietnam
To: Distribution List

Subj: Document; forwarding of

Encl: (1) An Analysis of Interdiction Barrier Operations and Effectiveness on SEALORDS Operations TRAN HUNG DAO, BARRIER REEF and GIANT SLINGSHOT (RN-28)

1. Enclosure (1) is forwarded for information and retention.
2. Comments concerning subject document or inquiries regarding further evaluation may be directed to the Progress Appraisal Division, Commander U. S. Naval Forces, Vietnam.

J. A. Bray

J. A. BRAY
Assistant Director
Progress Appraisal Division

Distribution:

Scientific Advisor to COMNAVFORKOREA (1)
Director, Navy Laboratories (1)
NWC, China Lake (Attn: Mr. Schaniel) (18)
MACV (MAC J3-052, J3-053-1) (2)
Defense Documentation Center (1)
RACIC (1)
Navy War College (1)
U.S. Naval Postgraduate School (Attn: Department of Operations Research) (1)
NRDU-V (1)
NIOTC, Mare Island (1)
CINCPAC (SA) (1)
CINCPACFLT (302) (1)
→ CNO (OP-03-EG, OP-96) (2)
CNO (OP-03) (1)
CNO (OP-345) (1)
CNO (OP-721) (1)
Chief Combined Development Division, OSD/ARPA RDC-T APO S.F. 96346 (1)
NELC (2) (1)
CNO (OP-601V) (1)

035585

1-6
~~CONFIDENTIAL~~

CONFIDENTIAL

UNCLASSIFIED

This paper presents the findings of the author and the Operations Analysis Branch, Commander U.S. Naval Forces Vietnam and is subject to revision at any time. It does not necessarily represent the views or policies of the Commander U.S. Naval Forces, Vietnam nor should it be interpreted as an official finding.

J. A. Bray

J. A. BRAY
CDR, SC, USN
Special Assistant for
Operations Analysis

CONFIDENTIAL
NOT AUTOMATICALLY DECLASSIFIED
DOD USE ONLY

"This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law."

035585

UNCLASSIFIED

CONFIDENTIAL

ABSTRACT

This study deals with only the three interdiction barriers TRAN HUNG DAO, BARRIER REEF and GIANT SLINGSHOT prior to the start of Allied Cambodian Operations. Consideration is restricted primarily to watercraft assets. This study considers certain Activity Level Indicators based on UNSAT (Unified Naval Statistical and Analytical Tabulation) statistical data, various effectiveness indicators based on available intelligence and the subjective appraisals of barrier personnel. A mathematical model for a line barrier operation is constructed. Use of the probability of detecting an infiltration attempt as a Measure of Effectiveness is considered.

It is concluded that (1) The line barrier is superior to patrolling as a means of infiltration interdiction but it is by no means impenetrable. (2) The river interdiction barriers cause the enemy severe operational problems as they greatly increase the enemy's logistic lead time and make it difficult to assemble the requisite material for a large scale operation.

Major recommendations are (1) Issue two Night Observation Devices (NOD) per boat to the watercraft standing night long Waterborne Guard Post (WBGP) on the line barriers. (2) Continue the line barrier concept as long as the present level of air support is maintained. If and when the air support is withdrawn the whole line barrier concept of operations should be carefully re-examined in light of available assets.

UNCLASSIFIED

TABLE OF CONTENTS

	<u>PAGE</u>
ABSTRACT	i
TABLE OF CONTENTS	iii
LIST OF TABLES	iv
LIST OF FIGURES	v
I. INTRODUCTION	I-1
A. OPERATION SEALORDS	I-1
B. STUDY OBJECTIVE AND SCOPE	I-1
II. DESCRIPTION OF THE BARRIER AREAS OF OPERATIONS	II-1
A. ENEMY INFILTRATION EFFORTS	II-1
B. TRAN HUNG DAO	II-1
C. BARRIER REEF	II-2
D. GIANT SLINGSHOT	II-3
E. A COMPARISON OF THE BARRIERS	II-5
III. OPERATIONAL TACTICS AND ENEMY INFILTRATION EFFORTS	III-1
A. BARRIER MISSION	III-1
B. ORIGINAL OPERATIONAL TACTICS	III-1
C. CHANGE IN OPERATIONAL TACTICS	III-2
IV. INTERDICTION BARRIER STATISTICS	IV-1
A. ABBREVIATIONS AND DEFINITIONS	IV-1
B. STATISTICS	IV-1
C. ACTIVITY LEVEL INDICATOR	IV-3
V. BARRIER EFFECTIVENESS	V-1
A. MEASURES OF EFFECTIVENESS	V-1
B. IMPORTANCE OF AIR SUPPORT	V-4
VI. A MATHEMATICAL MODEL FOR THE LINE BARRIER	VI-1
A. WBGPMATHEMATICAL MODEL	VI-1
B. THE COMPLETELY UNINFORMED INFILTRATOR	VI-3
C. THE COMPLETELY INFORMED INFILTRATOR	VI-4
D. THE REASONABLY INFORMED INFILTRATOR	VI-5
E. PROBABILITY OF ULTIMATE SUCCESSFUL CROSSING AND EXPECTED NUMBER OF CROSSING ATTEMPTS	VI-6
VII. CONCLUSIONS	VII-1
VIII. RECOMMENDATIONS	VIII-1
LIST OF REFERENCES	A-1
FIGURES	

UNCLASSIFIED

LIST OF TABLES

<u>TABLE</u>		<u>PAGE</u>
IV-1	TRAN HUNG DAO ACTIVITY LEVEL STATISTICS	IV-2
IV-2	BARRIER REEF ACTIVITY LEVEL STATISTICS	IV-2
IV-3	GIANT SLINGSHOT ACTIVITY LEVEL STATISTICS	IV-3
V-1	III AND IV CORPS WATERMINING STATISTICS	V-2 V-3
VI-1	REASONABLY INFORMED INFILTRATOR EXAMPLE	VI-9

UNCLASSIFIED

LIST OF FIGURES

FIGURE

- II-1 III CORPS INFILTRATION ROUTES
- II-2 IV CORPS INFILTRATION ROUTES
- II-3 TRAN HUNG DAO BARRIER
- II-4 BARRIER REEF BARRIER
- II-5 GIANT SLINGSHOT BARRIER
- IV-1 ACTIVITY LEVEL INDICATOR, I
- IV-2 ACTIVITY LEVEL INDICATOR, I_f
- VI-1 TYPICAL BARRIER SEGMENT
- VI-2 CROSSING POINT DISTRIBUTIONS
- VI-3 PROBABILITY OF DETECTION
- VI-4 PROBABILITY OF ULTIMATE SUCCESSFUL PENETRATION
- VI-5 EXPECTED NUMBER OF ATTEMPTS TO CROSS SUCCESSFULLY

