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DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

An Assessment of the Rolling Thunder Program Through 31 May 1967

JCS review completed.

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AN ASSESSMENT OF THE ROLLING THUNDER PROGRAM THROUGH 31 MAY 1967

Summary

The Rolling Thunder program has made some progress in meeting its current twofold objective:

1. To limit, or raise the cost of, the movement of men and supplies to South Vietnam.
2. To make North Vietnam pay a price for its aggression against the South.

The recent expansion of the bombing program has had some positive effects relative to these objectives, particularly in the modern sector of the North Vietnamese economy. Increased disruptions to orderly economic activity and sustained pressures on North Vietnam's limited human and material resources are evident. The damage to economic and military target systems has not been sufficient, however, to cause a meaningful degradation of North Vietnam's ability to support the war, at least at current levels of combat. There are no signs that the determination of the regime to persist in its aggression has abated. Despite increasing hardships, popular morale has not eroded to the point where widespread apathy and war weariness are threatening the control of the Hanoi regime.

The bombing program has forced North Vietnam to divert from 575,000 to 700,000 individuals, about equally divided between full-time and part-time workers and troops, to air defense activities and to repair, reconstruction, and dispersal programs. The cost of physical and military damage has been growing. Total damage resulting from air attacks through May 1967 is estimated at nearly $266 million. Nearly 70 percent of this damage was inflicted on economic target systems (see Figures 1 and 2, following p. vii).

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Despite the increasing costs and burdens resulting from the air attacks, North Vietnam, aided by an increased flow of imports from the USSR and Communist China, has managed to maintain, and in many respects to improve, its organized support of the war. The electric power industry has been the most heavily damaged sector of the economy, and its neutralization may paralyze almost all of the modern industrial sector. However, the modern sector makes only a marginal contribution to the war effort since virtually all war-supporting materiel is imported. Other important targets which have been subjected to heavy attack -- particularly transportation and petroleum storage facilities -- have successfully employed countermeasures so that their overall performance and support capabilities remain as high as, if not higher than, they were when the bombing programs started.

The attacks on military target systems through May 1967 had not significantly reduced the capabilities of the military establishment. These capabilities have, in fact, been greatly expanded through large infusions of military aid from the USSR and Communist China.

The ability of North Vietnam to withstand the pressures of air attacks is explained by several factors. The economy is essentially agrarian and provides little direct input, other than manpower, into the war in the South. The increasing flow of essential economic and military aid into North Vietnam far surpasses the total damage resulting from air attacks. This aid provides North Vietnam the necessary materials to continue the war. It also implies that the USSR and Communist China will underwrite the damage sustained and the eventual reconstruction of the country, as they did in the case of North Korea. Finally, the North Vietnamese have devised and employed an elaborate and highly successful system of countermeasures -- dispersal of industry, mobilization of labor units, evacuation of population, and the like -- which negates most of the desired impact of air attack on the vital flow of men and supplies to the war in the South.

During January-May 1967 the number of sorties flown against North Vietnam was at a rate about 22 percent higher than during 1966 (see figures 3 and 4 following p.vii). Over 2,500 sorties were flown against fixed JCS targets compared with 2,620 sorties during all of 1966. The armed reconnaissance program changed dramatically. Almost one-half of all armed reconnaissance sorties were flown against non-JCS fixed targets compared with about 25 percent throughout 1966. Despite the extension of the Rolling Thunder program to more densely populated and heavily defended areas, the overall aircraft loss rate during 1967 declined, with the exception of losses during strikes against targets in the immediate urban areas of Hanoi and Haiphong.

The recent concentration of attacks against lucrative fixed targets in the northern parts of North Vietnam has resulted in an improved trend in the costs of inflicting damage on North Vietnam. There is little prospect for improved cost effectiveness in the future, however, because the number of significant undamaged targets is decreasing rapidly.

The results to be expected from a further expansion of the bombing program, with the possible exception of a mining program, are limited, ruling out attacks on dikes or population centers. Experience indicates that the remaining land transportation targets will be extremely difficult and costly to interdict. The few lucrative economic targets remaining do not make a significant contribution to the war effort, and their loss can be compensated by additional foreign aid. The neutralization of the remaining military targets, such as airfields, SAM sites, and radars, would reduce losses to US aircraft but would have virtually no effect on the ability of Hanoi to support the war in the South.

In summary, no bombing program alone is likely to create sufficient pressures or problems to prevent Hanoi from sustaining the flow of essential military materials and continuing its support of

the war in the South. While the mining of Haiphong and other ports would impose greater hardships on North Vietnam and raise further the cost of sustaining the insurgency than would other alternatives, such action, by itself, would probably not have a decisive impact on North Vietnam's determination to pursue the war.

Virtually all of the remaining economic targets are concentrated in densely populated and heavily defended areas of North Vietnam. Their neutralization could be very costly to US air forces. The recent attacks on targets in the immediate Hanoi-Haiphong areas indicate, for example, that the combat loss rate for US aircraft could be as much as 10 times greater than that experienced in the air campaigns over other areas of North Vietnam.

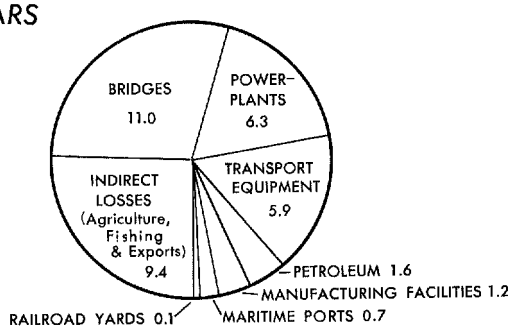
Continued harassment and attacks on the road, rail, and trail network in the southern portion of North Vietnam and in Laos will not prevent or stop infiltration but will make it more costly and will force North Vietnam to pay a continuing price on its own territory for its continued support of the war in the South.

ECONOMIC DAMAGE

MILLION US DOLLARS

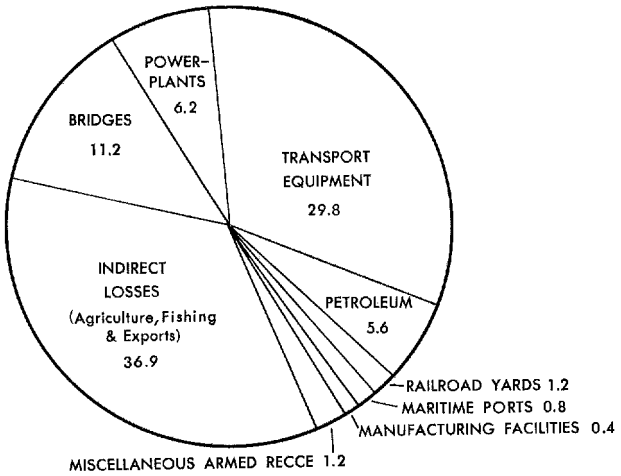
1965

36.2



1966

93.3



1967
Jan-May

53.4

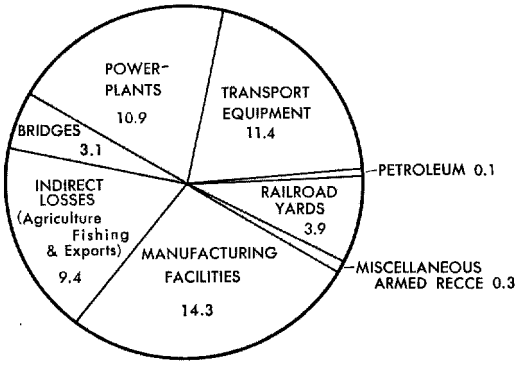


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Figure 1. Value of Economic Damage in North Vietnam, by Sector, 1965, 1966, and January - May 1967

