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INTELLIGENCE MEMORANDUM

**The Effectiveness
of the Rolling Thunder Program
in North Vietnam**

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THE EFFECTIVENESS
OF THE ROLLING THUNDER PROGRAM
IN NORTH VIETNAM*
1 JANUARY-30 SEPTEMBER 1966

The Rolling Thunder air offensive against North Vietnam has been accelerated sharply in 1966, compared with operations in 1965. The 59,000 attack sorties flown in the first nine months of 1966 against targets in North Vietnam were about 2.3 times the 1965 effort; the 90,000 tons of ordnance dropped was 2.6 times the ordnance delivered on targets in 1965. The 1966 air operations have also been carried out more efficiently than the 1965 campaign. The average bomb load per attack sortie has increased, and the rate of aircraft losses has been some 58 percent of the 1965 rate.

In spite of these improvements, it is estimated that the cost effectiveness of the air campaign diminished in 1966. The direct operating cost of inflicting a dollar's worth of damage in North Vietnam has increased by about 28 percent -- from an estimated \$6.80 in 1965 to about \$8.70 in 1966. The major determinants of this decrease in cost effectiveness have been the far greater proportion of attack sorties accounted for by armed reconnaissance strikes (as opposed to initial strikes on fixed targets) and the geographic concentration of the air effort against logistic targets in the southern areas of North Vietnam, principally Military Region IV.

By the end of 1965, a growing scarcity of fruitful fixed targets outside of sanctuary areas, as well as other operational restrictions virtually forced a continually increasing emphasis on armed reconnaissance. This trend was temporarily interrupted by the strikes against major petroleum storage installations, which began late in June 1966. Strike sorties against JCS fixed-target systems dropped from more than 30 percent of

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the total sorties flown in 1965 to less than 3 percent in 1966. Armed reconnaissance sorties increased by over 230 percent, from about 17,300 sorties in 1965 to 57,300 in 1966. Almost two-thirds of these -- 37,000 sorties -- were directed at the southernmost areas of North Vietnam, the Panhandle section south of Vinh.

The air campaign over Laos shows similar emphasis on the attempted interdiction of the infiltration network into South Vietnam. Attack sorties flown under the Barrel Roll and Steel Tiger programs increased from 11,000 sorties in 1965 to about 38,000 during the first nine months of 1966. Ninety-five percent of the attack sorties flown in Laos in 1966 were on armed reconnaissance missions.

The major measurable effects on North Vietnam of Rolling Thunder attacks are:

(1) About 20 percent, or 70,000, of the total military forces are engaged directly in defensive programs and countermeasures against the Rolling Thunder program. About 220,000 full-time and 100,000 part-time workers have been diverted to repair, reconstruction, and dispersal programs in North Vietnam and Laos. In 1965 and 1966, from 25,000 to 35,000 persons are tentatively estimated to have been casualties of air attacks in the North.

(2) Physical damage to economic and military targets has also increased. This damage amounted to \$65 million in 1965 and an additional \$95 million in the first nine months of 1966. Of the latter total, over 70 percent represented damage to economic targets.

Despite the increased weight of air attack, North Vietnam continues to increase its support to the insurgency in South Vietnam. The Rolling Thunder program has not been able to prevent about a threefold increase in the level of personnel infiltration in 1966. The external logistic support needed to maintain the expanded VC/NVA force in South Vietnam has been adequate. In particular, despite the neutralization of the major petroleum storage facilities in the North, petroleum supplies have continued to be imported in needed amounts.

Taking a broader view, during the course of the Rolling Thunder program the North Vietnamese capability to support the war effort has improved.

(1) The capacity of the transportation system, at least as it affects the ability to handle the flow of men and military supplies to South Vietnam, has been increased.

(2) The sizable manpower drain has peaked, unless there is a sharp increase in estimated VC/NVA manpower losses in South Vietnam or a radical change in the nature of the air campaign against North Vietnam. In 1965 and 1966, North Vietnam had to mobilize 80 percent of its physically fit males as they reached draft age. Subject to the assumptions just delineated, this levy could be as low as 50 percent of the 1967 class.

(3) Aid from the USSR and Communist China received in 1965 and 1966 has amounted, in estimated value, to about five times the total damage caused by Rolling Thunder attacks.

The fact that a large share of the imports now flowing into North Vietnam is not military aid but machinery and equipment seems particularly significant. On the one hand, it reflects a willingness of the major Communist powers to provide additional equipment for war-related industrial facilities, probably encouraged by the fact that the modern industrial sector of the North Vietnamese economy has been largely off-limits to air attack. On the other hand, it suggests that adequate reserves of skilled manpower, electric generating capacity, and other essential inputs are available on a significant scale for conversion to a war-supporting role. While this new emphasis accelerates the ability to support military operations in the short run, it does postpone Hanoi's long-run plans for the development of heavy industry.

Nor has Rolling Thunder served visibly to reduce the determination of Hanoi to continue the war. We see no signs that the air attack has shaken the confidence of the regime, and with increased Soviet and Chinese aid to bolster its capabilities, North Vietnam in the short term, at least, will apparently take no positive step toward a negotiated settlement. In any event, it is estimated that Hanoi will continue to be insistent on a cessation of the bombings as a prerequisite for negotiations. Analysis of popular attitudes in North Vietnam indicates a continued firmness in support of the regime's policies. Although the long-term effects of the war may have some wearying effect on the population, there is no evidence

that it has yet reached a point sufficient to deter Hanoi's leaders from their present policies.

Finally, the course of the air campaign in 1966 has had no significant effect on the attitudes of third countries. From the resumption of the bombings in January 1966 to the escalation represented by the bombing of the petroleum storage facilities, third-country attitudes have been, predictably, relatively constant. The unyielding attitude of the North Vietnamese, particularly during the January bombing pause, has had a somewhat sobering impact on some third countries. Indeed, the escalation against POL storage facilities produced a reaction more restrained and less critical than had been anticipated. Among Communist third countries, the USSR and the Eastern European countries would prefer a negotiated settlement because they regard a continuation of the war as potentially dangerous to themselves and in any case as posing an awkward dilemma for them within the Communist world. The Chinese Communists, however, remain adamant in their attitudes toward the war and any steps leading toward a negotiated settlement.

Over and above the measurable effects discussed in the foregoing, the Rolling Thunder program has certain intangible aspects such as enemy morale and determination which are much more difficult to assess. The Rolling Thunder program has been the object of much neutralist criticism and the target of a concerted Communist diplomatic and propaganda campaign. In one sense, this must serve to stiffen Hanoi's back; at the same time, the program has become one way Hanoi probably measures US determination -- though the extent of US commitment on the ground conveys this determination far more persuasively. Moreover, the Rolling Thunder operation carries some threat of further escalation, and in this way may exert a certain worrisome pressure on Hanoi. On the other hand, if Rolling Thunder were to be terminated at this point without concessions, the United States would be deprived of one form of leverage against Hanoi which it now has.

I. The Rolling Thunder Attack in January-September 1966

A. Scale of Operations

During the first nine months of 1966, US/GVN forces flew nearly 59,500 attack sorties against North Vietnam.* Of this total, the United States flew 58,700 sorties and the Vietnamese Air Force (VNAF) the remaining 800. The combined effort represents an increase of approximately 130 percent over the nearly 26,000 attack sorties flown against North Vietnam in all of 1965. As shown in Table 1, the air attack on North Vietnam in 1966 represents a larger share of the total attack in Southeast Asia than it did in 1965. The number of attack sorties flown in South Vietnam, on the other hand, represents a smaller share of the total number of attack sorties in Southeast Asia in 1966 than it did in 1965.

Attack sorties specifically flown as initial strikes or restrikes on fixed targets from the target list of the Joint Chiefs of Staff (JCS) have become very rare. In 1965, such sorties accounted for nearly 30 percent of all attack sorties flown against North Vietnam, and armed reconnaissance sorties accounted for approximately 70 percent. In 1966 the share of fixed target attack sorties not involving any armed reconnaissance had shrunk to 0.6 percent, with armed reconnaissance sorties accounting for 99.4 percent. This change was a continuation of a trend already under way in the latter months of 1965, when, in comparison with previous levels, fixed target sorties declined both absolutely and as a share of the total attack on North Vietnam. The decline undoubtedly reflects the diminishing number of new fixed targets available for attack, broadened authorization for armed reconnaissance, and, at least in part, a change in definitions used. Restrikes on JCS fixed targets were also carried out by armed reconnaissance sorties. Including these restrikes on armed reconnaissance, about 1,600 sorties, or somewhat less than 3 percent of the total number of attack sorties on North Vietnam, were directed against JCS targets.