CONFIDENTIAL

I. INTRODUCTION

A. OPERATION SEALORDS. Operation SEALORDS (Southeast-Asia-Lake-Ocean-River-Delta Strategy) was established by COMNAVFORV OPLAN 111-69 promulgated 5 November 1968. The mission of SEALORDS is to conduct aggressive naval operations in order to assist the government of Vietnam in expanding control throughout III and IV combat tactical zones (CTZs) and contiguous zones. Specifically, SEALORDS forces are to (1) maintain naval superiority on the inland waterways and contiguous waterways, (2) interdict the enemy's communication-liaison routes, (3) conduct coordinated counter infiltration operations in coastal and inland waterways in III and IV CTZs, (4) conduct operations to open and pacify assigned riverine areas essential to military, economic and political efforts, and (5) conduct coordinated and combined offensive operations in conjunction with friendly forces to destroy enemy forces, base areas and logistics systems by riverine and coastal assault raiding operations.

B. STUDY OBJECTIVE AND SCOPE. The purpose of this paper is to assess quantitatively the effectiveness of certain aspects of Operation SEALORDS. From the outset it was clear that in the available time frame a single analyst would not be able to adequately conduct a comprehensive study of all facets of so vast an operation. In addition, although recent allied penetrations into Cambodia will undoubtedly have a drastic and lasting effect on the nature of SEALORDS related activity, the situation there will probably be in a state of flux for some time to come. Therefore, it was necessary to somehow limit the scope of this study to a moderate and manageable size, subject area and time frame. Accordingly, it was decided

CONFIDENTIAL

to deal with only the three interdiction barriers TRAN HUNG DAO, BARRIER REEF and GIANT SLINGSHOT prior to the start of Allied Cambodian Operations. Furthermore, consideration is restricted primarily to boat assets. These three particular barriers were selected for study because they comprise the major Vietnamese-Cambodian border interdiction effort in the delta and, also, for reasons to be described in more detail in section II-E, they are of similar natures in certain important respects.

CONFIDENTIAL

II. DESCRIPTION OF THE BARRIER AREAS OF OPERATIONS

A. ENEMY INFILTRATION EFFORT. One of the major enemy efforts in Southern RVN has been directed towards infiltrating men and material from Cambodian sanctuaries through the interdiction barriers TRAN HUNG DAO, BARRIER REEF and GIANT SLINGSHOT for the resupply of VC/NVA units operating in the interior of III Corps and Southern IV Corps. The major known infiltration routes and the location of the TRAN HUNG DAO, BARRIER REEF and GIANT SLINGSHOT barriers are shown in figures II-1, II-2, II-3, II-4, II-5.

B. TRAN HUNG DAO.

1. The TRAN HUNG DAO operation was commenced 21 November 1968. The area of operation includes the Vinh Te Canal and the Giang Thanh River. The Vinh Te Canal is a relatively straight waterway 65 kilometers in length and averaging about 35 meters wide. The canal is navigable to PBRs throughout the year except for a short period, approximately mid-April to early June, at the end of the dry season. During this period the water level in the canal drops to an average depth of about one foot and can be transited only by small sampans. The canal joins the Giang Thanh River which comprises the Western portion of the area of operation. The river in the TRAN HUNG DAO area of operation has an average width of about 100 meters and is navigable to PBRs year around. ASPBs can operate in the Western 20 kilometers for the entire year.

2. The Vinh Te Canal and the Giang Thanh River both parallel the Cambodian border and are within two kilometers of it. Just below the Vinh Te Canal portion of the area of operation lies the rugged Seven

UNCLASSIFIED

EDITOR'S NOTE

The computer retrieval system referred to herein as the Unified Naval Statistical and Analytical Tabulation (UNSAT) has undergone a title change to "Statistical Tabulation of NAVFORV Engagements (STONE)." "NAVFORV" is the abbreviation for U.S. Naval Forces, Vietnam.

CONFIDENTIAL

Mountains area, and below the Giang Thanh River portion, along the coast, is a large region of swamps, marshes and dense forests.

3. Seasonal variations have a significant effect on operations in the area. Heavy rainfall begins abruptly in June and lasts into November. The resulting flooding greatly improves the waterways' navigability. However, troop movement through rice paddies and swamps is very difficult.

4. There are two major population centers in the area of operation. The city of Chau Doc is at the Eastern end of the Vinh Te Canal where it joins the Bassac River. Chau Doc is a province capital, and is an important marketing center for the area. The city of Ha Tien is at the mouth of the Giang Thanh River on the Gulf of Thailand. Fishing is the primary industry in this region. The area between these two cities is primarily devoted to agriculture and the population is scattered into small hamlets near the waterways.

C. BARRIER REEF.

1. The BARRIER REEF interdiction effort was commenced on 6 December 1968. The 88 kilometer area of operation of BARRIER REEF consists of the La Grange Canal from Tuyen Nhon Southwest to the Ong Lon Canal, and then West to the Dong Tien Canal which extends to An Long. These canals have an average width of 25 to 50 meters, and a minimum low water depth of about 3 meters. The entire area of operation is navigable throughout the year to PBRs and LCM6s and LCM8s can navigate the Dong Tien Canal 30 to 40 kilometers from An Long. Canal bank characteristics are fairly uniform throughout the area of operation; steep medium height, silt and clay compositions. Several minor canals join or intersect this barrier but they

CONFIDENTIAL

are generally shallow and narrow, and are navigable primarily to small sampans.

2. The BARRIER REEF area of operation lies in the Plain of Reeds and varies between 10 and 35 kilometers from the Cambodian border. It is important to note that the Eastern portion of BARRIER REEF is screened by the upper half of Operation GIANT SLINGSHOT on the Vam Co Tay. During the wet season from July to October flood waters from the upper Mekong River flow into the area and water levels rise until the entire area is like a shallow lake, freely navigable to small sampans. At the end of the wet season these waters eventually run off via the Vam Co Tay River into the lower delta, but the area never dries enough to support population centers and agricultural development. Population is therefore sparse along BARRIER REEF.

D. GIANT SLINGSHOT.

1. The GIANT SLINGSHOT barrier operation was commenced on 2 January 1969. The area of operation covers both the Vam Co Tay and the Vam Co Dong Rivers. Together these rivers form a giant letter V which encloses between its two branches the Angels Wing/Parrots Beak/Elephant Ear section of Cambodia which juts into South Vietnam.