MILITARY DAMAGE

MILLION US DOLLARS

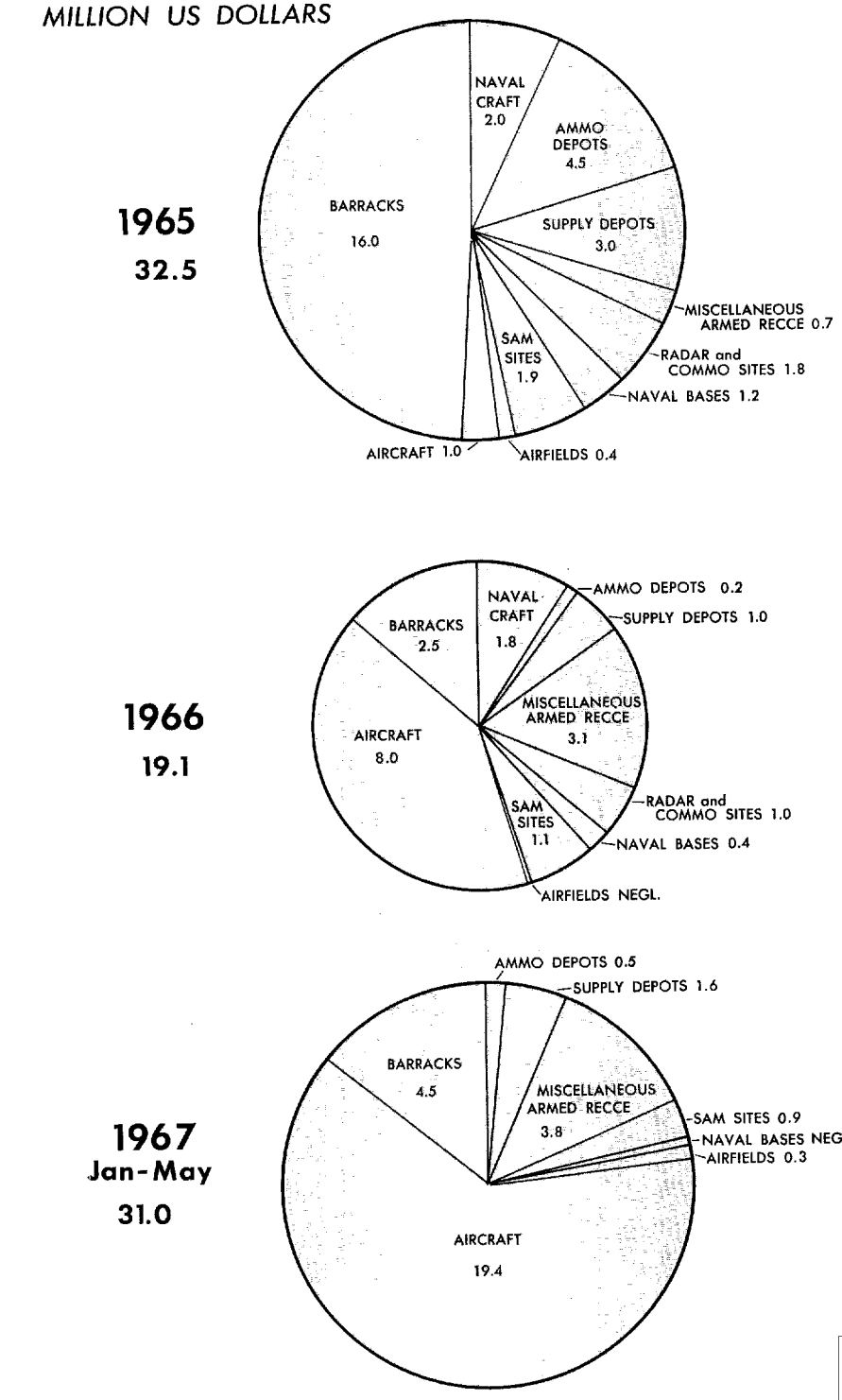

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Figure 2. Value of Military Damage in North Vietnam by Sector 1965, 1966, and January - May 1967

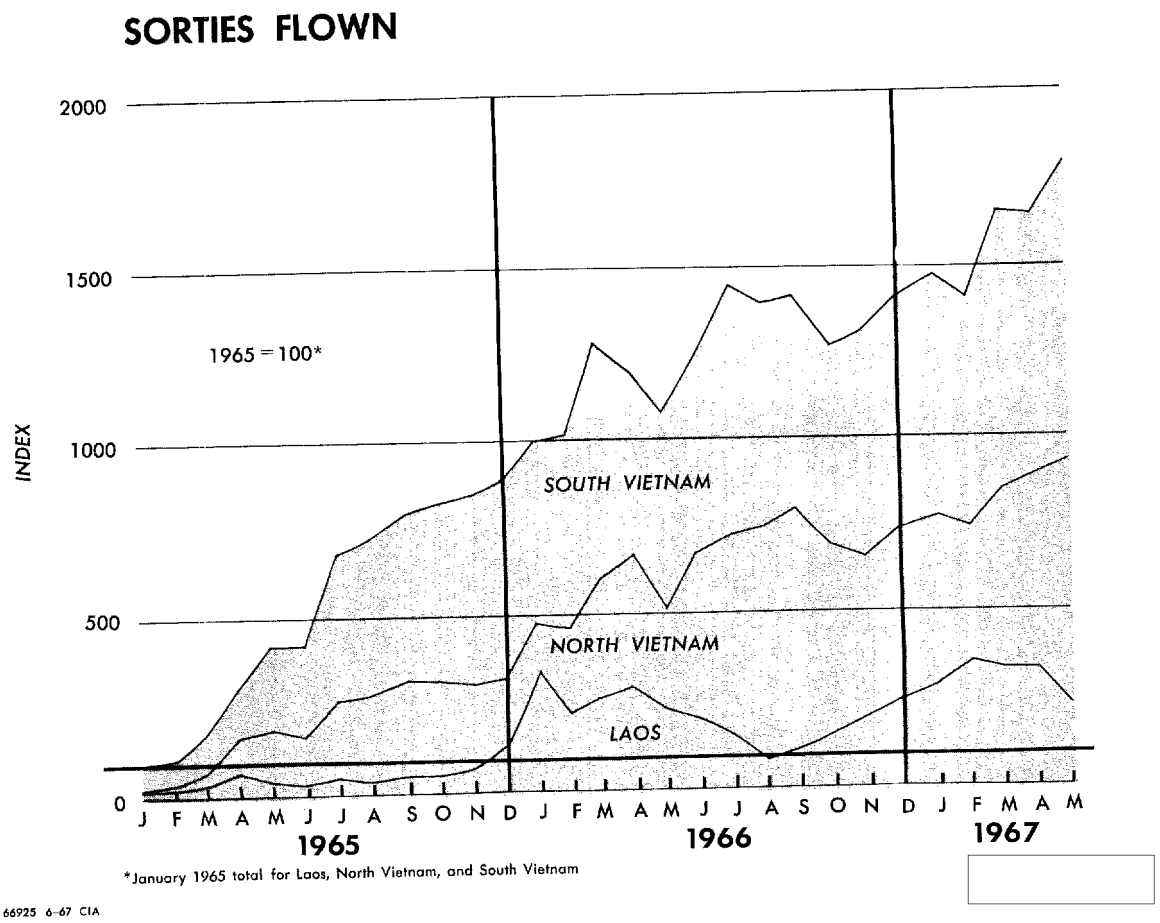

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Figure 3. Index of Sorties Flown in Southeast Asia and Relative Amounts in Each Area, 1965, 1966, and First Five Months 1967