B. Ordnance

During the first nine months of 1966, approximately 90,000 tons of ordnance were delivered on North Vietnam, or about 2.6 times the

* Attack sorties include: strike, flak suppression, armed reconnaissance, and air interdiction.

Table 1

Attack Sorties by US/GVN Forces in Southeast Asia
During 1965 and January-September 1966

Area	Force	1965		January-September 1966	
		Number of Sorties	Percent	Number of Sorties	Percent
North Vietnam		<u>25,890</u>	<u>20</u>	<u>59,494</u>	<u>28</u>
	US	25,276		58,696	
	VNAF	614		798	
South Vietnam		<u>96,549</u>	<u>72</u>	<u>121,388</u>	<u>55</u>
	US	73,412		97,299	
	VNAF	23,137		24,089	
Laos	US	<u>10,819</u>	<u>8</u>	<u>38,291</u>	<u>17</u>
All areas of operation		<u>133,258</u>	<u>100</u>	<u>219,173</u>	<u>100</u>
	US	109,507		194,286	
	VNAF	23,751		24,887	

tonnage delivered in 1965. The amounts delivered on North Vietnam during the early months of the year were much smaller than in the later months. The total for the three-month period January-March was only 12,795 tons, whereas 16,342 tons were delivered in July and 17,333 tons in August. The amount delivered in August was equal to approximately 50 percent of the total delivered on North Vietnam in 1965.

The total ordnance tonnage delivered by air in Southeast Asia, however, has remained fairly constant throughout the year. It was a little over 38,000 tons in January and had increased to over 44,000 by August. As indicated in Table 2, during the early months of the year, when the tonnage delivered on North Vietnam was small, the tonnage delivered on Laos was relatively large. In the spring and summer the tonnages delivered on Laos decreased as the tonnages delivered on North Vietnam increased. Deliveries on targets in South Vietnam have remained relatively constant.

Table 2

Ordnance Delivered by Air in Southeast Asia
January-August 1966

<u>Month</u>	<u>Country</u>			<u>Tons</u>
	<u>North Vietnam</u>	<u>Laos</u>	<u>South Vietnam</u>	<u>Total</u>
January	273	13,918	23,869	38,060
February	4,780	10,878	21,783	37,441
March	7,742	8,983	24,093	40,818
April	9,037	9,287	18,921	37,245
May	7,556	7,126	18,080	32,762
June	10,963	4,519	19,025	34,507
July	16,342	2,358	23,182	41,882
August	17,333	1,435	25,590	44,358
Total	<u>74,026</u>	<u>58,504</u>	<u>174,543</u>	<u>307,073</u>

During the first nine months of 1966 the average ordnance load per attack sortie against North Vietnam was a little more than 1.5 tons per sortie -- a slight increase over the 1.4 tons per sortie averaged in 1965. In July 1966 the average load was 1.9 tons, approximately the same as the average load per bomber sortie flown by US Air Forces against Germany in World War II. In August 1966 the average load per attack sortie flown against North Vietnam was 1.6 tons.

C. Aircraft Losses

A total of 228 planes, including support as well as attack aircraft, were lost during the nine-month period January-September 1966. All were US aircraft. The ratio of total losses to attack sorties was about 0.38 percent in 1966, compared with a ratio of approximately 0.65 percent in 1965. This is equal to an average loss of a little more than 3.8 aircraft per 1,000 attack sorties in 1966, compared with a loss of 6.5 aircraft per 1,000 attack sorties in 1965. Losses, by model, of fixed-wing aircraft in 1965 and 1966 are compared in Table 3. Losses as a percent of total sorties flown by models of aircraft most used either remained the same or declined.

Table 3

Losses by Model of Fixed-Wing Aircraft
During 1965 and January-September 1966

Aircraft Model	Losses in <u>March-December 1965</u>		Losses in <u>January-September 1966</u>	
	Number	As Percent of Sorties Flown	Number	As Percent of Sorties Flown
F-105	54	0.6	96	0.6
A-4	29	0.3	35	0.2
F-4	19	0.3	25	0.1
A-1	26	0.7	17	0.1
F-8	15	0.4	12	0.4
RF-101	6	2.1	11	0.5
A-6	3	0.6	7	0.6
RF-8	6	1.7	6	1.4
F-104	0	0	5	0.3
RF-4	0	0	4	0.2
F-100	5	1.2	1	0.3
RA-3	0	0	1	0.9
RA-5	3	2.3	1	0.1
C-130	0	0	1	0.2
RB-66	0	0	1	Insig.
EB-66	0	0	1	Insig.
RC-130	0	0	1	4.0
EF-10	0	0	1	0.1
RC-47	0	0	1	11.1
EA-1	1	0.1	0	0
B-57	1	0.7	1	0.2
Total	<u>168</u>		<u>228</u>	

D. Cost Effectiveness of Operations Against North Vietnam
in 1966

The value of the aircraft lost on sorties against North Vietnam in 1966 may be estimated at about \$480 million, on the basis of average costs for production models of the types of aircraft lost. A preliminary estimate of the sortie overhead costs for the attack sorties and for the accompanying support sorties is about \$200 million. If the ordnance mix in 1966 was about the same as in 1965, the cost of the ordnance delivered by sorties against North Vietnam in 1966 may have been in the

neighborhood of \$150 million. On this basis, the direct operating cost (excluding manpower losses) of the aerial attack on North Vietnam during the first nine months of 1966 may be estimated at about \$830 million, as follows:

	<u>Million US \$</u>
Aircraft losses	480
Sortie overhead costs	200
Ordnance costs	150
Total	<u>830</u>

A preliminary estimate of the damage done to North Vietnam by the aerial attack is about \$95 million. Thus the cost of one dollar's worth of damage to the DRV may be estimated at roughly \$8.70. This is an increase of about 28 percent above the estimated cost of \$6.80 per dollar's worth of damage in 1965. The increase in cost per unit of damage has been caused by loss of planes of more expensive models, by the increased sortie overhead costs resulting from flying a larger number of sorties, and by the fact that many of the most attractive targets were destroyed in 1965.

II. Target Systems Attacked in January-September 1966

A. Fixed Targets

1. General

The Rolling Thunder attacks during January-September 1966 continued trends that were well defined by the last quarter of 1965. The growing scarcity of fruitful fixed targets which were eligible for attack by the criteria of Rolling Thunder forced a continually increasing emphasis on armed reconnaissance missions and a consequent decline in the number of fixed target strikes. Although 125 fixed targets were struck in 1965, most of the 1966 counterpart effort was in restrikes of these targets. Only 25 new fixed targets were struck in the first nine months of 1966 (see Table 4). Attack sorties flown against JCS fixed target systems dropped dramatically in 1966, compared with 1965. In 1965, about 30 percent of total attack sorties were flown specifically as fixed-target sorties. In 1966, including both fixed-target sorties and restrikes of fixed targets on armed reconnaissance sorties, only somewhat less than 3 percent of total attack sorties were directed against JCS fixed targets. (See Table 5.) Nevertheless, the effectiveness of fixed-target strike attacks, measured in terms of damage costs, more than doubled. Damage directly attributable to airstrikes on fixed targets rose from \$5,000 per sortie in 1965 to \$11,000 per sortie in 1966. The principal cause of this rise undoubtedly is the concentration of the attack effort on high cost target systems such as powerplants, bridges, and POL storage areas. Strikes on these three target systems accounted for over 60 percent of the fixed target program thus far in 1966, whereas they comprised only 24 percent of the effort in 1965. Other factors, such as the reduction in average strike size, may have contributed to the rise in fixed-target strike effectiveness, but it is apparent that target selection is the key element.

Strikes on military installations included in the JCS fixed-target system accounted for only 40 percent of the total fixed-target strike sorties in 1966. The major portion of this program consisted of restrikes on targets already hit in 1965, and, in general, these attacks produced damage of lower economic cost than those directed against industrial targets.

2. Electric Power Targets

Despite the destruction of about one-third of North Vietnam's electric power industry by US airstrikes, the loss is not yet large enough to have an important impact on the economy. The effectiveness of the strikes has been reduced by carrying out strikes against targets of small economic significance.