2. The Vam Co Tay River extends 165 kilometers from the confluence of the Vam Co River to the Cambodian border West of the Angels Wing. Its upper half lies in the Plain of Reeds and screens the Eastern portion of the BARRIER REEF area of operation. The river meanders extensively, folding an average of 1.5 kilometers of river into each straight line kilometer. Minimum low water depths vary from four meters down river from Moc Hoa to

CONFIDENTIAL

1.2 meters up river. The river is navigable year around to PBRs. The river width ranges from 100 to 200 meters and the river banks are covered with dense Nippa Palm as far North as Tuyen Nhon. Above Tuyen Nhon the banks tend to be covered with heavy brush. Diurnal tidal variations of up to one meter are seen all the way to the end of the area of operation.

3. Because the Vam Co Tay is unable to carry off accumulated rainfall rapidly enough, the water level begins to rise with the start of each rainy season, usually in May, and reaches a relatively shallow plateau in June. During this time the water level of the Mekong River is also rising and eventually spills out into the canals leading North, causing the water level in the Plain of Reeds and nearby waterways to begin rising again. This new rise floods most of the plain and does not recede until December. Since this excess Mekong River water as well as local rainfall must all be drained by the Vam Co Tay River, the water level in the river, as well as in nearby canals, remains relatively high until December. Consequently, much of the area adjacent to the Vam Co Tay area of operation is very sparsely populated. The only important population centers are Moc Hoa, the capital of Kien Tuong Province and Tan An, the capital of Long An Province.

4. The Vam Co Dong River area of operation extends from its confluence to about 34 kilometers Northwest of Tay Ninh, a river distance of about 185 kilometers, but this river also meanders extensively. The areas contiguous to the Vam Co Dong are very flat, with the exception of Hill 986 (Nui Ba Den) just North of Tay Ninh, and tides affect the canal water levels as far inland as Go Dau Ha. The whole area of operation can be characterized as typical rice land with some coffee, sugar and tea plantations.

CONFIDENTIAL

There are also marshlands and forests along the river. The river is navigable year around to PBRs. Since the Vam Co Dong River is screened from the Mekong River by the Vam Co Tay River it is not affected by the Mekong River flooding. Therefore, its highwater period coincides with the local rainy season and runs from May or June to October. There are scattered hamlets along the river, but population is somewhat more sparse North of Ben Luc with the exception of Tay Ninh which is the only major city on the river.

E. A COMPARISON OF THE BARRIERS.

1. The main similarity between the three barriers is that each is geographically located closely adjacent to enemy Cambodian sanctuaries, although in the case of BARRIER REEF the distance to Cambodia tends to be greater than for the other two barriers.

2. Enemy forces located in the areas are dedicated almost exclusively to the mission of pushing men and material through these barriers. There is a strong tendency on their part to avoid contact with barrier forces whenever this tactic shows good promise of allowing them to accomplish their primary mission of infiltration.

3. When the enemy does initiate action against the boats it is frequently only with the intention of creating an infiltration opportunity by causing the friendly units to break guard post. The transient enemy forces in the area are usually rather unfamiliar with the terrain and consequently must rely heavily on the local commo-liaison-personnel for guides and intelligence support. In much of the area along the TRAN HUNG DAO and GIANT SLINGSHOT barriers the enemy can effectively operate out of

CONFIDENTIAL

his Cambodian sanctuaries. Since these provide his essential food and rear support he is not crucially pressed for time and can afford to choose his time and place of infiltration somewhat judiciously. In addition, if detected he can withdraw to the safety of his sanctuary for a future infiltration attempt, assuming he can successfully disengage from contact with barrier assets. This capability has the effect of lowering the risk level to him and increasing his ultimate chance of successful barrier penetration.

4. The situation along BARRIER REEF is somewhat different due to the very flat and open nature of the countryside and the fact that the barrier is located a greater distance from the Cambodian border. This forces infiltrating enemy units into the open in the flat country between the border and their ultimate destination, and consequently makes it much more difficult to disengage and withdraw when detected. Thus the enemy is forced to accept a higher level of risk to ensure that his infiltrating units, once underway, make it through the barrier.

CONFIDENTIAL

III. OPERATIONAL TACTICS AND ENEMY INFILTRATION TACTICS

A. BARRIER MISSION. The major mission of the barrier operations is to interdict infiltration of enemy men and supplies across and along the border area waterways and to weaken/destroy enemy influence on the indigenous population.

B. ORIGINAL OPERATIONAL TACTICS.

1. For approximately the first ten months of SEALORDS operations primary reliance was placed on the following two operational tactics.

a. Day and Night Patrol. Although the situation varied with area of operation, roughly speaking, during the day roving patrols were carried out in an attempt to prevent the enemy from crossing by masquerading as ordinary daytime civilian traffic, and at night a cruise/drift covert patrol tactic was employed in which the boats attempted to patrol silently in areas thought likely to be transitted by infiltrating enemy personnel. These patrol tactics or variations of them were used extensively from the very beginning of Operation SEALORDS.

b. Night Ambush. In recent days this tactic has usually been referred to by the euphemism WBG (Water Borne Guard Post). A boat setting WBG will anchor along the bank or otherwise secure from movement and utilize available terrain characteristics for maximum concealment. The WBG was often set in areas of known previous enemy activity or in areas intelligence indicated as likely crossing points. The WBG tactic was evolved in Operation SEALORDS and there are many variations of it. In the past, troops and/or sensors have been used in a shore based defense/warning perimeter around boats. Depending on the size and firepower of

CONFIDENTIAL

the unit it may establish WBGPs singly in a relatively isolated position, or it may enter WBGPs in close proximity to other units for mutual protection. The WBGPs tactic eventually largely supplanted the night patrol tactic.

2. The night patrol tactic proved unsuccessful for a variety of reasons. First, and perhaps most important, the enemy developed a very sophisticated and efficient warning system of agents and observation posts to protect his border crossings. Simply put, he would just wait for the boats to pass and then cross. Intelligence indicators are that he was quite successful in this effort. Under interrogation PWs and Hoi Chanh have repeatedly referred to the ease with which small groups can effect crossings. Secondly, boats on night cruise/drift patrol are themselves extremely vulnerable to ambush due to the impossibility of quiet nighttime operations of the units. Enemy ambushes of friendly watercraft on night patrol were frequent and often devastating. Finally, enemy communications and signal intelligence capabilities were initially badly underestimated and only through a drastic improvement of radio security measures by friendly units has the enemy been denied easy opportunity to make tactical use of information gleaned from interception of friendly radio communications.