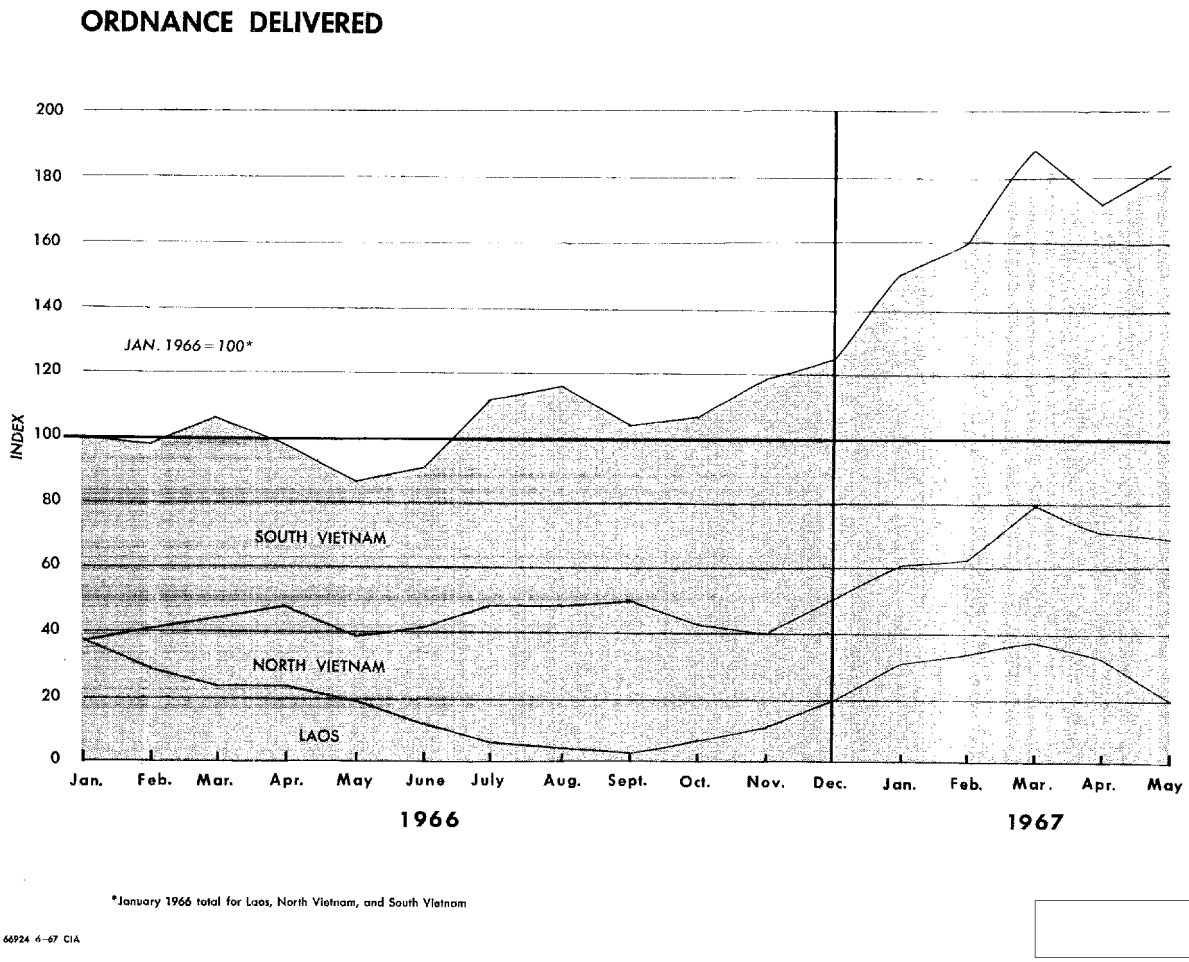

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Figure 4. Index of Ordnance Delivered in Southeast Asia and Relative Amounts in Each Area, 1966 and First Five Months 1967

I

Physical Effects

I. Physical Effects

A. General

The extension of the Rolling Thunder program during 1967 to include attacks against major industrial facilities in former sanctuary areas and against important military targets such as airfields has given new dimensions to the nature of US air operations. However, the program remains preponderantly an interdiction campaign against lines of communication and logistic targets of opportunity in the southern part of the country.

The changed scope of the bombing program has been sufficient to erode significantly North Vietnam's limited industrial base. A large number of military facilities and equipment also have been hit heavily. The increased damage inflicted on North Vietnam undoubtedly will have unfavorable repercussions, particularly in the modern industrial sector of the economy. Many of the achievements of a decade of industrial growth have been neutralized, if not lost. Programs for orderly economic development have been forgone. The allocation of limited human and material resources has been a particularly disruptive problem.

The cumulative measurable damage to economic and military target systems through May 1967 is estimated at nearly $266 million.* Nearly 70 percent of the cumulative damage has been inflicted on economic targets. A comparison of total measurable damage to economic and military target systems for 1965, 1966, and January-May 1967 is as follows:

These estimates are based on bomb damage assessments using post-strike photography available to this Agency as of 12 June 1967. This photographic coverage, with minor exceptions, includes all major targets as of the end of May 1967.

Type of Target	Million US$ 1965	1966	Jan-Mar 1967	Apr-May 1967
Economic	36.2	93.3	28.0	25.4
Military	32.5	19.1	11.9	19.1
Total	68.7	112.4	39.9	44.5

The cost of damage to both economic and military target systems has increased as the US air campaign has been directed against the more lucrative targets in the Hanoi-Haiphong area of North Vietnam. Economic damage in the first five months of 1967 has been at an average monthly rate of $10.7 million, compared with rates of $3.6 million during 1965 and $8.5 million during 1966. Military targets have sustained damage at an average monthly rate of $6.2 million during January-May 1967, compared with rates of $3.3 million during 1965 and $1.7 million during 1966. The estimated value of damage to the economic and military facilities and equipment attacked under the Rolling Thunder program through May 1967 is given in Table 1, following page 2.

Despite the rising costs inflicted by the Rolling Thunder program, the damage to North Vietnam has apparently been within acceptable limits, and the regime has continued its hard-nosed stand on negotiations. No vital part of Hanoi's military establishment has been neutralized nor has its war-supporting capability been significantly reduced. With the exception of electric power generation, the North Vietnamese have been able to devise and execute adequate countermeasures to keep most essential economic war-supporting activity going. The loss of electric power facilities is having unfavorable repercussions throughout most of the modern industrial sector. But modern industry does not play a vital part in sustaining North Vietnam's ability to continue

Table 1

Value of Economic and Military Damage Attributed
to the Rolling Thunder Program
1965 Through May 1967

Economic	Million US $	Military	Million US $
Direct Losses a/	127.2	Direct Losses	82.6
Transportation equipment	47.1	Aircraft b/	28.4
Railroad/highway bridges	25.4	Barracks	23.1
Electric powerplants	23.4	Supply depots	5.6
Manufacturing facilities	15.9	Ammunition depots	5.2
Petroleum	7.4 c/	SAM sites	3.9
Railroad yards and shops	5.2	Naval craft b/	3.8
Maritime ports	1.4	Radar sites	2.6
Miscellaneous armed reconnaissance	1.5	Naval bases	1.6
		Airfields	0.6
		Communications sites	0.2
		Miscellaneous armed reconnaissance	7.6
Indirect Losses	55.7		
Exports	21.9		
Agriculture	25.5		
Fishing	8.3		
Total, direct and indirect losses	182.9		82.6

a. Because of rounding, components may not add to the total shown.
b. Until recently, assessments of the value of aircraft and naval craft damaged or destroyed by air attack were calculated on the basis of US production costs for comparable equipment. The assessment in this report is made on the basis of Soviet foreign trade prices (prices charged for similar equipment sold to less developed countries) as those most closely approximating the true value of this equipment.
c. Midpoint of the range at $7.1 million to $7.8 million.

the war. The USSR and Communist China are underwriting most of the costs of the war by providing the military and economic aid necessary for the defense of North Vietnam and its aggression in the South. The North Vietnamese regime shows no apparent weakening in either its determination or its ability to continue with the war. Although reports of food shortages, distribution problems, and increasing hardships being borne by the people are received more frequently, popular morale is judged not to have eroded significantly.

B. Economic Damage

1. Direct Effects

The cost of direct damage inflicted on economic target systems in North Vietnam through May 1967 is estimated at over $127 million. More than one-third of this damage -- $43.9 million -- occurred in the first five months of 1967, as shown in the following tabulation:

	Million US $			
	1965	1966	Jan-Mar 1967	Apr-May 1967
Damage to economic facilities and equipment	26.8	56.5	22.9	21.0

The emphasis on the Rolling Thunder program as an interdiction campaign is reflected in the losses sustained by the several economic target systems. More than one-third -- $47.1 million -- of the estimated direct damage is accounted for by the destruction or damage of transport equipment. Destruction or damage of railroad and highway bridges amounts to $25.4 million. In terms of value, the greatest amount of damage to industrial target systems was inflicted upon the electric power industry, which lost about 80 percent of its power-generating capacity at an estimated cost of $23.4 million. The recent emphasis in attacks on modern industrial

facilities such as the Thai Nguyen Iron and Steel Complex and the Haiphong cement plant is reflected in the estimates of damage to manufacturing facilities. Direct damage to manufacturing facilities is estimated at almost $15.9 million. About 90 percent of this damage was inflicted during the first five months of 1967.

The most heavily damaged target system in terms of loss of capacity has been the petroleum storage system which has lost about 86 percent of the major bulk storage facilities existing prior to the Rolling Thunder. This loss amounted to an estimated $7.4 million. The disruptive effects of the loss of storage facilities have been offset by an elaborate system of dispersed storage and distribution of petroleum stocks.