Table 4

Comparison of Rolling Thunder Strikes
on Major Fixed-Target Systems:
1965 and January-September 1966

JCS Fixed Target System	Number of Targets Struck			
	Number Targeted	Struck 1965	Restruck Jan-Sept 1966	New Strikes Jan-Sept 1966
Barracks/supply depots/ ammunition depots	106	64	46	11
POL storage	13	4	4	7
Powerplants	20	6	6	1
Manufacturing and explosives plants	1	1	0	0
Airfields	11	4	3	0
Bridges	61	44	42	6
Radar and communications installations	5	2	0	0
Total	<u>217</u>	<u>125</u>	<u>101</u>	<u>25</u>

US airstrikes against North Vietnamese powerplants have resulted in the neutralization of an estimated 59,000 kilowatts (kw), or 32 percent, of a total installed generating capacity of 187,000 kw. The total cost of damage inflicted is estimated to be \$11.5 million. During 1965 there was a total of 21 strikes and restrikes against six Vietnamese powerplants. The cost of damage inflicted is estimated to be about \$6.3 million, and the total capacity put out of service amounted to 47,000 kw, of which 24,000 kw was put back into service by March 1966. During 1966 there was a total of 12 strikes and restrikes against five powerplants. The cost of damage in 1966 is estimated to be about \$5.2 million, and the amount of capacity neutralized was about 12,000 kw, plus another 24,000 kw of capacity destroyed that probably would have gone into service during 1966. The following tabulation presents details of the air strikes during 1966:

<u>Powerplant</u>	<u>Date of Air Strikes</u>	<u>Estimated Cost of Damage (Million US \$)</u>	<u>Capacity Out of Service</u>	
Uong Bi	18 Apr 66	Negl.	24,000 kw. Put back in service July 1966.	25X5
	28 Apr 66	Negl.	No known additional damage.	
	11 Aug 66	4.4	24,000 kw put back in service was again neutralized; 24,000 kw being installed was also neutralized.	
	14 Aug 66	Negl.		
	17 Aug 66	Negl.		
Thai Nguyen	Between 6-8 Jul 66	0.8	12,000 kw out of 24,000 kw put out of service.	25X5
Viet Tri	Prior to 19 Jul 66	Negl.	Probably not out of service more than a few days.	25X5
Thanh Hoa	22 Sep 66	N.A.	Restoration under way	
	23 Sep 66	N.A.	but estimated not to	25X5
	23 Sep 66	N.A.	have operated since summer 1965.	
Ben Thuy	23 Oct 66	N.A.	Restoration under way	
	26 Oct 66	N.A.	but estimated not to have operated since summer 1965.	25X5

During 1966, most of the strikes (7 out of 12) took place in the northern part of the country, while the majority of the strikes (17 out of 21) during 1965 occurred in the south. Two single strikes against the Thai Nguyen and Viet Tri powerplants and five restrikes against the Uong Bi powerplant all were in the north. The remaining missions were accounted for by five restrikes against the Ben Thuy and Thanh Hoa powerplants in the south, both of which were initially put out of operation in the summer of 1965.

The 11 August 1966 strike against the Uong Bi powerplant rates as the most effective single strike against a North Vietnamese powerplant, severely damaging and putting out of service 24,000 kw that had been in service and another 24,000 kw that was almost ready for operation. Total cost of damage resulting from this strike alone was about \$4.4 million. Loss of the plant denies North Vietnam the use of its largest and most efficient powerplant for at least one year.

Table 5

Comparison of Rolling Thunder Strike Sorties
on Major Fixed-Target Systems:
1965 and January-September 1966

<u>JCS Fixed-Target System</u>	<u>Ordnance in Tons</u>		
	<u>1965</u>	<u>Jan-Sept 1966</u>	<u>Total</u>
Barracks/supply depots/ ammunition depots			
Sorties	4,291	272	4,563
Ordnance	7,299	337	7,636
POL storage			
Sorties	128	400	528
Ordnance	120	480	600
Powerplants			
Sorties	229	50	279
Ordnance	370	47	417
Manufacturing and explosives plants			
Sorties	28	N.A.	28
Ordnance	90	N.A.	90
Airfields			
Sorties	421	91	512
Ordnance	330	85	415
Bridges			
Sorties	1,713	565	2,278
Ordnance	3,198	856	4,054
Radar and Communications installations			
Sorties	15	N.A.	15
Ordnance	20	N.A.	20
Naval bases, railroad yards, and ports			
Sorties	1,875	222	2,097
Ordnance	1,373	327	1,700
Total			
Sorties	8,700	1,600	10,300
Ordnance	12,800	2,132	14,932

Airstrikes against powerplants during 1966 generally appear to be more effective than in 1965. In terms of capacity put out of operation, each strike averaged some 2,240 kw in 1965 compared with only 1,000 kw in 1966. In value terms, the cost of damage averaged about \$300,000 for each strike in 1965 and \$430,000 in 1966. However, if the strikes for both years are weighed in terms of long-range effectiveness, the above comparisons are misleading. Accounting of the damage to the Uong Bi powerplant makes a significant difference. If all the capacity put out of operation at Uong Bi is counted in 1966, including the amount being installed which was destroyed, then average capacity put out of operation per strike in 1965 amounts to 1,095 kw, as against 5,000 kw per strike in 1966. The comparison in value terms would not change.

3. Petroleum Storage Targets

US airstrikes against JCS-designated petroleum storage target systems have destroyed almost 80 percent of the pre-strike capacity of 129,110 tons. Almost three-fourths of this destruction was achieved during 1966 when 59 air strikes were flown against petroleum storage targets, compared with only 9 strikes in 1965. The following tabulation summarizes the air campaign against petroleum storage targets during 1965:

<u>JCS</u>	<u>Name</u>	<u>Capacity 1965</u>		<u>Number of Strikes</u>
		<u>Beginning</u>	<u>End</u>	
	Phu Van	840	0	1
	Vinh	8,000	1,180	5
	Nam Dinh	11,020	0	2
	Phu Qui	7,560	0	1
Total	<u>27,420</u>	<u>1,180</u>	<u>9</u>	

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Destruction of JCS petroleum storage targets during the first nine months of 1966 was as follows:

<u>JCS</u>	<u>Name</u>	<u>Capacity ^{a/}</u>		<u>Number of Strikes</u>
		<u>28 June</u>	<u>25 October</u>	
	Phu Van <u>b/</u>	0	0	0
	Haiphong	40,620	4,330	3
	Hanoi	30,620	0	1
	Vinh	1,180	1,180	12
	Nguyen Khe	7,500	6,680	10
	Ha Gia (Phuc Yen) <u>b/</u>	9,910	9,910	0
	Bac Giang	2,260	1,560	4
	Nam Dinh <u>b/</u>	0	0	0
	Do Son	2,860	1,430	14
	Viet Tri	1,400	40	8
	Phu Qui <u>b/</u>	0	0	0
	Duong Nham	4,130	0	7
	Can Thon (Kep) <u>b/</u>	1,210	1,210	0
	<u>Total</u>	<u>101,690</u>	<u>26,340</u>	<u>59</u>

- a. Tons of average petroleum.
b. Not struck to date in 1966.

The effects of neutralizing most of the major petroleum storage facilities have been largely offset by the development of an elaborate system of resupply and dispersed storage sites. The North Vietnamese have been able to maintain petroleum imports at almost normal levels by a combination of movement of petroleum overland from China, the lightering of 10,000-ton Soviet tankers, and, more recently, the use of small 4,000-ton Soviet tankers delivering petroleum from the Soviet Far East.

Difficulties in distributing petroleum internally have been noted, but they do not appear to be sufficient to cause other than highly local transportation difficulties or to interfere with the logistic resupply of the Communist forces in South Vietnam.

4. Lines of Communications

a. North Vietnam

The rail lines, highways, and waterways of North Vietnam were hit continually from January through September 1966, with emphasis primarily on the same areas that were struck in 1965. Of the 355 bridges confirmed by aerial photography to have been struck since the start of bombing, about 140 were targets struck for the first time in 1966. All lines of communications (LOC's) were hit with greater intensity during 1966, but the only new LOC's taken under attack were the roads developed as alternates to routes bombed in 1965.

Airstrikes against JCS-targeted bridges, like strikes against all bridges in North Vietnam, have been concentrated in the southern part of the country. The number of strikes against highway bridges on the JCS target list decreased during 1966, whereas strikes against JCS bridges on the rail lines increased as shown in Table 6.