C. CHANGE IN OPERATIONAL TACTICS.

1. Beginning in October/November 1969 a change of tactics was initiated by the forces on TRAN HUNG DAO and BARRIER REEF. Whereas previously they had followed a strategy which relied heavily on roving patrols and setting relatively isolated WBGPs either randomly or based on intelligence, they now began to institute a line barrier concept. To the extent that

CONFIDENTIAL

availability of assets allowed, boats were stationed in night-long WBCP positions approximately every 1 to 1.5 km along the entire length of the barriers. Of course, intimate knowledge of their areas of operations by local commanders often dictated the concentration of assets in areas of known infiltration routes and heavy enemy activity at the expense of less coverage in other less active areas, but, in general the concept was to create a tight line barrier of boats for the purpose of sealing off the Cambodian border. This change in tactics took about a month to fully accomplish and was occasioned by a build up in barrier watercraft assets. The WBCP positions were augmented to some extent by sensor fields and land based outposts manned by troops, especially during periods when portions of the areas of operations were inaccessible to barrier watercraft because of low water levels.

2. In the GIANT SLINGSHOT area of operations a line barrier per se was never actually instituted. However, as the WBCP tactic was refined and experience in using it gained, it came to be employed as the primary operational tactic. The Vam Co Dong and Vam Co Tay Rivers are especially well suited to its employment because of the heavy bank foliage and the relative narrowness of the rivers. It was typical on GIANT SLINGSHOT for the WBCPs to be set only in areas intelligence indicated as containing the most likely crossing points. In these areas strings of WBCPs would be set but held only during that period of the night, frequently only until about 0200, that past experience indicated the enemy invariably preferred. Thus the GIANT SLINGSHOT use of the WBCP tactic came to be based on what could be called a short-duration line-segment barrier concept. Use of this tactic significantly increased contact with the enemy.

CONFIDENTIAL

3. One of the most useful pieces of equipment available to watercraft personnel standing night WBGPs on interdiction barriers is the NOD (Night Observation Device). Use of NODs has significantly extended the range of vision of WBGPs personnel. Although they do induce eye fatigue and cause temporary night blindness after use, barrier personnel seem to unanimously feel that these devices give them an important advantage. In one field interview, a former commander of BARRIER REEF indicated that in his experience about half of the crossings detected were detected by personnel using the NOD. In addition, the NOD detections strongly tended to be at longer ranges than the detections by unaided human eyes and ears. He felt his experience in this respect was rather typical. This individual also highly favored issuing two NODs to each boat. The following quotation is from his end of tour report:

1
"Surveillance of a narrow canal to prevent crossings requires two night observation devices (NOD) per boat. If one kilometer spacing between WBGPs is considered optimum the boat must cover the 500 meters on either side as visibility rarely permits much over 500 meter full coverage. Thus, assignment of one NOD, if constantly in use guarantees 50 percent coverage. The necessity of two NODs on each boat was vividly dictated by the experience of an ATC in WBGPs on the Vinh Te Canal. The crewmember manning the NOD was seated on the flight deck of the Tango and was periodically scanning upstream then downstream. As he turned to look downstream, he said something "told him to look back upstream." He immediately turned and sighted the first of four crossing sampans which were taken under fire resulting in six enemy KIA and substantial cap-

CONFIDENTIAL

tured material. These sampans were less than 100 meters from the boat and I believe that the enemy was observing the surveillance pattern of the NOD operator. The secondary observations from this incident were the chilling realization by the operator that he was being watched from within small arms range and the apparent hesitance of the enemy to make contact but rather take the calculated risk of making it across the canal."

It is interesting to note that he places the maximum full coverage range at about 500 meters. Approximately the same estimate of maximum range was also made by other line personnel in field interviews.

4. In the line barrier concept the barrier units are placed approximately 1 to 1.5 kilometers apart, forcing the enemy to cross within five to seven hundred and fifty meters of some barrier unit, which under very good conditions is within the range of the NODs carried by barrier watercraft. However, the enemy has developed elaborate and sophisticated counter tactics. According to cross-verified PW and Hoi Chanh interrogations, the infiltrating unit will usually approach to within 600 to 800 meters of the boats and then send out scouts to locate the WBGPs. The enemy usually likes to cross at one of several predetermined points. If the way is blocked by friendly watercraft and crossing immediately is not of crucial importance, the infiltrating unit will usually withdraw and attempt a crossing at a later more favorable time. If it is imperative that they cross immediately they will often launch a diversionary attack against the boats in an attempt to force them to break WBGPs. If, however, the scouts ascertain that the way is clear they will signal the waiting unit by lights.

CONFIDENTIAL

The unit then comes forward, splitting into smaller and smaller groups as it approaches the water. If at any time after the foremost elements enter the water they are fired upon by Allied forces, the remaining elements will withdraw and those already in the water will attempt to continue across.

5. Intelligence reports of specific crossings are available. An example is given below.

a. The 195th NVA regiment crossed through the middle part of the TRAN HUNG DAO barrier during the period March-April 1970. It is estimated that their strength was approximately 1,025 men. According to the interrogation of a PW captured 12 April 1970 they moved across in cells of size three to five.²

6. In an April 1970 field interview one RIVDIV Commander on the Vinh Te Canal gave the following account.

"In the last six to eight weeks we have captured about twelve enemy personnel crossing the Vinh Te Canal. They said they had seen the boats when they crossed. An enemy battalion crossed the Vinh Te at NSGL 97 in March 1970. The battalion CO was captured. He said his men split into three groups to approach the berm, at which point they split into nine groups. He said they completed the crossing within five minutes."

7. Another indicator that individuals and small groups can cross the barriers with a good chance of success are PW interrogations in which the individuals state that VC units operating in areas contiguous to the Cambodian border routinely cross over to pick up their own supplies rather than rely on the regional level supply system.²

CONFIDENTIAL

8. Finally, intelligence indicates that in the past year the enemy has attempted to infiltrate at least five new regiments into the delta. Significant elements of these units have successfully reached the corps interior although their subsequent operations have been hampered by the lack of supplies.

9. Thus an individual or a small group of individuals crossing midway between two WBPGs at night appears to have an excellent chance of success. However, for enemy personnel attempting to carry across heavy and/or bulky ordnance in a sampan, for example, the chance of successfully crossing after detection is small.

10. This is not to say that sampans don't frequently get across. For example, in November 1969 a document (letter) was captured in which a lower echelon functionary in the 195th VC/NVA transportation company was reporting to his superior.³ According to this letter, in the time period 15 August to 1 October 192 sampans crossed the Kinh Ong Lon on BARRIER REEF between the 620 and 690 NS grid lines. It is interesting to note however, that a check of the UNSAT data records shows no sampan incidents at all for this time frame and stretch of canal. This indicates a large successful enemy crossing effort completely unhindered by barrier forces.