None of the remaining economic target systems has sustained direct bomb damage to any significant extent. The physical effects of the direct bomb damage to each of the major economic target systems are discussed in the following sections.

2. Electric Power

As of 12 June 1967, airstrikes against electric power facilities in North Vietnam had put out of operation some 150,000 kilowatts (kw) of power-generating capacity, or about 80 percent of the national total (see Table 2, following P.40). This is a provisional assessment, however, as the status of several powerplants is uncertain. Capacity out of operation during May temporarily reached about 165,000 kw, but rapid restoration of the Hanoi powerplant to partial operation and probable partial operation of the Uong Bi powerplant may have reduced this figure to 125,000 to 140,000 kw by the end of May 1967. Subsequent strikes against Uong Bi appear to have again put that plant out of operation, at least temporarily. The cost of restoring damaged power facilities is estimated at $23.4 million.

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Overall damage to the Hanoi powerplant as a result of strikes on 19 and 21 May was moderate. Two of the boilers were severely damaged and two additional boilers may have been slightly damaged. The remainder of the plant, including the turbine hall and at least three boilers, apparently was undamaged.

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25X1 the plant was back in partial operation within five days of the last strike, and it is believed that some 10,000 kw (of the 32,500 kw installed) were serviceable at that time. The plant probably will be capable of operating at one-half of capacity within one month. Results of the 10 June strike are not known. Additional power reportedly was being supplied to the city by five undergound diesel generating stations. The capacity of these emergency sources of power is estimated to be around 5,000 kw. At least 25 to 30 percent of Hanoi's normal power requirement can be supplied by the 15,000 kw of capacity currently estimated to be available.

All powerplants in the main power network, which is centered on Hanoi and Haiphong, have now been struck, and most of the damage has resulted from attacks during 1967. Damage to central generating facilities has reduced serviceable capacity of the main network from 136,000 kw to between 10,000 and 15,000 kw in Hanoi, or roughly 7 to 11 percent of the pre-strike capacity of the network. In addition to damaging the Hanoi powerplant, airstrikes during January-June 1967 inflicted severe damage on powerplants at Hon Gai (with an original capacity of 15,000 kw), Thai Nguyen (24,000 kw), Viet Tri (16,000 kw), Haiphong West (10,000 kw), Haiphong East (7,000 kw), and Uong Bi (24,000 kw). Uong Bi, which apparently was restored to service in May, may again be out of operation. The time required to restore the other plants to partial operation will be a minimum of four months from the end of May, with the exception of the Haiphong East plant which will require at least one year. Complete restoration in every instance will take one year or more.

Damage inflicted by strikes on the Dong Anh transmission substation, the most important

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in the Hanoi-Haiphong network, will prevent operation of the installation for another two to three months. The results of a 22 May strike on the substation are not yet known. A powerplant at Bac Giang (12,000 kw), which is outside the main power network, was put out of operation for a minimum of three months. Results of a 12 June strike against the Thanh Hao plant (5,000 kw), another plant outside of the network, are not available.

Loss of the central generating plants has eliminated the source of supplementary power formerly received by Hanoi and Haiphong from the main transmission network. Hanoi now is dependent on one partially serviceable, local powerplant and a number of diesel generating units. Haiphong is without a central power supply and must rely on whatever mobile or stationary diesel-generating equipment is available. It is possible that a small amount of power can be transmitted from Hanoi to Haiphong via existing transmission lines.

The loss of powerplants undoubtedly has created a severe shortage of electric power and has disrupted activities that normally depend on a reliable central supply of steam and power. Many industrial processes have been fragmented or in some cases completely shut down. Although there are conflicting reports on the gravity of shortages, it seems probable that a system of power rationing was inaugurated in Hanoi during May and that even some diplomatic embassies, previously allocated high-priority service, receive power only part of the time.

Because diesel-generating equipment is available to partly offset losses, minimal power supplies for high-priority consumers will continue indefinitely. Every significant town or city, and particularly the cities of Hanoi and Haiphong, will be able to maintain a limited power supply, which in some cases may range from 10 to 15 percent of normal requirements.

The persistence of North Vietnamese efforts to restore damaged power facilities underlines the importance of central generating plants and indicates that imported diesel-driven units have not adequately compensated for loss of the central plants. Progress in reconstructing power facilities that were damaged during 1965-66 had reached a stage in May where five powerplants -- Ban Thach, Nam Dinh, Ben Thuy, Thanh Hoa, Uong Bi -- appeared either partly serviceable or almost ready for partial operation. The Thanh Hoa and Uong Bi plants were restruck in June. There has been no known attempt to repair recent damage at Hon Gai, Bac Giang, Thai Nguyen, Viet Tri, or the two plants in Haiphong. Photography suggests that two transformers in the on-site substation of the Thai Nguyen steel plant have been removed. If so, it seems likely that damage to the steel plant and to the Thai Nguyen powerplant several miles away has been severe enough to preclude indefinitely the need for a bulk power supply.

3. Petroleum Storage Facilities

On 1 January 1965, North Vietnam had a combined petroleum storage capacity of about 128,000 tons* at 13 fixed facilities that were JCS-targeted. By the end of 1966 about 85 percent of this capacity was destroyed (see Table 3, following P. 40). There were ten airstrikes against JCS-targeted facilities during the first five months of 1967. The only identified damage was inflicted on Do Son, where all of the residual capacity was destroyed -- an additional one percent of the original capacity. Damage to the Haiphong terminal as a result of attacks in 1967 was restricted to rail facilities and buildings in the terminal. No damage to tankage was observed. At the end of May 1967, therefore, a combined

** Unless otherwise indicated, tonnages are given in metric tons.*

capacity of only about 18,000 tons, or 14 percent of the original capacity, remained at seven JCS-targeted facilities.

The total value of the tankage, contents, and related facilities destroyed at JCS-targeted sites is estimated at about $6.7 million to $7.4 million. In addition, an estimated 5,000 tons of storage capacity -- including contents -- at dispersed tank sites were destroyed during 1966 with a value of about $0.4 million. Although the inventory of 55-gallon drums also has been attacked since 1965, no adequate assessment of the damage inflicted can be made. Thus the measurable damage to all petroleum facilities and contents through May 1967 is estimated at about $7.1 million to $7.8 million.

Airstrikes against JCS-targeted petroleum facilities undoubtedly have been effective when measured in terms of the storage capacity and petroleum destroyed. Although the cost and difficulty of importing and distributing petroleum have been increased, the bombing has not effectively reduced North Vietnam's capability to maintain petroleum supplies. This capability stems principally from the development of dispersed bulk oil storage capacity before extensive attacks against JCS-targeted facilities began.

By the end of May 1967, there probably were more than 100 dispersed petroleum storage tank sites in North Vietnam with a total estimated capacity of between 30,000 and 40,000 tons. The accumulation of 55 gallon drums also has given North Vietnam increased flexibility in petroleum storage and distribution. The storage capacity represented by the drum inventory at the end of May 1967 probably was between 35,000 and 40,000 tons. In addition, there is an indeterminate amount of "floating storage capacity" represented by oil barges, rail tank cars, tank trucks, and a newly assigned small tanker for use in North Vietnamese waters. Delivery procedures for petroleum imports from the USSR have been modified to provide greater flexibility in the utilization

of available petroleum storage capacity in North Vietnam. Imports are now obtained from sources of supply in the Soviet Far East -- only 5 days' sailing from North Vietnam -- as well as from the Black Sea -- almost 30 days' sailing.* For the most part, small tankers, with a carrying capacity of about 4,000 tons, are used for transport from the Far East. The relative invulnerability of the dispersed tank sites and drums makes it improbable that bombing will adversely affect the North Vietnamese capability to import and distribute petroleum.

There is no evidence that the bombing of petroleum targets has seriously weakened the economy, produced significant shortages of petroleum, or diminished North Vietnam's capability to support military activities or the infiltration of men and supplies into Laos and South Vietnam.

4. Manufacturing Facilities

The small manufacturing sector of North Vietnam has suffered important setbacks as a result of US airstrikes during the first five months of 1967. North Vietnam's industry not only is now faced by a general electric power shortage, but also the Thai Nguyen Iron and Steel Complex and the Haiphong Cement Plant -- North Vietnam's largest industrial facilities -- have been seriously damaged by bombing. The value of bomb damage, in terms of costs of repairs, to North Vietnamese manufacturing facilities through May 1967 is estimated to total $15.9 million (see Table 4, following P.40), of which $10.0 million is accounted for by damage to the steel plant and $3.0 million by damage to the cement plant, both in 1967, as shown in the following tabulation:

*In this report no attempt has been made to measure the impact of the closing of the Suez Canal on shipments to North Vietnam.