(1) Railroads

In spite of the increase in airstrikes against the rail lines in 1966, there has been no significant increase in the total length of time the rail lines have been interdicted for through rail service during the year as shown in Table 7. Aerial photography confirmed that a total of 82 railroad and combination rail/highway bridges were damaged or destroyed on all rail lines in North Vietnam since the start of the bombing. This figure represents 28 percent of all rail bridges in the country, half of which were destroyed or damaged from January through September 1966. Table 8 shows a comparison of data by individual line. The Hanoi - Dong Dang and Hanoi - Haiphong lines, the two most important lines for the movement of both imports and domestic goods, have been interdicted for a total of only about two months and one month, respectively, during 1966. The average volume of traffic moved on these two lines could easily have been equal to that moved in 1965 because the lines are normally used below maximum capacity, thus traffic backlogged during periods of interdiction could have been moved while the lines were open. Two additional

bridges were struck on the Dong Dang line during 1966 bringing the total on this line to four bridges, all located approximately midway between Hanoi and the China border. No additional bridges were struck on the Haiphong line.

Table 6

North Vietnam: Airstrikes Against JCS Targeted Bridges
1965 and January-September 1966

Type and Location	Number of JCS Targeted Bridges Struck		Number of Strikes ^{a/}	
	1965	Jan-Sep 1966 ^{b/}	1965	Jan-Sep 1966
Railroad and railroad/ highway	<u>16</u>	<u>16</u>	<u>67</u>	<u>96</u>
Hanoi - Dong Dang line	3	3	6	14
Hanoi - Lao Cai line	1	2	7	9
Hanoi - Haiphong line	2	1	5	5
Hanoi - south ^{c/}	10	10	49	68
Highway	<u>31</u>	<u>16</u>	<u>77</u>	<u>37</u>
21° to 23°	12	7	28	12
19° to 21°	3	1	5	1
17° to 19°	16	8	44	24
Total	<u>47</u>	<u>32</u>	<u>144</u>	<u>133</u>

a. Including restrikes against JCS bridges.

b. Including JCS bridges initially struck in 1965.

c. Including the Hanoi-Vinh line and the makeshift line south of Vinh.

Table 7

North Vietnam:
Estimated Total Length of Time Railroad Lines were Interdicted
for Through Rail Service
1965 and January-September 1966

<u>Railroad Line</u>	<u>1965</u>	<u>Jan-Sep 1966</u>
Hanoi - Dong Dang	1 month	2 months
Hanoi - Haiphong	1 week	1 month
Hanoi - Lao Cai	5 months	5 months
Hanoi - Vinh	9 months	8 months
Hanoi - Thai Nguyen	Negl.	Negl.

Table 8

Railroad Bridges Destroyed or Damaged, by Line
1965 Through 30 September 1966

<u>Railroad Line</u>	<u>Total Bridges on Line</u>	<u>Percent Destroyed/Damaged in 1965</u>	<u>Percent Destroyed/Damaged in 1965 and 1966 Through Sep 30</u>
Hanoi - Lao Cai	139	8	12
Hanoi - Dong Dang	53	4	8
Hanoi - Haiphong	10	20	20
Hanoi - Dong Hoi	85	32	69
Hanoi - Thai Nguyen	7	0	14
Total	<u>294</u>		
Average		14	28

The Hanoi - Lao Cai line has been interdicted for through service for almost 60 percent of 1966, compared with about 40 percent of 1965. The Hanoi - Vinh line has been disrupted for through rail service almost continually since it was first struck in April 1965, except during the cessation of bombing in January 1966. Four of the major bridges destroyed on this line during 1965 have bypass bridges in place and shuttling operations under way. At least 32 additional railroad and combination bridges have been struck on this line in 1966.

(2) Highways

The most significant hindrance to highway traffic has resulted from strikes against routes in the southern part of North Vietnam. Strikes against the central and northern parts of the country have resulted in only minor disruptions of truck service. Route 1A, running along the coast to the DMZ, has been subjected to the most bombing, but apparently also continues to be the most heavily used road in the south. Other north-south routes, such as routes 15 and 101, have been used primarily as supplements or as alternates when portions of route 1A were interdicted. Aerial photography has confirmed the destruction or damage of about 100 additional highway bridges, primarily in the south, in 1966, for a total of 273 highway bridges struck since the start of the bombing. In addition, roadbeds have been cratered at chokepoints, and alternate routes have been bombed. The southernmost motorable road crossing into Laos west of Dong Hoi, completed in April, also has been heavily bombed. The significantly higher level of reported destruction and damage of trucks in the south during 1966, shown in Table 9, has added greatly to the problem of moving supplies south. In spite of these heavy losses, there have been no indications of serious shortages of supplies resulting from either the loss of trucks or of lowered road capacities.

(3) Waterways

The most significant change in the movement of supplies to the south thus far in 1966 has been the increased emphasis on the use of inland and coastal waterways. Airstrikes against the waterways followed the same pattern during 1966 as in 1965, with attacks primarily against watercraft, port areas, and other cargo-handling facilities. No significant damage to the water LOC's has resulted from the numerous strikes against the ports and transshipment facilities in southern North Vietnam. Dredging of waterways, an annual project for the North Vietnamese, probably increased during 1966 in the south. Airstrikes against watercraft probably have been more important in hindering water shipments than strikes against facilities. The number

of watercraft reported destroyed and damaged in 1966 increased nearly five-fold over 1965. The number of watercraft used in the southern area apparently has not decreased, however.

Table 9

Reported Losses of Transport Equipment Due to Bombing in North Vietnam a/
1965 and January-September 1966

	<u>1965</u>		<u>Jan-Sep 1966</u>	
	<u>Destroyed</u>	<u>Damaged</u>	<u>Destroyed</u>	<u>Damaged</u>
Vessels	460	750	2,700	4,350
Trucks <u>b/</u>	320	480	1,600	1,500
Railroad freight cars <u>c/</u>	230	590	1,060	870
Locomotives	6	6	10	13

a. These data are basically those from pilot reports but adjusted downward to eliminate some duplication. Data probably include some exaggeration.

b. Additional trucks were destroyed and damaged in Laos, resulting in effective losses of about 1,000 trucks from the inventory.

c. Including small makeshift railroad cars used on the line south of Hanoi. This type of car is not included in the inventory of mainline freight cars.

b. Laos


Air operations against lines of communications have been concentrated in the north-central and Panhandle areas of Communist-held Laos. The roads and river crossings in the Panhandle were hardest hit in 1966, with about 70 percent of the sorties flown in this region. Strikes have been carried out against bridges, fords, ferries, and choke-points. Some 38,000 sorties, primarily armed reconnaissance, were flown against LOC's and fixed targets located in the north central area and the Panhandle during the first nine months of 1966. Air attacks were heaviest during the dry season, when an average of about 1,300 sorties were flown per week. The level of sorties dropped to an average of about 150 per week during the rainy season, which started

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in June. Pilots reported the following damage to LOC's in Laos for the period from 1 April through 30 September 1966:

<u>Region</u>	<u>Bridges</u>	<u>Road Cuts</u>	<u>Fords and Ferries</u>
North Central (Barrel Roll)	13	99	2
Panhandle (Steel Tiger/ Tiger Hound)	173	1,071	114

Aerial photography  has confirmed that seven bridges in the north-central region and 57 bridges in the Panhandle, most of which are on fordable streams, were heavily damaged or destroyed. It is estimated that about 1,000 trucks have been destroyed on roads in the Panhandle since the start of bombing in southern Laos.

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B. Targets of Opportunity (Armed Reconnaissance Missions)

A total of 57,300 armed reconnaissance sorties were flown in the first nine months of 1966, compared with 17,300 sorties in 1965. This increase of about 230 percent reflects not only the scarcity of authorized fixed targets but also the increasing concern with infiltration of men and supplies into South Vietnam. The latter concern is apparent in the fact that almost two-thirds of the armed reconnaissance sorties were directed against targets in the southernmost areas of North Vietnam, the Panhandle section south of Vinh.

The rise in damage effectiveness for armed reconnaissance sorties -- from \$600 per sortie in 1965 to \$900 per sortie in 1966 -- is principally attributable to the concentration of attack on transportation facilities south of Vinh and their systematic destruction. There are, however, two other factors that contribute to the rise in damage per sortie, neither of which is a truly sound comparable indicator of mission effectiveness. The first of these is the inclusion of damage inflicted on naval craft -- a figure unavailable and thus excluded from the assessment of strikes made in 1965. The second is represented by the downing of North Vietnamese interceptor aircraft by Rolling Thunder missions. The cost of these aircraft and the number downed is not related to the number of Rolling Thunder sorties flown, and the disproportionate rise in dollar replacement cost to North Vietnam should therefore be taken into account when measuring effectiveness of the Rolling Thunder program.