CONFIDENTIAL

IV INTERDICTION BARRIER STATISTICS

A. ABBREVIATIONS AND DEFINITIONS. The following abbreviations and definitions are used in this section.

1. ABBREVIATIONS.

FRIFF - friendly initiated firefights

ENIFF - enemy initiated firefights

FRENG - friendly engagement

ENENG - enemy engagement

KIA - killed in action

WIA - wounded in action

CIA - captured in action

2. DEFINITIONS.

FRIFF - a contact with the enemy in which fire is initiated by friendly forces and the enemy returns fire.

ENIFF - a contact with the enemy in which fire is initiated by the enemy and fire is returned by friendly forces.

FRENG - a (possible) contact with the enemy in which fire is initiated by friendly forces but there is no return fire.

ENENG - a contact with the enemy in which fire is initiated by the enemy but friendly forces do not return fire.

B. STATISTICS. Below are presented certain relevant statistics for the border barrier operations. The time frame was selected so as to include several months both before and after the change to line barrier tactics.

CONFIDENTIAL

TABLE IV-1

		<u>TRAN HUNG DAO ACTIVITY LEVEL STATISTICS</u>								
		FRIFF	ENIFF	FRENG	ENENG	FRIENDLY		ENEMY		
						KIA	WIA	KIA	CIA	
1969	June	12	13	36	5	0	16	5	2	
	July	28	5	18	4	2	0	5	2	
	Aug	18	5	34	3	1	6	12	0	
	Sep	14	6	28	1	1	5	28	0	
	Oct	15	18	53	6	0	13	62	2	
	Nov	23	7	30	1	2	8	41	0	
	Dec	30	23	44	3	1	14	100	0	
1970	Jan	24	23	34	2	0	26	24	1	
	Feb	18	15	30	5	0	12	24	3	
	Mar	19	16	22	1	0	1	29	3	

TABLE IV-2

		<u>BARRIER REEF ACTIVITY LEVEL STATISTICS</u>								
		FRIFF	ENIFF	FRENG	ENENG	FRIENDLY		ENEMY		
						KIA	WIA	KIA	CIA	
1969	Jun	4	7	12	2	0	7	17	13	
	Jul	1	3	12	1	0	0	23	4	
	Aug	2	1	2	0	0	0	4	4	
	Sep	0	0	1	1	0	0	1	0	
	Oct	5	1	14	0	0	1	22	0	
	Nov	5	0	24	0	0	0	7	0	
	Dec	8	0	18	1	0	0	15	1	
1970	Jan	13	11	36	3	0	6	11	3	
	Feb	2	4	25	0	1	1	11	2	
	Mar	10	5	26	2	2	0	9	0	

CONFIDENTIAL

TABLE IV-3

GIANT SLINGSHOT ACTIVITY LEVEL STATISTICS

		FRIFF	ENIFF	FRENG	ENENG	FRIENDLY		ENEMY	
						KIA	WIA	KIA	CIA
1969	Jun	55	78	101	16	3	80	271	43
	Jul	48	52	116	18	4	24	129	16
	Aug	42	62	90	20	6	89	258	29
	Sep	28	21	68	6	0	13	74	7
	Oct	35	22	89	6	0	13	149	3
	Nov	26	21	66	4	3	7	53	6
	Dec	33	18	48	5	4	28	144	7
1970	Jan	34	21	56	5	6	35	136	0
	Feb	20	15	34	3	2	30	28	2
	Mar	27	20	37	4	2	15	40	2

C. ACTIVITY LEVEL INDICATOR. An activity level indicator to reflect the intensity of action in the various areas of operations was devised and is plotted in figure IV-1. Hereafter this indicator will be denoted by the letter I.

1. I is obtained as a weighted sum of the numbers of FRKIA, FRWIA, ENKIA and ENCIA divided by a weighted sum of the numbers of FRIFF, ENIFF, FRENG and ENENG. Specifically,

$$(IV-1) I = \frac{2(\#FRKIA) + (\#FRWIA) + 2(\#ENKIA) + 2(\#ENCIA)}{2(\#FRIFF) + (\#FRENG) + 2(\#ENIFF) + (\#ENENG)}$$

The weightings used were chosen according to subjective judgement and hence are somewhat arbitrary. In the numerator FRKIA, ENKIA and ENCIA were each weighted 2 and FRWIA was weighted 1. In the denominator FRIFF and ENIFF were each weighted 2 and FRENG and ENENG were each weighted 1. Note that

CONFIDENTIAL

I is just a slight modification by weighting of the concept of "number of casualties per contact." For example, the value of I for the TRAN HUNG DAO area of operations during the month of June is obtained as

$$I = \frac{2 \times 0 + 16 + 2 \times 5 + 2 \times 2}{2 \times 12 + 2 \times 13 + 36 + 5} = .33$$

2. Figure IV-1 suggests that the change in tactics resulted in an initial increase in intensity followed by a brief slackening which, after another temporary surge in December, continued on a downward trend. Field interviews generally confirm this interpretation of figure IV-1. They indicate that the enemy, after suffering increased contact due to the new friendly tactics, decreased his activity for a short period in order to observe the line barrier in operation. He then attempted to strike decisive blows against line barrier watercraft in some areas of operations but had no great success. Since that time the general trend in barrier related actions has been downward.

3. It is also informative to plot a modification of I which we shall call I_f . I_f is obtained by using the same denominator as for I but including in the numerator only the two weighted terms depending on FRKIA and FXNIA. Thus I_f can be thought of as a slight modification by weighting of the concept of "number of friendly casualties per contact." I_f is plotted in figure IV-2. An examination of figure IV-2 shows that I_f was, with the exception of the month of August on GIANT SLINGSHOT, relatively constant for all three barriers for about a five month period, the last two months of which coincided with the change in tactics time frame. However, after the new tactic had been in effect for approximately one month all three barriers show an abrupt surge for January and February. This reflects an increased cost to barrier forces in terms of personnel casualties and suggests the interpretation that the enemy was successful, at least temporarily, in applying "lessons learned" in the first month or two of observing the line barrier after it was instituted.

CONFIDENTIAL

V BARRIER EFFECTIVENESS.

A. MEASURES OF EFFECTIVENESS.

1. It is difficult to determine with any great degree of accuracy the full measure of success of the interdiction barrier operations. It is also difficult to determine exactly which reactions of enemy units occur as a direct result of the existence of the barriers. However the success realized is at least partially evidenced by the number of enemy killed and captured, the amount of enemy material destroyed and captured, and the lack of successful enemy initiated action. Indications are that the tactics employed have been at least partially successful. However, probably the only agency that has sufficiently intimate knowledge of the level of enemy infiltration effort to actually write a comprehensive and accurate evaluation of the interdiction barriers effectiveness resides in North Vietnam.