Million US $

	1965	1966	1967 Jan-Mar	1967 Apr-May	Total
Thai Nguyen Iron and Steel Complex			9.5	.5	10.0
Haiphong Cement Plant				3.0	3.0
Nam Dinh Textile Mill	0.8	0.2	0.4		1.4
Cam Pha Coal Treatment Plant		0.1			0.1
Viet Tri Paper Mill		0.1			0.1
Lang Chi Explosives Plant	0.4				0.4
Bac Giang Chemical Fertilizer Plant			0.2	0.1	0.3
Hon Gai Calcium Carbide Plant			0.1	0.1	0.2
Haiphong Enamelware Plant				0.4	0.4
Total	1.2	0.4	10.2	4.1	15.9

The costs of the bombing to the manufacturing sector in terms of lost production and loss of foreign exchange earnings probably will amount to tens of millions of dollars annually. For example, most of North Vietnam's major chemical facilities have probably been forced to curtail operations because of the damage to electric powerplants. The more intensive use of capital equipment in manufacturing and the inclusion of additional women in the labor force have mitigated some of the losses to production. Nevertheless, apparently the best that North Vietnam could claim for the chemical and coal industries -- even in 1966 -- was that they "continued operating" and

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for light industry that it "increased production of necessities and turned out new varieties of goods."

The effect of the airstrikes on North Vietnam's two major manufacturing plants has been severe. The Thai Nguyen Iron and Steel Complex has been engaged in two basic activities during the past year or more: (1) the production of pig iron for domestic use and for export, mainly to Japan; and (2) the fabrication, from imported steel, of barges, small watercraft, pontoons, petroleum storage tanks, and construction materials. Most of these fabricated products have been inputs to North Vietnam's transportation and logistics system. As a result of 15 airstrikes and the loss of electric power, the complex is believed not to be producing any pig iron and the fabrication activities have been seriously disrupted. Many months will be required to restore pig iron production and possibly the fabrication activities at the complex. It is quiet possible that pig iron production has been or will be abandoned until the cessation of air attacks on North Vietnam.

The Haiphong Cement Plant is inoperative both because of damage to the plant in airstrikes during the period 20 April - 27 May 1967 and because of the loss of electric power from the damaged Haiphong Thermal Powerplant west. Partial operation of the cement plant at about 40 percent of its capacity of 700,000 tons a year could probably be achieved in six months, coinciding with completion of repairs of the present damage to the powerplant. It is highly unlikely, however, that the North Vietnamese would restore either partial or full operation of the cement plant at the risk of a repetition of bombing. The loss of cement output will deprive North Vietnam of one of its few means of earning foreign exchange.

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25X1 North Vietnam could not supply 10,000 tons of cement requested by Cambodia, and domestic shortages in Hanoi suggest that the inventory of cement is probably now exhausted. North Vietnam will be forced to import cement for bomb damage

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repair and military construction, probably from Communist China.

It is not possible to quantify the effect on production at most of the other manufacturing facilities. No effort has been made to repair the Nam Dinh textile mill, which accounted for half of North Vietnam's weaving capacity in 1965. Much of the equipment from this mill was dispersed, however, after the first inadvertent strike in July 1965. The Cam Pha coal-treatment plant has been inadvertently struck at least three times. Although damage to this plant apparently has been minor, this damage, in combination with a shortage of power normally supplied from Hon Gai, apparently was the reason for a sharp drop in coal exports during April and May. The Viet Tri Paper Mill, the largest producer of paper in North Vietnam, was inadvertently struck in July 1966, and the damage was repaired by the end of 1966. Production may again have been disrupted by the damage to the Viet Tri powerplant in March 1967. The Lang Chi explosives plant remains inoperable from the heavy damage inflicted by airstrikes in July and August 1965. The Bac Giang Chemical Fertilizer Plant, a new large ammonium nitrate facility, probably had not even even become operational when it was struck in February 1967. It is probable that its first year of operations would in any case have been so troubled with initial technical difficulties that it would not have approached its estimated capacity of 100,000 tons. The Haiphong Enamelware Factory, a fairly large producer of household utensils, was seriously damaged inadvertently in April 1967 and may not be put back into operation while airstrikes continue. Other, minor plants have been damaged but they may already have been at least partly evacuated.

The damage already inflicted to North Vietnamese industry by the bombing undoubtedly has crushed North Vietnam's once promising hopes for a high rate of economic growth and has added to the heavy burden on economic management. Still, North Vietnam has always been a predominantly agricultural nation with an important local industry and handicraft sector providing for a large degree of self-sufficiency. Moreover, industry has played only a small role in support of the military

effort, with a great part of military and military-associated materiel being imported from North Vietnam's Communist allies. Thus the destruction of the remainder of North Vietnam's major industrial facilities -- mainly the large chemical, fertilizer, and engineering plants and the undamaged part of the cement plant -- would not add significantly to the problem of the civil population or detract significantly from the military effort. Added imports would be required, but not at a level beyond North Vietnam's present import and distribution capability.

5. Transportation

Airstrikes against the transport system of North Vietnam during the past two years have not significantly affected North Vietnam's transport capability or its ability to move supplies in support of the economy or the war effort. There have been no indications of serious supply shortages or bottlenecks. Interdictions have been effectively repaired, and the use of rail ferries, pontoon bridges, bypasses, and shuttling facilities has been effective in reducing time lost due to damage caused by airstrikes.

The capacity of nearly all major transport routes continues to be greater than the volume of traffic to be moved on the routes -- thus traffic delayed due to bombing is moved after repairs are made. Total ton-kilometer performance declined slightly during 1963-66, but the total amount of tons carried has increased from year to year as shown in the following tabulation:

	Million Ton-Kilometers			
	1963	1964	1965	1966
Railroad	847	927	770	620
Highway	164	179	200	200
Inland waterway	448	490	540	590
Coastal waterway	142	156	170	190
Total	1,601	1,752	1,700a	1,600

	Million Tons Carried			
	1963	1964	1965	1966
Railroad	3.86	4.13	3.7	3.3
Highway	6.71	7.18	7.9	7.9
Inland waterway	6.56	7.01	7.7	8.5
Coastal waterway	0.35	0.37	0.4	0.5
Total	17.48	18.69	19.7	20.2

a. Total does not add because of rounding.

Performance on the rail lines has decreased from the high in 1964, when tons carried were 4.13 million and ton-kilometers equaled 927 million. In 1966, it is estimated that 3.3 million tons were carried and that ton-kilometers reached 620 million. The decline in rail performance is attributable for the most part to the loss of apatite exports normally carried by rail to Haiphong and to the ending of Chinese rail transit traffic through North Vietnam.

Performance on highways has increased slightly, and waterway and coastal transport have shown the largest increases. The increased use of these modes of transport reflects North Vietnam's increasing reliance on means of transport which are less vulnerable to air attack.

The data on performance make it clear that the transport network is still providing adequate service to meet the country's economic and military needs.

a. Railroads

The Rolling Thunder program has had some adverse effects on the railroad system of North Vietnam, but the network generally is still capable of fulfilling the country's requirements. The destruction of the rail bridge at Viet Tri in the summer of 1966, the most significant result of the program against lines of communication during the year, reduced the capacity of the Hanoi-Lao Cai line from 3,000 to 700 tons each way per day. In addition, attacks against the rail ferry during May have probably reduced the capacity below 700 tons per day. The line south of Hanoi, which accounted for less than 5 percent of the total rail performance in North Vietnam prior to the initiation of the Rolling Thunder program, has been repeatedly attacked. Capacity has been reduced from 1,800 to 500 tons each way per day, but this capacity can seldom be used for through service because the line and rail yards are frequently interdicted. Infrequent attacks against the Hanoi-Thai Nguyen and Kep-Thai Nguyen lines have disrupted through traffic for only a day or two at a time. However, attacks against the Thai Nguyen rail yard in the first quarter of 1967 have created more severe problems for the movement of traffic on the Kep-Thai Nguyen and Hanoi-Thai Nguyen lines.