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C. Laos Air Operations

Approximately 38,000 attack sorties were flown under the Barrel Roll and Steel Tiger programs against the north-central and Panhandle areas of Communist-held Laos during the first nine months of 1966. This air effort shows a marked increase over nearly 11,000 attack sorties flown in similar missions during 1965. Of the attack sorties flown over Laos during January-September of this year, 95 percent were on armed reconnaissance missions. About 70 percent of the attack missions struck targets of opportunity within the Steel Tiger area of operations; the other 30 percent performed similar tasks within the Barrel Roll area.

The intensity of the current air war over Laos is varied to meet fluctuations in weather and the level of enemy truck traffic and infiltration. During 1966, monthly attack sorties over Laos ranged from 8,000 in January (dry season) to 800 in August (wet season). Air-strikes were heavily directed against trucks, bridges, fords, ferries, and road chokepoints. It is estimated that during 1966, air attacks in Laos have inflicted at least \$5 million damage against the Communist forces. The bulk of this damage, primarily accounted for by truck and bridge destruction, was inflicted in the Steel Tiger area of operation.

III. The Effects of the Rolling Thunder Program in 1966A. Physical Damage

Attack sorties flown by the Rolling Thunder program increased approximately 130 percent during the first nine months of 1966, compared with all of 1965, but the value of physical damage increased by only about 45 percent. A comparison of total measurable damage to economic and military target systems for 1965 and January-September 1966 is as follows:

	<u>Million US \$</u>	
	<u>1965</u>	<u>January-September 1966</u>
Economic targets	34.8	67.2
Military targets	30.4	28.0
Total	<u>65.2</u>	<u>95.2</u>

Damage to military targets, which accounted for 47 percent of the total damage in 1965, accounted for less than 30 percent in 1966. By far the greatest share of damage to military targets was inflicted on aircraft and naval craft, which accounted for 90 percent of the total military damage in 1966. No estimates of damage to naval craft are available for 1965; damage to aircraft in that year accounted for only 10 percent of total damage to military targets.

The major changes in damages inflicted on economic target systems in 1966 as compared with 1965 were the sharp increases in the destruction or damage sustained by transport equipment and the indirect losses of exports and agricultural crops which are attributable to the bombings. Losses in transport equipment jumped from US \$6 million in 1965 to \$24.5 million in 1966. Indirect losses of agricultural crops and export earnings almost tripled -- from \$9.2 million in 1965 to \$25.4 million in 1966.

The air attack in 1966 shows some general correlation between the increase in attack sorties and the level of physical damage. Thus, the months of July, August, and September accounted for almost one-half -- 47 percent -- of the total damage sustained by

economic targets. During the same period the air attack accounted for almost 58 percent of the sorties flown to date in 1966. Military damage has remained at relatively low levels during 1966 except during the last four months, when increasing losses of aircraft and naval craft have been sustained. The cumulative effects, by economic sector, of the Rolling Thunder program are discussed in Part IV of this memorandum. The overall effect has been to inflict increasing damage to the transportation system and to cause extensive distribution problems, most notably in petroleum distribution. The airstrikes have continued to depress economic growth and to cause the abandonment of some plans for economic development. Nevertheless, essential economic activities continue; most transportation routes remain open. The level of damage has not been sufficient to cause any sector of the economy to collapse. Nor has popular support of the war been significantly diminished. Hanoi's support of its military activities in South Vietnam has been made more costly and burdensome but has not been reduced below the levels required to continue military operations at the levels maintained throughout most of 1966.

B. Casualties in 1966

All estimates of casualties from bombing North Vietnam are subject to an unknown and conceivably large margin of error because of the questionable validity of the assumptions and estimates used in the calculations. Information emanating from Hanoi is of little value in estimating casualties, with propaganda pronouncements continuing to be directed to the large but usually unspecified numbers of casualties inflicted from the bombing of schools and hospitals. The few numerical reports of civilian casualties produced by Hanoi have been notable for the relatively insignificant quantities shown. By all yardsticks of measurement, however, we conclude that casualties from US/GVN bombing attacks are not a major effect of the air war, in the sense that this number is probably relatively small. Our estimate of 16,000 to 21,000 casualties for the first nine months of 1966 is considered to be preliminary.

1. North Vietnamese Claims of Casualties

There have been no official North Vietnamese estimates of total casualties since September 1965, when Egyptian journalists were reportedly told that 40,000 North Vietnamese had already been killed and 35,000 wounded. This claim is unsupported and far too high. A letter in May 1966 from the Hanoi Red Cross to the International Committee of the Red Cross in Geneva specifically cited

only 239 civilian casualties inflicted since 31 January 1966, although implying many more. Despite the claims concerning school children, the Education Ministry admitted in October 1966 to the death of only 300 students and 30 teachers since the inception of the bombing in August 1964. Hanoi, of course, must balance the propaganda benefits of claiming heavy casualties against the adverse effect on popular morale.

2. Estimated Casualties from Strikes Against Fixed Targets

A recent comprehensive study of civilian casualties in 90 JCS-targeted areas, both urban and rural, carried out by the Defense Intelligence Agency (DIA), based on photography and demographic statistics for the targeted areas, indicated that a minimum of some 500 civilian casualties were inflicted by some 525 strikes. The minimum estimate, equating to about one civilian casualty per strike, presumes adequate warning for the personnel in the targeted areas. If the personnel received no warning, casualties could be as high as ten times the minimum estimate, the DIA study concluded. For the purposes of our current estimate, the method derived from the Nam Dinh case study was used for urban areas. The conclusion of the Nam Dinh analysis was that casualties ranged from 1 per 12,000 of population to 1 per 18,000 of population. For rural areas a minimum ratio of 0.7 casualties per strike (and a maximum of 7.0 casualties per strike) was implied by the DIA study. For the purpose of estimating casualties against fixed targets in rural areas, the mean of 3.8 casualties per strike has been used in our current estimate.

The application of the Nam Dinh example to 1966 strikes against JCS targets in urban areas yields a total estimate of 200 civilian casualties. If it is assumed that the rural population near JCS fixed targets has less access to sophisticated air raid warning systems and that therefore casualties per average strike are more likely to be close to the 3.8 average between the minimum (0.7) and maximum (7.0) suggested by the DIA photographic study, total civilian casualties from the 218 airstrikes against fixed targets in rural areas in the first nine months of 1966 probably amounted to about 800. The combined nine month 1966 total estimate is that civilian casualties from attacks against JCS fixed targets in 1966 to date have not exceeded 1,000.

Military casualties in fixed target areas in the first nine months of 1966 are estimated to have been negligible.

3. Estimated Casualties from Armed Reconnaissance

[redacted] our first casualty study indicated that an average of 1.3 civilian casualties occurred per armed reconnaissance mission, each mission including an average of 5 aircraft. Each sortie thus produced an average of about 0.25 casualty. Comparative analysis of weapons effectiveness and civilian population density supplied by DIA for our first casualty study resulted in a ratio of 0.17 casualties per sortie. In January-September 1966 there were a total of some 57,000 armed reconnaissance attack sorties (excluding those against fixed targets), yielding an estimate of some 10,000 to 15,000 total civilian casualties from armed reconnaissance in the first nine months of 1966, compared with some 4,000 in 1965.

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One casualty is normally assigned by DIA for each truck or watercraft damaged or destroyed and 0.01 casualty for each railroad car or locomotive damaged or destroyed. Since some 10,000 motor trucks and watercraft have been reported damaged or destroyed during the first nine months of 1966, casualties of 10,000 are indicated. It is estimated, however, that at least half of these vehicles are operated by civilians whose casualties as a consequence of armed reconnaissance have already been estimated above. The total derived from this method has therefore been reduced to 5,000 and is regarded to comprise only military personnel. Estimates for the first nine months of 1966 are as follows:

	<u>Casualties</u>
Civilian	
Attacks against fixed targets	1,000
Armed reconnaissance	10,000 to 15,000
Subtotal	<u>11,000 to 16,000</u>
Military	
Attacks against fixed targets	Negl.
Armed reconnaissance	5,000
Subtotal	<u>5,000</u>
Total (half killed, half wounded)	<u>16,000 to 21,000</u>

C. North Vietnamese Countermeasures

1. Repair and Reconstruction

The intense effort by the North Vietnamese to keep LOC's open and to maintain an acceptable level of output from its limited industrial capacity has improved their ability to counter the effects of US/GVN air strikes in 1966. Indeed, the capacity of the transport network has been increased by their efforts. Rapid repair and expansion of the road network together with the transfer of traffic from railroads to roads and waterways have been the major determinants of North Vietnamese success.