2. As a result of this lack of detailed knowledge of the level of enemy effort being expended it is extremely difficult to develop a meaningful, useful and yet numerically quantifiable MOE (Measure of Effectiveness) for the interdiction barrier operations.

3. It seems clear one should not attempt to justify an effort as large as the operations considered in this study solely on the basis of enemy KIA by barrier associated forces since the influence of the barriers is felt far beyond the immediate areas of operations, and the fact of their existence frequently severely hampers enemy operations in the III and IV corps interiors. However, it is questionable whether one can meaningfully quantify these effects with only the sketchy information that is available to allied agencies.

4. Nevertheless, a certain amount of information is available, and in addition, a vast amount of combat experience and expertise has been gained

CONFIDENTIAL

large numbers of field personnel. Interviews with such individuals have yielded various subjective indicators of barrier effectiveness which shed considerable insight into the problem of infiltration interdiction, and are therefore felt to be useful and meaningful, although non-quantifiable. Since they are non-quantifiable we shall refer to them as IOE's (Indicators of Effectiveness) rather than as MOE's. They fall in two main categories.

5. INDIRECT IOE's

a. Following are a few of the answers given by RIVDIV commanders in reply to the question "How do you know when you are being effective?".

(1) "When Charlie comes out in the daytime you know you're being effective".

(2) "If you lose contact for a period you begin to wonder if you're being effective".

(3) "When Charlie starts to come after the boats it means you're hurting him".

(a) In connection with targeting against the boats, in April 1970 COMNAVFORV Combat Intelligence Branch's appraisal was that the enemy had shifted his emphasis in watermining attacks from major rivers, bridges, and civilian craft and was concentrating on Naval Craft on interdiction barriers. The statistics on watermining are as follows.

	TABLE V-1 III CORPS		IV CORPS	
	1969	1970	1969	1970
Incidents	10	13	35	35
Detonations	4	10	32	24
Watercraft sunk	0	3	4	10
Watercraft damaged	0	5	12	1

CONFIDENTIAL

TABLE V-1 (CONT'D)	III CORPS		IV CORPS	
	1969	1970	1969	1970
Bridges damaged	1	1	5	1
Misses/recoveries	9	7	14	17

An examination of the above data reveals that although the number of watermining incidents has not increased appreciably the number of enemy successes has. This has been due primarily to the presence of better trained enemy sappers in the interdiction areas of operations.

(b) Level of Enemy Initiated Activity Inside the Barriers.

Some RIVDIV commanders and other field personnel have stated that they base their own "gut feeling" of what their effectiveness is on the level of enemy initiated activity in the enemy areas of operations that have to be resupplied through the interdiction barriers they man. A lack or slackening of enemy initiated activity is considered an indication of effective interdiction. The trend of enemy initiated activity was downward until recently. However, several people indicated in field interviews a feeling that the enemy had been able to pass significant resupply through the middle of TRAN HUNG DAO in March and April of 1970. They attributed this decrease in barrier effectiveness to low water levels and the resulting absence of watercraft on that portion of the Vinh Te Canal.

(c) Pacification. Perhaps one of the best indirect indications of the effectiveness of operations is the degree to which pacification has occurred. There is a direct observable, although difficult to quantify, relationship between level of enemy initiated activity and level of pacification. For example, on GIANT SLINGSHOT there are areas which at one time were free fire zones but now are being settled. In field interviews GIANT SLINGSHOT line officers cited this high level of pacification in certain localities as obviating the need for a tight line barrier of boats there.

CONFIDENTIAL

6. DIRECT IOE's.

a. The best direct IOE is probably gained from the interrogations of PW's and Noi Chanh's. Frequently, captured enemy personnel complain of severe shortages of equipment, particularly heavy crew-served weapons and large bulky ordnance. In addition, even when supplies are gotten through, the barriers introduce a new and very troublesome factor into enemy planning because they greatly lengthen the logistic lead-time required to assemble the necessary equipment and ordnance for any operation of significant magnitude. Unfortunately, only the enemy has numerical data on the number of missions aborted, etc., because of the existence of the interdiction barriers.

B. IMPORTANCE OF AIR SUPPORT. Although this study deals primarily with boat assets, it is difficult to overstate the importance of air support to barrier boat operations. The enemy is fully aware of the fact that, when needed, effective air support is available to barrier watercraft on very short notice. His vulnerability to devastating attack from friendly air assets has the effect of preventing him from concentrating his forces in large units and makes him a somewhat less formidable opponent to barrier watercraft assets. However, after Vietnamization of the barrier operations has been completed it appears unlikely that the air support now enjoyed by U.S. Naval units will be available to the Vietnamese Navy. Therefore, the enemy may well choose to attack barrier assets in much greater force. Should this come to pass, it is unclear that the present mode of line barrier operations using single WBGP's spaced 1 km or more apart will remain feasible. If the air support is withdrawn the whole line barrier concept should be re-examined in light of available assets.

VI. A MATHEMATICAL MODEL FOR THE LINE BARRIER

A. WBGPMATHEMATICAL MODEL. The following discussion concerns a mathematical model for a WBGPM line barrier.

1. It should be acknowledged at the outset that certain aspects of the tactical situation as regards interdiction barrier operations are not particularly amenable to any elegant analytical technique. The model as constructed in this section is a simplification of reality necessitated by considerations such as, for example, the fact that the environment in which the interdiction units set WBGPM's is by no means uniform over the entire length of the barrier. Therefore, with respect to the barrier as it exists in reality, the numerical results derived under the mathematical model should be recognized for what they are, approximations. However, they do bear sufficient relation to reality to be useful in assessing barrier effectiveness.

2. The utility of the model is that it provides the simplification necessary to gain a clearer understanding of the fundamental tradeoffs involved.

3. It is assumed that:

a. Watercraft are uniformly spaced along the barrier at intervals of length $2d$.

b. The enemy crosses in uniform size identical "elements".

c. The probability of detecting a crossing attempt at a lateral range x from a given boat can be represented as a function $p(x)$, $-r \leq x \leq r$, where r denotes the maximum range at which detection is possible.