During April 1967 the Hanoi Railroad/Highway Bridge over the Canal des Rapides was struck, destroying two spans. This interdiction cut Hanoi's connection with the Lao Cai and Dong Dang lines, and pilot reports of large concentrations of rolling stock in yards on the Dong Dang and Thai Nguyen lines after the interdiction indicated that it probably effectively limited operations. Photography [redacted] however, revealed that a bypass at the site had been completed, restoring Hanoi's connection to the North.

The important line between Hanoi and Haiphong, on which most of North Vietnam's import and export materials enter and leave the country, has been open for through traffic most of the time during the Rolling Thunder program. The Hanoi-Dong Dang line, the other major import and export rail line in North Vietnam, has been only intermittently attacked during much of the Rolling Thunder program. During the last two weeks of April 1967 and all of May, however, the level of airstrikes against the line increased. The key rail yards at Vu Chua, Kep, Bac Giang, and Cao Nung were attacked, as were the bridges at Bac Giang and Dap Cau, probably disrupting traffic. The interdicted bridge at the Canal des Rapides cut the lines' connection to Hanoi for about three weeks.

Despite two years of bombing, there have been no significant adverse effects on the North Vietnamese rail system as a whole. Indeed the system has been extended and improved. The network is still able to move adequate supplies to meet the country's requirements, although hindered at times by interdictions, shuttling, and damaged yard facilities. In terms of total capacity on all lines, the system has improved slightly during the past year, as the Kep-Thai Nguyen line has been completed and dual-gauging is in progress on the lines between Hanoi and Dong Dang and Thai Nguyen.

b. Highways

Airstrikes against the highway system of North Vietnam have had no sustained effects on motor truck operations. The road system serves primarily as a short-haul feeder service for the railroads and connects areas not served by other transport facilities. The majority of the airstrikes have been concentrated in the region south of Thanh Hoa, with Routes 1A, 15, and 7 receiving the heaviest damage. Although traffic has been interrupted and slowed by frequent interdictions and the need for shuttling operations, North Vietnamese repair efforts have been effective and sufficient to maintain traffic at required levels. Route 15, near the Mu Gia Pass, however, has been repeatedly attacked and seeded

with delayed action bombs, and maintenance of traffic on this route has probably been difficult.

During May, several motor vehicle repair shops were attacked, including Kinh No, which represents 10 percent of North Vietnam's motor vehicle maintenance and repair capacity and is that country's only known armored vehicle repair shop. Strikes against the facilities at Kinh No, Cam Pha, Bac Mai, Van Dien, and the Ha Dong Army Barracks probably disrupted motor transport repairs seriously, and will force the North Vietnamese to rely more on the less efficient local shops of which they claim to have many.

Average truck traffic, as reported by ground observers, has increased significantly during the first five months of 1967, compared with that in past years. It is estimated that the tonnage delivered daily by truck into Laos during the current dry season is considerably higher than that delivered during the 1964-65 and 1965-66 dry seasons.

c. Waterways

Attacks against the waterway system in North Vietnam have not appreciably affected operations on the inland waterways or along the coast. While important transshipment areas such as Quang Khe, Dong Hoi, and Vinh have been repeatedly attacked, in many instances causing supplies to be off-loaded "over-the-beach," the system remains very flexible and capable of meeting the country's requirements because of the ability of the North Vietnamese to restore, improvise, or relocate their transfer operations.

Total sightings of watercraft by pilots and naval observers have remained at fairly constant levels -- with some minor fluctuations -- throughout the bombing, but during May reported sightings and losses increased to record levels. This increase is probably due to the increased number of sorties flown, rather than to a large increase in watercraft activity.

The mining of the Kien Giang, Song Giang, Cua Sot, Song Ca, and Song Ma rivers, all key waterways in the southern portion of the country, has probably impaired operations of larger watercraft in these areas, but has not affected activity by small craft. There are reports that two large barges were sunk by mines, but photography of the Song Ca shows small craft sailing directly through mined areas. These are probably small wooden sail boats of the type usually sighted in these areas which do not produce the proper stimuli to detonate the mines. The apparent ineffectiveness of the mines and effective North Vietnamese countermeasures have allowed operations to continue at fairly normal levels.

d. Railroad Yards and Shops

Eight comparatively important railroads yards have been attacked since the beginning of the Rolling Thunder program, four of which are JCS-targets. Two of these yards, at Gia Lam and Thai Nguyen, also have railroad repair facilities in the complex. In addition, many small yards and sidings have been attacked under miscellaneous armed reconnaissance.

The key rail yard and repair facility at Gia Lam was attacked in April 1967 in one of the most significant airstrikes against rail yards thus far in 1967. An initial readout indicates that numerous buildings and some rolling stock were destroyed. Sixteen percent of the rail car repair shop floor plan is estimated to be destroyed, as well as 27 percent of the floor plan area of support buildings. Another very significant rail yard attacked during May was Yen Vien, the largest rail classification yard in North Vietnam. The latest photography indicates that 47 percent of the floor plan area of the supporting area, 21 percent of the southwest warehouse area, and 6 percent of the northeast warehouse area was destroyed. However, the yard is operational and damage to the adjacent support areas should not seriously limit through rail capability. In general, more than 10 percent of the

national capacity of North Vietnam's railroad repair shops and over 20 percent of its rail yard capacity have been neutralized as of 31 May 1967. The minimum estimated cost of restoration of the damage inflicted on railroad yards during April and May is $3.1 million, compared to $0.8 million from January through to March 1967 (see Table 5, following P.40). The total of damage to these facilities by the Rolling Thunder program is about $5.2 million. Most of this estimate stems from the cost of repairing or reconstructing warehouses and other buildings rather than yard track. Airstrikes, in general, have resulted in only minor disruptions to through rail service, which has usually beeen restored in about 24 hours after each attack. However, the interdiction of the Canal des Rapides bridge cut Hanoi's connection to the Lao Cai and Dong Dang lines for about three weeks, until a bypass bridge at the site was completed. Adequate road and inland waterway transshipment facilities at the site maintained traffic while the bypass was being completed.

e. Maritime Ports

Six North Vietnamese ports, representing 88 percent of the country's total maritime cargo-handling capacity, have been selected as JCS-targets. Ben Thuy with 4 percent of total capacity and Ham Rong with only 1 percent of the capacity were struck in 1965. Ben Thuy has been restruck many times in both 1966 and 1967.

More significant action occurred during 1966 and 1967. During 1966 the support facilities and the coal treatment plant at Cam Pha port were attacked for the first time. During the first five months of 1967 the support facilities and coal treatment plant at Hon Gai were attacked. Damage to port facilities and related support areas through 1966 is estimated at $1.4 million (see Table 6, following P.40). Information is not available to assess the damage done in 1967.

The direct impact of this damage on North Vietnam's economy is not significant, although important indirect export losses have resulted, particularly from the attacks against Cam Pha, where 21 percent of the support facilities were destroyed at a cost of $160,000. This damage reduced the port's capacity for exporting washed and graded coal, resulting in a loss of coal exports valued at $7.6 million through May 1967. At Hon Gai, attacks in April and May against adjacent facilities reduced its capacity for exporting coal, resulting in a loss of coal export during the two months of $0.1 million.

f. Transport Equipment

Destruction and damage of all types of transport equipment by airstrikes increased during the first quarter of 1967, compared with the same period in 1966. However, the extent of destruction and damage was significantly lower than the quarterly average for 1966. Destruction and damage of trucks and watercraft increased significantly in the months of April and May. Losses of watercraft reached record highs in May and truck losses were only slightly less than the record levels of August 1966. Table 7, following P.40, which is based primarily on pilot reports and includes some duplication,* provides a general indication of the damage inflicted by type of equipment.

The estimated cost to the North Vietnamese of replacing or repairing transport equipment damaged from the initiation of airstrikes through the first five months of 1967 is estimated at $47.1 million. During May, costs were $5.5 million, only 10 percent less than the record high achieved during August 1966.