The roads in North Vietnam, primarily south of Hanoi, have been kept open almost continuously since the start of the bombing by the extensive use of bypasses to destroyed highway bridges and the construction of new alternative routes. Although the air attack in 1966 concentrated on neutralizing these new projects, the system of countermeasures inaugurated in 1965 has been successful in diminishing the effect of bombings. We estimate that 400 miles of short bypasses and an additional 300 miles of alternative routes were constructed in 1965, with the larger projects completed by September 1966. To complete this work, a system of workcamps was organized. The North Vietnamese used these work camps to anticipate airstrikes on LOC's by pre-positioning labor and materials for repairs to damaged bridges or cratered roads and railbeds. Speed and simplicity of repair have been the main features of the maintenance program which uses large amounts of highly mobile labor and local building materials to insure the required flexibility. Rather than repair highway bridges, the North Vietnamese have chosen to build multiple stream crossings such as fords, ferries, and culverts at any one point. The proliferation of stream crossings has greatly improved their ability to maintain through traffic.

Aerial photography in 1966 has revealed a new bridging technique based on the use of steel cables and removable bridge decking to further reduce vulnerability to air attack. Thirty-eight of these cable bridges have been seen on major routes in North Vietnam to date. Comparative day and night photography of one cable bridge showed that the bridge decking is in place at night for traffic and removed at dawn, leaving only the steel cables exposed to air attack. The North Vietnamese have also expended greater effort in 1966 in camouflaging existing bridges and building alternate dummy bridges with rope and netting.

Although rail traffic has been maintained almost continuously in 1966 on their main lines from China and Haiphong port to Hanoi, the North Vietnamese have not been able to repair rail bridges rapidly or provide as many multiple stream crossings as they have done on the highways. This has resulted in some lowering of capacity on rail lines relative to other means of transport. Comparisons of rates of repair reveal that the Dong Dang line from China and the line from Haiphong have been kept open more than the other lines. Chinese railway engineering units stationed on the Dong Dang line have apparently been instrumental in keeping this line open for a greater time. Bypass bridges have been built and original rail bridges repaired to operable condition. A new standard-gauge rail line which runs west from Kep to Thai Nguyen is almost complete, while an additional rail has been installed on the meter-gauge line northeast from Kep to the China border. This work provides the North Vietnamese with a standard-gauge line from China and avoids the need to transload goods at Dong Dang on the China border. Bypass railroad bridges have been seen under construction next to bridges in the suburbs of Hanoi and Haiphong which have not been bombed.

An analysis of North Vietnamese repair practices reveals that they have chosen to resort to temporary bridges and bypasses rather than attempt to provide more permanent replacement spans. The estimated cost for permanent replacement of all damaged bridges to date totals \$16.2 million, up about \$6 million since 1 January 1966. Since other types of bypasses were used more often to replace damaged highway bridges, the North Vietnamese have spent only \$2.5 million to date to repair some bridges to operable condition and to provide bypasses to the remainder. This implies an actual North Vietnamese expenditure on repairs and bypasses amounting to only 14 percent of the cost of permanent repairs. In addition we estimate it would cost another \$1.1 million to temporarily replace the present inventory of unrepaired bridges. The total labor input required to complete temporary repairs to all bridges to date is estimated to be 153,000 man-days. By comparison, it is estimated that the North Vietnamese have expended 62,000 man-days on bridge repairs to date, or only 40 percent of what all temporary repairs would require.

2. Civil Defense

The North Vietnamese civil defense system has been characterized by increased precautions to minimize casualties and damage during 1966. A new dispersal of the urban population was ordered this year, and shelter systems have been improved and multiplied.

a. Organization and Manpower

Controlled nationally by a Directorate in the Ministry of Defense, Vietnamese civil defense at the province and town level remains a civilian rather than military type of organization. Peoples "air defense work committees" are established in districts, towns, wards, enterprises, and on state farms. These committees are headed by Party or administrative officials, and their subordinate civil defense units are manned by local residents and employees. Steps have been taken to divide medical assets more equitably, undoubtedly because of urban evacuation and the air raids, which occur principally in areas outside Hanoi and Haiphong. In April 1966 the North Vietnamese claimed they had substantially increased the number of medical workers and dispersed medical installations to the countryside. Thus "92 percent of the villages now have medical stations."

Because civilian volunteers (perhaps 150,000) are used almost exclusively to perform civil defense duties and because each household is responsible for providing its own shelter, no severe manpower drain seems to have been imposed by civil defense work.

b. Protective Construction

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[redacted] published statements agree that old shelters were refurbished and large numbers of new shelters prepared during 1966. Most progress was reported during the June-September period, and this was probably in compliance with a general order. Shelters of various types are quickly available in Hanoi, and many of the foxholes along the streets have been lined with sections of concrete sewer pipe. According to the North Vietnamese press, some 55,000 shelters were built in Haiphong during one ten-day period. In Vinh, it is claimed that every family has its own shelter, and that there are also 150 kilometers of communication trenches, 8,000 other shelter spaces, and special shelters for machines, documents, and state property. The Vinh Linh area claims 1,000 kilometers of trenches and tunnels, or nearly 15 meters per capita. Other provinces report in a similar manner -- thousands of shelters and many kilometers of trenches built.

Protective measures for industrial equipment are said to have been taken in Hanoi plants -- probably in the form of blast walls between machines, similar to those built in Japan during World War II.

c. Dispersal of Population and Industry

Although the precise degree of urban population dispersed and resettled outside cities is not known, about a 50-percent evacuation seems to have been accomplished. Efforts prior to 1966 may have resulted in about a one-third evacuation of Hanoi. There has been a tendency for evacuees to return to the city, and a letdown in civil defense interest in early 1966 may have had a permissive effect in this regard. A new dispersal order reportedly was issued about 1 July. Recent newspaper accounts have stated that as much as 75 percent of Hanoi's population may now have been evacuated. However, difficulties in persuading people to relocate has been confirmed, and in August a city official told a newsman the city was about 50 percent evacuated but that the effort was continuing.

The population of Haiphong was partially dispersed, largely this year, after near-by bombings. According to French press reports, over half the people have left; schools are closed and "not an idle hand remains."

Some dispersal of industry is still reported. However, sample photography of plants has failed to bear out anything more than slightly decreased activity at bona fide industrial installations in Hanoi and Haiphong. It is probable that some small industry and shops have been moved out of urban areas. For example, a North Vietnamese newspaper stated on 1 September, "Over one hundred handicraft cooperatives in Haiphong have been carrying out the evacuation policy seriously." The North Vietnamese concede that the movement of many industries is not possible because of lack of electricity outside cities.

Dispersal, camouflage, and personnel shelters for construction workers are used to reduce damage at road camps.

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d. Other Civil Defense Measures

The North Vietnamese use camouflage, movement by night with reduced lighting, and dispersal to reduce transport vulnerability. Business, marketing, and the movement of people and goods is frequently restricted to evening and early morning hours.

The movement of goods offloaded at Haiphong takes place under the cover of darkness. At times, poor weather, hampering air operations, has been reported as a factor inducing some shops to keep open during daylight hours.

In addition to the general effort to resettle permanently residents not directly engaged in production or anti-aircraft defense, a noticeable portion of the population of Hanoi disperses during the day and returns at night. [redacted] as recently as mid-October -- an appreciable increase at night and on weekends in the size of the capital's population. The daily exodus serves not only to reduce the concentration of people in daylight hours but also to provide manpower for industry and agriculture in outlying areas. The influx of people into the city at night has been attributed to a lack of accommodations in the nearby countryside as well as to the opportunity to shop and conduct business in the evening and early morning hours when markets are open.

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e. Alerts

[redacted] the North Vietnamese population usually takes shelter in a disciplined manner during air alerts, which are signaled by sirens, whistles, or other audible means. This, of course, means a disruption of industrial and transport operation, and some personal hardship in areas frequently approached or overflowed by aircraft. While such lost production and hardships are not readily measurable, they seem cumulative in effect and may have particular consequences in some critical areas, such as ports.

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[redacted] dock work ceased completely during air alerts when workers took shelter. [redacted] the alerts "greatly disrupted" dock work and that one ship was damaged while docking during an alert.

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It thus appears that a population disciplined in taking shelter may be vulnerable in the production sense to frequent harassing overflights or to approaches of aircraft toward transportation and industrial centers.

D. North Vietnamese Political Reactions

After enduring 18 months of air attack, the North Vietnamese appear as determined as ever to continue the war. There has been no indication that the bombing program has shaken the confidence of the Hanoi leadership in their ultimate victory. Communist leaders who have talked with the North Vietnamese recently have been greatly impressed with their firmness. A Polish government official recently told a US newsman that Ho Chi Minh's first words to any Communist visitor are always, "We are winning."