4. The curve $p(x)$ is called a lateral range curve and represents the probability of detection by all available means; unaided human sensory perception (primarily audio-visual) as well as NOD's. Obviously $p(x)$ is affected

CONFIDENTIAL

by lighting conditions, weather and a host of other factors, but for purposes of this model we have assumed a specific $p(x)$. Field interviews have indicated that by far the majority of enemy crossing attempts occurs during periods of subdued moonlight, so the range of the NOD's used is restricted. Based on conversations with boat personnel, in this study we have assumed the maximum range, r , at which detection is possible to be 600 meters. In addition, it was felt that a curve that decreased slowly at first and then very rapidly was appropriate. Figure VI-1 shows a typical section of a line barrier. The boats are stationed at $-d$ and d . $p_1(x)$ is the right half of the lateral range curve for the boat at $-d$ and $p_2(x)$ is the left half of the lateral range curve for the boat at d . The functional forms of $p_1(x)$ and $p_2(x)$ are

$$(VI-1) \quad p_1(x) = \begin{cases} \frac{1 - e^{-\lambda(x-r+d)}}{1 - e^{-\lambda r}} & -d \leq x \leq r-d \\ 0 & r-d \leq x \leq d \end{cases}$$

and

$$(VI-2) \quad p_2(x) = \begin{cases} 0 & -d \leq x \leq -r+d \\ \frac{1 - e^{-\lambda(x+r-d)}}{1 - e^{-\lambda r}} & -r+d \leq x \leq d \end{cases}$$

5. These forms were chosen because they have the general shape desired, they are mathematically tractable, and their shapes can be easily controlled by varying the magnitude of the parameters λ and r .

6. The denominators are simply normalizing factors for the purpose of making $p_1(0) = 1$, $p_2(0) = 1$. The choice $\lambda=3$ makes the value of the lateral range curve function approximately .5 at 400 meters, which is two thirds of the maximum range.

7. If an infiltrator attempts to cross at a point x between $-d$ and d , the probability of detection by at least one of the boats is given by the composite lateral range curve

$$(VI-3) \quad p(x) = 1 - (1-p_1(x))(1-p_2(x)), \quad -d \leq x \leq d$$

CONFIDENTIAL

Should the infiltrator know the exact position of the boats his optimal crossing point would be at $x=0$. Should the infiltrator have no information at all about boat locations we can model the situation by assuming his crossing point between boats to follow a uniform probability distribution on the interval $(-d,d)$. However, in the real life situation the infiltrator has some, but usually not exact, knowledge of boat locations. This situation is best modeled by using a unimodal crossing point distribution.

8. The preceding three situations shall in the following be referred to as the cases of the Completely Informed Infiltrator (CII), the Completely Uninformed Infiltrator (CUI), and the Reasonably Informed Infiltrator (RII). Figure VI-2 shows appropriate crossing point probability distributions.

B. THE COMPLETELY UNINFORMED INFILTRATOR.

1. In this case the point between $-d$ and d at which the infiltrator attempts to cross is governed by a uniform distribution with density function (See figure VI-2)

$$(VI-4) \quad f(x) = \begin{cases} \frac{1}{2d} & -d \leq x \leq d \\ 0 & \text{otherwise.} \end{cases}$$

Hence the probability, say P , of detection by barrier units is obtained by integrating $p(x)$ with $f(x)$ over $(-d,d)$.

That is

$$(VI-5) \quad P = \int_{-d}^d f(x)p(x)dx .$$

The evaluation of P is strictly routine, if somewhat laborious. In any case, the following expression results.

CONFIDENTIAL

$$(VI-6) \quad P = \frac{2\lambda d - \lambda r + e^{-\lambda r} - e^{-2\lambda(r-d)}}{\lambda d(1 - e^{-\lambda r})}$$

$$+ \frac{\lambda(r-d)(1 - e^{-\lambda r})^2 - \lambda(r-d)e^{-2\lambda r}(1 + e^{2\lambda d}) + e^{\lambda r}(1 - e^{-2\lambda(r-d)})}{\lambda d(1 - e^{-\lambda r})^2} \quad \text{for } d \leq r$$

and

$$(VI-7) \quad P = \frac{r\lambda - 1 + e^{-\lambda r}}{\lambda d(1 - e^{-\lambda r})} \quad \text{for } d > r$$

P can now be easily computed given values of x , d and r . P is plotted in figure VI-3 as a function of d .

C. THE COMPLETELY INFORMED INFILTRATOR.

1. In this case the infiltrator, having complete information on boat locations, always crosses halfway between the boats, i.e., at $x=0$ (see figure VI-2). Thus P, the probability of detection, is

$$(VI-8) \quad P = \begin{cases} 1 - (1 - P_1(0))(1 - P_2(0)) & , \quad r \leq d \\ 0 & , \quad r > d. \end{cases}$$

CONFIDENTIAL

Again P is easily computed given values of x, d and r.

P is plotted as a function of d in figure VI-3.

D. THE REASONABLY INFORMED INFILTRATOR.

1. In this case the infiltrator has some knowledge of boat locations but his knowledge is not exact. We have chosen to represent the crossing point distribution by assigning it the density function (see figure VI-2 for rough sketch)

$$(VI-9) \quad f(x) = \frac{\frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}}{1 - 2\Phi(-d)}, \quad -d \leq x \leq d$$

where Φ is the cumulative distribution function of the normal distribution with mean zero and variance one. This particular choice of f was based on subjective judgement and mathematical tractability. The above f seems fairly reasonable because it is unimodal and concentrates its mass fairly heavily about zero. This implies that the infiltrator can, with a reasonably high probability, cross "fairly close" to the mid-point between boats. P is again obtained by integration as in expression (VI-5). After a certain amount of rather tedious but elementary manipulation the following expression results

$$(VI-10) \quad P = \frac{2\Phi(-r+d) - \Phi(-d)}{(1 - 2\Phi(-d))(1 - e^{-\lambda r})} - \frac{2e^{-\lambda(r-d) + \frac{\lambda^2}{2}}}{(1 - 2\Phi(-d))(1 - e^{-\lambda r})} \left\{ \Phi(d-r-\lambda) - \Phi(-d-\lambda) \right\}$$

CONFIDENTIAL

$$\begin{aligned}
 & + \frac{2(1 - 2e^{-\lambda r} - e^{-2\lambda(r-d)})}{(1 - 2\Phi(-d))(1 - e^{-\lambda r})^2} \left\{ \frac{1}{2} - \Phi(-r+d) \right\} \\
 & + \frac{2e^{-2\lambda r + \lambda d + \frac{\lambda^2}{2}}}{(1 - 2\Phi(-d))(1 - e^{-\lambda r})^2} \left\{ 1 - \Phi(-r+d+\lambda) - \Phi(-r+d-\lambda) \right\} \\
 & \text{for } d \leq r
 \end{aligned}$$

and

$$\begin{aligned}
 \text{(VI-11)} \quad P & = \left\{ \Phi(r-d) - \Phi(-d) \right\} - e^{-\lambda(r-d) + \frac{\lambda^2}{2}} \left\{ \Phi(r-d-\lambda) - \Phi(-d-\lambda) \right\} \\
 & \text{for } d > r.
 \end{aligned}$$

Although these expressions for P appear rather formidable, their numerical evaluation is quite routine, although tedious, with the aid of appropriate tables. The probability of detection, P, is again plotted in figure VI-3.