While the level of damage inflicted during 1966 and 1967 was significantly higher than in 1965, there has been no evidence of serious transport problems resulting from shortages of equipment. Imports of trucks have been sufficient to

*Data have been adjusted downward to eliminate duplication whenever possible.

maintain the inventory at previous levels. Imports of railroad rolling stock have not equaled the reported attrition rate,* but there is no indication of any problems associated with rail equipment shortages. In addition, Chinese rail equipment is available in sufficient numbers to compensate for any shortages. Destruction and damage of watercraft have not been significant in relation to the North Vietnamese watercraft inventory.

g. Bridges

The number of attacks against JCS-targeted bridges increased slightly in 1966 compared with 1965, but the number of such bridges attacked was slightly less than the 1965 total. During April and May, 77 strikes were carried out against 25 bridges, compared with 48 strikes against 18 bridges in the first quarter of 1967. Table 8, following P. 40, summarizes strikes against bridges since the beginning of the Rolling Thunder program.

The total number of bridges (both JCS-targeted and non-targeted) confirmed by available photography to have been damaged or destroyed by the Rolling Thunder program now stands at 418. In this total, which includes both original and bypass bridges, there are 306 highway, 80 railroad, and 32 combination railroad/highway structures. These figures understate somewhat the number of smaller bridges (primarily highway) that actually have been damaged or destroyed because photography may not be available for some of these bridges. The estimated cumulative cost of completely restoring the confirmed damaged or destroyed bridges to their original condition through May 1967 would be $20.9 million -- an increase of 10 percent since 31 December 1966 and better than double the estimate of 1965.** It is estimated that at least $4.5 million

Reported losses of railroad rolling stock have included many small, makeshift cars used on the rail line south of Hanoi which are not included in the inventory estimate of mainline freight cars.

**The estimated costs for restoring bridges to their original condition as of the end of 1965 and 1966 were $10.1 million and $19 million, respectively.*

have been spent already on temporary repairs to bridges through May 1967, of which an estimated $1.2 million were spent during the first five months of 1967. Estimated cost of temporary repairs to the number of unrepaired bridges at the end of May 1967 is $1.25 million.

Although estimates of what it would cost the North Vietnamese to restore bridges to their original condition or how much they have spent on temporary repairs are of value, they do not give any qualitative answer to the effects of bomb damage on bridges. Thus a survey of the 418 bridges confirmed by available photography to have been damaged or destroyed showed that 385 bridges have had one or more "serious damage occurrences" (SDO's).* There have been a total of 621 SDO's since the beginning of the bombings in February 1965 through May 1967 (see Table 9, following P.40). The number of SDO's by year and the average number of times each of the 385 bridges were interdicted are as follows:

Year	SDO's	Number of Bridges With SDO's	Average Number of Interdictions Per Damaged Bridge
1965	218	177	1.23
1966	334	185	1.81
1967 (through May)	69	23	3.00 a/

a. *The high figure for 1967 is not comparable to the earlier two periods because the time span is too short for a meaningful comparison.*

A "serious damage occurrence" consists of initial hits and re-hits and is defined as damage sufficiently severe that a crossing is denied to users until a significant amount of repairs has been performed -- requiring considerable time, materials, and labor. For example, serious damage would include a dropped span(s), a destroyed pier (s), or a destroyed abutment(s). Holes in a deck, cratered approaches, twisted superstructure, or a slight shifting of spans is not considered serious damage.

While a specific bridge may be interdicted an increasing number of times, in most cases the crossing is bypassed in a variety of ways. Of the 147 bypass bridges observed in aerial photography, 39 have sustained 65 SDO's.

6. Indirect Effects

The air campaign has also resulted in sizable losses to the economy of North Vietnam that are indirect results of the bombing. The principal indirect losses result from shortfalls in production, disruptions of normal economic activity, and the impairment of foreign exchange earnings through decreases in the quantities of goods available for export. Many of these losses cannot be quantified. The few that can -- reductions in agricultural output and the fish catch and the loss of export earnings -- totaled $55.7 million through May 1967, or about 30 percent of total economic damage. The unquantifiable losses -- production inefficiencies, the costs of dispersing industry, civil defense measures, production losses because of lack of power, the reallocation of manpower, and the like -- undoubtedly total in the tens of millions of dollars.

a. Agriculture and Fishing

Although agriculture and commercial fishing have not been direct targets of the air strikes against North Vietnam, the bombing campaign has had significant indirect effects on production. These indirect effects have resulted from the disruption of normal farming and fishing schedules, disruptions in the manufacture and distribution of fertilizers, and the loss of some managerial cadres and labor as a result of transfer to war-related activities which has intensified manpower problems during peak loads in the crop cycle. Since it is not possible to separate the effects of the bombing campaign from the effects of adverse weather on agriculture, the estimates of losses in agricultural output also include those resulting from adverse weather.

The cumulative losses in agriculture and fishing through the first five months of 1967 are estimated at about $33.8 million as shown in the following tabulation:

Million US $

Source of Revenue	1965	1966	1967 January-March	1967 April-May	Total
Rice Production	3.5	22.0	N.A.	N.A.	25.5
Fishing	1.7	3.3	2.0	1.3	8.3
Total	5.2	25.3	2.0	1.3	33.8

The shortfall in rice production is estimated to be about 300,000 tons below the normal average production of about 4.5 million tons. Although all of this loss occurred in 1966, $3.5 million is attributed to the effects of bombing in 1965 because the spring rice crop was planted in that year. The final outcome of the 1967 spring rice crop -- normally about one-third of the annual harvest -- cannot yet be evaluated. Because the acreage planted was less than usual and transplanting of the crop was delayed, the harvest probably will be below normal. The decrease in the salt-water fish catch resulted primarily from the interruption of normal fishing activities that resulted from the threat of air attacks.

Recent information indicates that shortages in agricultural production and in the fish catch have contributed to a deteriorating food situation in North Vietnam. Not only are such quality foods as salt water fish, fish sauce, and meat in short supply, but also rice rations -- the staple of the North Vietnamese diet -- have been diluted to an increasing extent with rice substitutes (corn, manioc, and sweet potatoes). Known seaborne imports of bulk foods in the first five months of 1967 -- about 178,200 tons are well over double the total imports in 1966. There are, however, no indications that the food situation has become critical, and it is believed that imports have been sufficient to prevent this.

The spring rice crop will undoubtedly give a temporary respite to the tight food situation in North Vietnam after it is harvested in May and June.

b. Export Losses

The cumulative measurable value of reductions in seaborne exports attributable to the bombing through May 1967 was about $21.9 million* as shown in the following tabulation:

	Thousand US $				
	Apatite	Pig Iron	Cement	Coal	Total
1965					
2nd quarter	665	0	192	0	857
3rd quarter	1,043	0	324	0	1,367
4th quarter	1,554	0	395	0	1,949
Subtotal	3,262	0	911	0	4,173
1966**					
1st quarter	1,554	0	205	0	1,759
2nd quarter	1,554	0	40	1,476	3,071
3rd quarter	1,457	0	244	2,192	3,893
4th quarter	1,554	0	243	1,060	2,857
Subtotal	6,118	0	733	4,729	11,580
1967					
1st quarter	1,554	0	199	1,273	3,026
April-May	1,036	49	287	1,759	3,131
Subtotal	2,590	49	486	3,032	6,157
Total	11,970	49	2,130	7,761	21,910

**Estimated dollar equivalents at f.o.b. prices.*

***Because of rounding, components may not add to the totals shown.*

Seaborne exports of apatite ceased abruptly after the interdiction of the Hanoi-Lao Cai rail line in July 1965 and when stockpiles at Haiphong became exhausted in early August. It is possible, however, that some apatite has been exported by rail from the mines near Lao Cai to China. Although known seaborne exports of cement declined after the initiation of the Rolling Thunder program, no direct connection between the program and the decline was determined until the Haiphong cement plant was put out of production in April 1967. It is possible that cement has been exported to China without being detected. Coal shipments decreased rapidly after the coal-processing facilities at Cam Pha, North Vietnam's major coal port, were damaged in April 1966 and huge stockpiles were drawn down. After a slow recovery to over half the prestrike level, exports declined sharply again in March, April and May 1967. This decline apparently resulted from the combined effects of damage to the Hon Gai powerplant, which supplies power for both the Hon Gai and Cam Pha port areas, and direct damage to coal-processing facilities. Seaborne coal shipments in May were the lowest recorded in the last 29 months. Pig iron has been added to the list of exports affected by bomb damage since it apparently is not being produced at Thai Nguyen, because of damage to auxiliary facilities and the loss of electric power. Seaborne exports of pig iron customarily fluctuate widely in response to market conditions, however, and a strong market might result in heavy shipments of pig iron from stockpiles.