There is no sign that any faction of the North Vietnamese leadership is out of step with Ho on the advisability of continuing the conflict, even though the airstrikes have caused the postponement of some of Hanoi's long-cherished program of heavy industry development. At the 12th Central Committee Plenum held some time in 1965, according to a captured document, a decision was made to put the program for the development of heavy industry on the shelf for the duration. Since that time the leadership has appeared to be in complete agreement that the war is the number-one order of business.

One effect of the Rolling Thunder program has been to reinforce certain North Vietnamese attitudes which existed prior to the airstrikes. For example, Hanoi has long been anxious to secure the closest possible Sino-Soviet cooperation in support of the Vietnam war. This has been one reason for the neutral position taken by the North Vietnamese in the Sino-Soviet dispute and for Hanoi's opposition to open hostility between the two powers.

The Rolling Thunder program has also resulted in Hanoi's increased emphasis on the necessity of a halt in US air attacks before there can be a negotiated settlement of the war. The current North Vietnamese position is that the United States must not expect or demand any quid pro quo in return for a cessation of the bombings.

The available evidence indicates that the people of North Vietnam still firmly support the policies of the Hanoi government. The regime has managed to maintain the swell of patriotism which was engendered by the first US airstrikes and has capitalized on a spirit of national resistance against the "US aggressors" to spur the people on to greater sacrifices on behalf of the war in South Vietnam.

Evidence on the feelings of the North Vietnamese toward the war in the south prior to February 1965 was scanty. The available information suggested that the northerners were interested in seeing the insurgents win, but that they did not relish the prospect of having to risk their own economic standing, let alone their lives, on behalf of the southern struggle. Since the bombings of North Vietnam began, however, there appears to be more enthusiasm for supporting the war in the south.

There are at present, however, no discernible political pressures from within North Vietnam sufficient to cause the Hanoi leaders to alter their decision to continue the war effort.

E. Soviet and Chinese Communist Assistance

1. Military Aid

During the first half of 1966, Soviet and Chinese military aid deliveries to Hanoi are believed to have been at an annual rate slightly above the 1965 level of \$250 million (see Tables 10 and 11). These data include the Soviet surface-to-air missile (SAM) program, the bulk of which (20 of 24 firing battalions) was provided during 1965. Non-SAM-related assistance in 1966 (estimated at \$218 million) is about 50 percent higher than the total non-SAM military aid in 1965 (\$144 million).

The USSR accounted for 80 to 85 percent of the military assistance provided by the two major Communist countries, USSR and Communist China, during 1965 and the first half of 1966. Thirty-six MIG's (11 of which were MIG 21's) and nearly 1,200 antiaircraft guns were delivered by the USSR in 1965 and 24 MIG's and about 425 guns during the first half of 1966. In addition, as many as 1,500 Soviet military technicians may have been engaged in training North Vietnamese military personnel in the use of SAM's and aircraft.

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Chinese Communist military deliveries during 1966 have been at a rate nearly double those in 1965. Aid has consisted primarily of small arms, ammunition, and trucks. The Chinese also delivered eight MIG-15/17 fighters and about \$5 million worth of radar equipment in 1965, as well as four small naval craft in the first half of 1966. In addition to the delivery of military equipment, there are between 25,000 and 45,000 Chinese logistic support troops in North Vietnam working on the construction and repair of transportation facilities. An unknown number of Chinese military personnel also are employed in training North Vietnamese to operate and maintain equipment provided by the Chinese.

2. Economic Aid

All developments foreshadow substantially increased aid to Hanoi from other Communist countries in late 1966 and 1967, a trend already confirmed by the volume and composition of North Vietnamese imports in 1966 to date. The frequent signings of aid pacts and the stress in the announcements on the support for the war effort indicate a growing emphasis on materials and services needed to continue the war. An unconfirmed report from Poland on the recent Warsaw Pact meeting stated that the Pact countries had signed pledges of \$1 billion in goods and cash to support Hanoi in the war effort. The Soviet Union would supply \$800 million of this aid.

It is estimated that deliveries of economic aid in 1965 were \$150 million, two to three times the average annual level in 1955-64. This sharp rise has been continued in 1966, and, as in 1965, the USSR is the major contributor. In the last nine months, deliveries of economic aid totaled about \$200 million, and an unusually large number of new Soviet industrial aid contracts with North Vietnam [REDACTED]

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After an apparent hiatus of two years, Communist economic assistance to Hanoi was revived in February 1965 when Premier Kosygin visited Hanoi. As the war expanded, numerous new extensions of economic aid were made in mid-1965, but these additions are believed to have been small. Since then, the tempo of aid agreement signings has increased sharply (see Tables 12 and 13).

In 1966, Moscow reported an agreement in May to provide technical assistance, one in September for \$2 million in "free

charge commodities" (possibly consumer goods and medicines), and one in October of additional grants for economic development and increased military aid. China announced additional aid for agriculture in July and a nonrefundable economic and technical agreement in August. In September and October 1966, North Korea and all the Eastern European Communist countries except Yugoslavia signed new aid agreements with North Vietnam. In addition, gifts of money and medicines from workers and other organizations in Communist countries have been announced at a value of \$5 million to \$10 million.

Table 10

Soviet and Chinese Military Equipment Delivered to North Vietnam
1965

	Total		USSR		Communist China	
	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)
Total		<u>250.0</u>		<u>217.2</u>		<u>32.8</u>
Surface-to-air missile firing battalions	<u>20</u>	<u>106.0</u>	<u>20</u>	<u>106.0</u>	<u>0</u>	<u>0</u>
Aircraft	<u>56</u>	<u>16.1</u>	<u>48</u>	<u>15.1</u>	<u>8</u>	<u>1.0</u>
Il-28 light jet bomber	8	2.8	8	2.8	0	0
MIG-21 jet fighter	11	8.8	11	8.8	0	0
MIG-15/17 jet fighter	33	4.2	25	3.2	8	1.0
Mi-6 helicopter	0	0	0	0	0	0
Mi-1 helicopter	4	0.3	4	0.3	0	0
Other aircraft	0	0	0	0	0	0
Naval craft	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Armor	<u>20</u>	<u>0.5</u>	<u>20</u>	<u>0.5</u>	<u>0</u>	<u>0</u>
PT-76 amphibious tank	5	0.3	5	0.3	0	0
BTR-40 armed personnel carrier	10	0.1	10	0.1	0	0
SU-76 assault gun	5	0.1	5	0.1	0	0
Artillery	<u>1,184</u>	<u>30.1</u>	<u>1,184</u>	<u>30.1</u>	<u>0</u>	<u>0</u>
100-mm AAA	64	3.2	64	3.2	0	0
85-mm AAA	250	10.0	250	10.0	0	0
57-mm AAA	350	12.2	350	12.2	0	0
37-mm AAA	500	4.5	500	4.5	0	0
Other artillery	20	0.2	20	0.2	0	0

Table 10

Soviet and Chinese Military Equipment Delivered to North Vietnam
1965
(Continued)

	Total		USSR		Communist China 25X1	
	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)
Radar	<u>81</u>	<u>12.7</u>	<u>41</u>	<u>7.8</u>	<u>40</u>	<u>4.9</u>
Trucks and vehicles	<u>2,000</u>	<u>10.0</u>	<u>1,000</u>	<u>5.0</u>	<u>1,000</u>	<u>5.0</u>
Small arms and infantry weapons	<u>0</u>	<u>13.2</u>	<u>0</u>	<u>6.6</u>	<u>0</u>	<u>6.6</u>
Ammunition	<u>0</u>	<u>61.4</u>	<u>0</u>	<u>46.1</u>	<u>0</u>	<u>15.3</u>

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Table 11

Soviet and Chinese Military Equipment Delivered to North Vietnam
January-June 1966