E. PROBABILITY OF ULTIMATE SUCCESSFUL CROSSING AND EXPECTED NUMBER OF CROSSING ATTEMPTS.

1. The Informed and Uninformed Infiltrator cases represent extremal situations which bracket reality; the probability of detection curves for these cases are lower and upper bounds for the probability of detection against a real life infiltrator. The Reasonably Informed Infiltrator case is a rough cut attempt at approximating a typical real life situation. An examination of the Reasonably Informed Infiltrator curve in figure VI-3 shows that at boat spacings of .5 and .75 the probabilities of detecting an attempted crossing are .71 and .23 respectively. As will be shown below these probabilities allow the enemy a significant chance of getting

CONFIDENTIAL

through by the simple expedient of continuing to try repeatedly.

2. In the areas of operation under consideration in this study the enemy frequently is in the position of being able to probe the barriers, perhaps not even making contact, and, if conditions do not appear favorable, withdrawing and trying again at a more propitious time. This capability significantly increases his probability of eventual undetected penetration. We model this situation as follows. For each attempted crossing by the enemy we assume he crosses undetected with probability p , is detected but successfully disengages friendly forces and withdraws with probability w , and is destroyed in the crossing attempt with probability r . We can equate the p above with $1-P$ of paragraphs B, C and D. We assume $p+w+r=1$ and that there is statistical independence between crossing attempts. Now the probability of crossing undetected on the n -th attempt is simply

$$(VI-12) \quad g(n) = w^{n-1}p$$

since $n-1$ successful withdrawals must be made. Hence the probability, say C , of eventually crossing undetected is

$$(VI-13) \quad C = \sum_{n=1}^{\infty} g(n) = p \sum_{n=1}^{\infty} w^{n-1} = \frac{p}{p+r} .$$

3. It is also of interest to consider the average number of attempts necessary to cross undetected given that an undetected crossing is accomplished.

4. Let N be an integer valued random variable whose value denotes the number of attempts necessary to cross, given that an undetected crossing is accomplished. Then N has density function

$$(VI-14) \quad h(n) = \frac{p w^{n-1}}{\left(\frac{p}{p+r}\right)} = (p+r) w^{n-1}$$

CONFIDENTIAL

and has expected value

$$\begin{aligned} \text{(VI-15)} \quad E(N) &= \sum_{n=1}^{\infty} n h(n) = (p+r) \sum_{n=1}^{\infty} n w^{n-1} \\ &= (p+r) \frac{d}{dw} \left(\sum_{n=1}^{\infty} w^n \right) = (p+r) \frac{d}{dw} \left(\frac{1}{1-w} \right) = \frac{1}{p+r} \end{aligned}$$

5. Expressions (VI-14) and (VI-15) furnish crucial insight into the situation faced by barrier forces. For example, if C is large and $E(N)$ is small we would have to judge the barrier ineffective, even if p is large.

6. Since C and $E(N)$ are each functions of both p and r , and $p+r = 1$, we need to assume some relationship between p , r and w . We reason heuristically as follows. For p very large (close to 1) r is of necessity small. As p , the probability of undetected crossing, decreases one would expect r , the probability of being detected and destroyed, to increase. Largely for reasons of simplicity we shall assume the relationship between r and p to be linear. Specifically, assume

$$\text{(VI-16)} \quad r = \Pi(1-p),$$

where Π is a proportionality constant to be specified. Thus r decreases linearly with p . But p is a function of d , one half of the spacing between the boats. Thus both C and $E(N)$ can be plotted as a function of d . This is done in figures VI-4 and VI-5. A value of .5 is assumed for Π .

7. The following example illustrates that one needs to look at more than just P in judging how effective the barriers are. Consider boat spacings of 1 km and 1.5 km for the Reasonably Informed Infiltrator. Then from figures VI-3, VI-4, and VI-5 we obtain the information below.

CONFIDENTIAL

TABLE VI-1

REASONABLY INFORMED INFILTRATOR EXAMPLE

	d=.5 km	d=.75 k
P	.71	.23
C	.45	.87
E(N)	1.55	1.13

We note that even for $P = .71$ a seemly large value, the infiltrator still has a .45 chance of successful penetration.

8. The effect of varying the distance, d , between barrier units is reflected strongly in the magnitude of P ; however, in light of the preceding example, use of P by itself as a MOE could be misleading. One really should consider all three of the quantities P , C and $E(N)$ in assessing barrier effectiveness.

CONFIDENTIAL

VII. CONCLUSIONS

A. The line barrier is superior to patrolling as a means of infiltration interdiction but it is by no means impenetrable. Even if the probability of detection of a single crossing attempt is fairly high, the infiltrator's probability of ultimate successful penetration can be significant.

B. The barriers cause the enemy extremely severe operational problems because their existence greatly increases the logistic lead time necessary to assemble the requisite material for an operation of any magnitude. In attempting to circumvent this barrier-induced uncertainty in their planning, the enemy has been forced to stockpile supplies in many locations. However, this policy has resulted in large numbers of cache seizures by friendly forces.

CONFIDENTIAL

VIII. RECOMMENDATIONS

A. The following recommendations are submitted for consideration.

1. Issue two NODs per boat to the watercraft standing night long WBGP on the line barriers.

2. Continue the line barrier concept as long as the present level of air support is maintained. However, if/when the air support is withdrawn the whole line barrier concept of operations should be carefully re-examined in light of available assets.

CONFIDENTIAL

REFERENCES

1. END OF TOUR REPORT OF LCDR N. B. CONNOLLY, USN, 21 APRIL 1970.
2. CONFERENCES WITH N2 AND N3 PERSONNEL AT HEADQUARTERS OF COMMANDER U.S. NAVAL FORCES, VIETNAM.
3. FIELD INTERVIEWS.
4. NAVAL OPERATIONS ANALYSIS, USNI, ANNAPOLIS, 1968.
5. W. J. DIXON AND F. J. MASSEY, INTRODUCTION TO STATISTICAL ANALYSIS, MCGRAW-HILL, INC., NEW YORK, 1969.
6. HANDBOOK OF TABLES FOR MATHEMATICS, THE CHEMICAL RUBBER COMPANY, 3RD EDITION, 1967.