	Total		USSR		Communist China	
	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)
Total		<u>130.0</u>		<u>101.4</u>		<u>28.6</u>
Surface-to-air missile battalions	<u>4</u>	<u>21.2</u>	<u>4</u>	<u>21.2</u>	<u>0</u>	<u>0</u>
Aircraft	<u>40</u>	<u>31.3</u>	<u>40</u>	<u>31.3</u>	<u>0</u>	<u>0</u>
Il-28 light jet bomber	0	0	0	0	0	0
MIG-21 jet fighter	14	11.2	14	11.2	0	0
MIG-15/17 jet fighter	10	1.3	10	1.3	0	0
Mi-6 helicopter	6	12.0	6	12.0	0	0
Mi-1 helicopter	0	0	0	0	0	0
Other aircraft	10	6.8	10	6.8	0	0
Naval craft	<u>4</u>	<u>3.6</u>	<u>0</u>	<u>0</u>	<u>4</u>	<u>3.6</u>
Shanghai-class PTF	4	3.6	0	0	4	3.6
Armor	<u>20</u>	<u>0.5</u>	<u>20</u>	<u>0.5</u>	<u>0</u>	<u>0</u>
PT-76 amphibious tank	5	0.3	5	0.3	0	0
BTR-40 armored personnel carrier	10	0.1	10	0.1	0	0
SU-76 assault gun	5	0.1	5	0.1	0	0
Artillery	<u>457</u>	<u>7.8</u>	<u>457</u>	<u>7.8</u>	<u>0</u>	<u>0</u>
100-mm AAA	0	0	0	0	0	0
85-mm AAA	75	3.0	75	3.0	0	0
57-mm AAA	50	1.8	50	1.8	0	0

Table 11

Soviet and Chinese Military Equipment Delivered to North Vietnam
January-June 1966
(Continued)

	Total		USSR		Communist China	
	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)	Quantity (Units)	Value (Million US \$)
Artillery (Continued)						
37-mm AAA	300	2.7	300	2.7	0	0
Other artillery	32	0.3	32	0.3	0	0
Radar	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Trucks and vehicles	<u>1,000</u>	<u>5.0</u>	<u>500</u>	<u>2.5</u>	<u>500</u>	<u>2.5</u>
Small arms and infantry weapons	<u>0</u>	<u>29.6</u>	<u>0</u>	<u>14.8</u>	<u>0</u>	<u>14.8</u>
Ammunition		<u>31.0</u>		<u>23.3</u>		<u>7.7</u>

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Table 12

Communist Economic Aid Extended to North Vietnam a/
1955-64

Million US \$

	<u>1955</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963-64</u>	<u>1955-64</u>
Communist China	200	<u>b/</u>	<u>b/</u>	<u>b/</u>	100	<u>b/</u>	157	<u>b/</u>	<u>b/</u>	457
USSR	100	8	12	21	25	200	4	N.A.	<u>b/</u>	369
Eastern Europe	50	8	7	<u>b/</u>	2	Negl.	62	<u>b/</u>	<u>b/</u>	130
Total	<u>350</u>	<u>16</u>	<u>19</u>	<u>21</u>	<u>128</u>	<u>200</u>	<u>223</u>	N.A.	<u>b/</u>	<u>956</u>

a. This is the minimum of economic aid extended by the USSR, Eastern Europe, and Communist China. In addition, insignificant amounts of aid have been extended by Albania, Mongolia, and North Korea. Because of rounding, components may not add to the totals shown.
b. No extensions are known to exist, although some may have taken place.

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Table 13

Credits and Grants Extended to North Vietnam by Communist Countries
January 1965 - October 1966

Country	Date	Amount	Description
USSR	Feb 1965	N.A.	Grant: Six fishing boats and an unspecified amount of hospital and medical equipment. The agreement also united credits extended in 1960-62, extended the repayment period to a later date, and wiped out interest.
	Jul 1965	N.A.	For the development of the national economy and strengthening the defensive potential. Provides supplementary assistance in addition to that being given under previously concluded agreements. Of the economic credits, 30 percent will go to power stations and transmission lines and 15 percent for the creation of state farms, irrigation, and other agricultural needs.
	Dec 1965	N.A.	Provides supplementary grant aid for 1966, supplementary technical aid, a credit to cover balance of 1965 clearing account, and deferred payments during 1966 on earlier extended credits.
	Jan 1966	N.A.	Provides supplementary aid for the development of the economy and the strengthening of defense.
	May 1966	N.A.	Technical assistance.
	Jul 1966	N.A.	Scientific cooperation for joint research and study.
	Sep 1966	\$2 million	"Free charge commodities" (possibly consumer goods and medicines).

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Table 13

Credits and Grants Extended to North Vietnam by Communist Countries
January 1965 - October 1966
(Continued)

Country	Date	Amount	Description
USSR (Continued)	Oct 1966	N.A.	Signed agreement for grants to aid economic development and increase military aid potential. (Signed agreement for additional credits and commercial trade at same time.)
Bulgaria	Jun 1965	N.A.	For the rendering of material aid.
	Jan 1966	N.A.	For the purchase of equipment and rendering of technical aid in the construction of complex projects which will contribute to development of economy.
	Sep 1966	N.A.	"Nonrefundable economic and technical assistance." (Commercial agreement for 1967 also signed.)
Czechoslovakia	Jan 1966	N.A.	A credit for economic aid.
	Jul 1966	N.A.	Scientific cooperation pact signed.
	Sep 1966	N.A.	Economic, technical, and military aid agreement signed.
East Germany	Jun 1965	N.A.	Economic aid.
	Jan 1966	N.A.	To provide further assistance.
	Oct 1966	N.A.	Agreement signed on granting of economic aid and a long-term credit for goods deliveries and services for 1967-70. Vocational and advanced training of North Vietnamese citizens included.
Hungary	Jun 1965	\$5.5 million	Economic aid. Long-term credit.

Table 13
(Continued)

Country	Date	Amount	Description
Hungary (Continued)	Dec 1965	N.A.	Provides for a further long-term and interest-free loan and economic aid of a different nature; also postpones the repayment of earlier loans.
	Aug 1966	N.A.	Scientific cooperation agreement.
	Sep 1966	N.A.	"Long-term, no interest loan" and an agreement on technical training.
Poland	Jun 1965	N.A.	Economic assistance.
	Jan 1966	N.A.	A credit.
	Oct 1966	N.A.	Economic assistance granted. (Agreement on mutual trade exchange and payments for 1967 signed at same time.)
Rumania	May 1965	N.A.	Economic aid.
	Jan 1966	N.A.	A credit. Also deferred the repayment of certain credits previously extended.
	Sep 1966	N.A.	Nonreimbursable aid and commercial exchanges.
China	Aug 1966	N.A.	"Nonrefundable aid." Both economic and technical.
	Oct 1966	N.A.	Health cooperation agreement.
Albania	Apr 1966	N.A.	Goods provided free of charge.
	Oct 1966	N.A.	"Nonrefundable economic aid."
North Korea	Sep 1966	N.A.	Nonrefund aid.
Mongolia	Oct 1966	N.A.	"Nonrefund material aid in 1966 and 1967." Also an agreement was signed for goods exchange and payments for 1967.

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IV. General Assessment of the Rolling Thunder Program

A. Agriculture

During the past 18 months the production of paddy rice in North Vietnam -- the main agricultural crop in that country -- was about 200,000 tons below the average. While this is only 3 percent below the average for the 18-month period, all of this shortfall occurred during the past six months. Such a shortfall amounts to about \$17 million worth of rice on the international market. In addition, the production of subsidiary crops -- manioc, sweet potatoes, corn, and green beans -- was probably below normal during the 1965/66 winter/spring season. There is insufficient information, however, on which to estimate the shortfall of these crops, which are important food substitutes for the preferred rice.

It is difficult to determine the extent to which the bombing attacks contributed to the shortfall of agricultural production. Undoubtedly, poor weather in the last half of 1965 and in the first half of 1966 contributed to the poor performance of agriculture. Although there is little evidence that air attacks directly damaged significant amounts of agricultural crops, the indirect disruptive effects of the bombing on agricultural production were considerable. Agriculture in North Vietnam has usually experienced difficulties -- partly because of the chronically undependable weather and partly as a result of management problems associated with the socialization of agriculture into agricultural cooperatives. The war has brought such additional problems as manpower shortages -- particularly skilled manpower -- disruption of normal farming and fishing schedules, and the interruption of electrically powered irrigation systems and the production and distribution of chemical fertilizers. The North Vietnamese have attempted to lessen the disruptive effects of the bombing attacks by importing increased amounts of chemical fertilizers and substantial numbers of diesel generators to power the irrigation systems. These measures have not been completely successful.

The agricultural shortfall, the disruptive effects of the bombing attacks on the transportation of food to deficit areas, and the increased requirements for the war, have contributed to food shortages -- particularly in rural areas. However, food supplies in the larger cities such as Hanoi have been maintained at adequate levels, and there have been no indications of critical shortages anywhere. The continuation of the bombing attacks will continue to exacerbate the tight food situation in North Vietnam. However, the self-sufficient nature of the agricultural economy and the availability of food imports -- particularly from Communist China -- suggest that food supplies are not likely to become critical.