C. Military Damage

The damage to military target systems through May 1967 is estimated at $82.6 million. Losses of aircraft and damage to barrack complexes comprised most of the damage, accounting for 62 percent of the total. The damage inflicted on military targets has had no significant impact on North Vietnam's military capabilities. The ammunition depots are the only military target system to have been attacked in depth. Yet the loss of about 74 percent

of ammunition storage capacity has had no measurable impact on the availability of ammunition. No other military target system has lost more than 25 percent of its pre-strike capacity. Although nearly 25 percent of the capacity of barrack facilities has been destroyed, most of the barracks attacked had been inactive by the end of 1965, the years when they were first struck. Despite the air attacks the North Vietnamese have been able to strengthen and improve the capability of most military target systems since the bombings started. Fighter aircraft facilities in North Vietnam are still sufficient to meet requirements. The inventory of SAM sites and radar and communications facilities has increased markedly since the bombings started. Although fighter aircraft losses have increased significantly in recent months, most of these losses have been made up through imports and the use of reserves in China.

The effects of the damage inflicted on military target systems are discussed in the following sections.

1. Barracks

North Vietnam had a total barracks capacity for about 443,000 men at the beginning of the bombing, of which JCS-targeted barracks had a capacity for 182,000 men. About 83 percent of the JCS-targeted barracks had been attacked by the end of May 1967, with a loss of capacity -- either destroyed or inactive -- for about 110,000 men. This loss represents about 25 percent of the total barracks capacity in North Vietnam, compared with nearly 23 percent at the end of 1966 and about 18 percent at the end of 1965. In addition, non-targeted barracks also have been struck under the miscellaneous armed reconnaissance program, but the loss of capacity resulting from this program cannot be estimated.

Airstrikes against JCS-targeted barrack complexes during the first five months of 1967 exceeded the total flown during all of 1966. The damage inflicted by these strikes is estimated at about $4.5 million, compared with $2.5 million in 1966 and $16.0 million in 1965, (see Table 10, following P.40). The increase in damage over 1966

resulted from strikes against barracks which had not been attacked before 1967. However, nearly 90 percent of the strikes in 1967 continued to be against complexes already damaged or inactive at the end of 1965.

The loss of both targeted and non-targeted barracks capacity in the outlying areas -- primarily in the southern part of the country, along the border of Laos, and in the northwestern provinces -- undoubtedly is causing much inconvenience. Damage to barrack complexes in these areas has not been repaired and the remaining barracks have usually been vacated. The troops apparently are being quartered with civilians in nearby villages, in tents, or in other makeshift shelters in the surrounding area. The North Vietnamese have had sufficient time to adjust to the loss of barracks in these areas, however, and the housing problem probably is less inconvenient now than it was at the end of 1965.

2. Airfields

Although the airfields at Kep, Haiphong/Kien An, and Hoa Lac were attacked for the first time during April-May 1967, no major change in the general capability of airfields has occurred since 1965. Kep and Kien An were operational for jets at the end of May, and Hoa Lac probably was operational, although it apparently was not being used because of its vulnerability to attack. About 19 percent of the national capacity of JCS-targeted airfields was destroyed or inactive at the end of 1965, 1966, and March 1967, compared with about 23 percent at the end of April 1967. The confirmed damage to date is estimated at only about $0.6 million (see Table 11, following P. 40).

Some fighter aircraft facilities in North Vietnam, which were inadequate at the beginning of the bombing, have been expanded significantly. The gradual expansion of the basic airfield and control apparatus apparently has been tailored to specific air defense needs to counter the Rolling Thunder program. At least five airfields -- Hanoi/Gia Lam, Phuc Yen, Kep, Haiphong/Cat Bi and Kien An -- could support MIG operations at the end of

May 1967, and an additional airfield under construction at Bai Thuong will be able to accommodate jets when it is completed. North Vietnam still can accommodate its present MIG force or even an expansion of the MIG inventory. In the event of attacks on the major airfield at Phuc Yen, the North Vietnamese can still sustain a fighter force, although less effectively, in the Hanoi area.

3. SAM Sites

From July 1965 through May 1967, approximately 630 airstrikes were directed against SAM installations in North Vietnam. The assessment of the effects of these strikes has been severely limited by the lack of post-strike photography.

The following tabulation reflects the minimum damage estimated to have been inflicted on SAM facilities:

	Thousand US $				
SAM Facilities	1965	1966	Jan-Mar 1967	Apr-May 1967	Total
Firing sites	310	900	--	600	1,810
Support facilities	1,600	170	300		2,070
Total	1,910	1,070	300	600	3,880

The attacks on the SAM sites have not significantly affected the total number of active SAM battalions, which have increased steadily and by spring 1967 totaled from 28 to 32 units. In addition, the number of prepared or pre-surveyed sites now totals at least 175.

By 31 May 1967, over 2,700 SA-2 missiles had been fired at Allied aircraft, resulting in the destruction of 64 airplanes (49 confirmed and 15 probable) and 29 reconnaissance drones.

4. Naval Bases

By the end of May 1967, nearly 20 percent of North Vietnam's naval base support facilities were destroyed or inactive, compared with about 15 percent at the end of 1965. The cumulative cost of repair for the damage inflicted is estimated at nearly $1.6 million, (see Table 12, following P. 40). It is doubtful that the damage to the naval bases has seriously affected the operations of the small North Vietnamese navy. Restoration of the damaged facilities can be accomplished quickly and without foreign assistance.

5. Radar*

North Vietnam expanded its radar system considerably during the first five months of 1967. At the end of May the country had over 180 known early warning and ground control intercept radars at 86 sites, compared with 149 known radars at 50 sites at the end of 1966. Five of these sites are JCS-targeted because of their strategic locations along the coast.

During 1965-66 the targeted sites at Hon Matt and Hon Nieu were totally destroyed, those at Vinh Son and Bach Long were damaged, and there was no significant damage to the site at My Duc. The cumulative cost of damage to these sites is estimated at $2.6 million, (see Table 13, following P. 40). The destroyed site at Hon Nieu was reactivated during the first quarter of 1967, and the sites at Vinh Son and My Duc were strengthened appreciably by the deployment of additional early warning, searchlight control, height-finding, and fire control radars. There were no known attacks against these radar sites during January-April 1967. Although the Vinh Son site was struck during May, it was not damaged.

During April and May, four radars were added to the My Duc site and a radar was installed at Hon Matt, thus reactivating the latter site. Sometime during May the radar at Hon Matt and four

**Excluding radar associated with SAM sites.*

of the radars located at My Duc stopped operating. It is not yet known if these radars were damaged or destroyed by airstrikes or if they were moved to other sites.

6. Communications

North Vietnam's telecommunications system remains operationally intact not only because relatively few facilities have been targeted and attacked but also because of large-scale imports of equipment. In fact, the overall capabilities of the system may have been improved since the beginning of the Rolling Thunder program. Radio facilities have been expanded and the message-handling capacity of the wireline system has been increased. In addition, the North Vietnamese have taken steps to reduce the potential effects of airstrikes on the telecommunications system. Newly constructed open wirelines are being placed from 150 to 600 yards away from railroads and highways, telephone poles are being pre-positioned along wireline routes, and a blast wall has been constructed around the radio broadcasting complex at Me Tri.

By the end of May 1967, the cumulative cost of the damage inflicted by airstrikes amounted to only about $185,000, of which about $105,000 occurred during 1965 and about $80,000 during 1966. No confirmed damage was inflicted on the system during the first five months of 1967.

7. Supply and Ordnance Depots

Nine of North Vietnam's JCS-targeted military supply and ordnance depots were attacked during January-May 1967, four for the first time. The most significant strike during the period was against the Thai Nguyen Army Supply Depot North which serves the area north of Hanoi and represents nearly 4 percent of the total national capacity.

Only about 17 percent of North Vietnam's supply and ordnance storage capacity was destroyed

or inactive as a result of airstrikes through May 1967. The damage inflicted is estimated at about $5.6 million. Except for the depots at Thai Nguyen, Ha Dong, and Van Dien and those at Vinh and Yen Bai (which were struck prior to 1967), the depots attacked are of relatively minor importance to the North Vietnamese Army. However, the functions that were performed by these depots are essential to maintain the infiltration system in support of activities in South Vietnam and Laos. The requirement to operate from a dispersed logistics base has probably resulted in increased management problems and reduced efficiency.

8. Ammunition Depots

During January-May 1967, five JCS-targeted ammunition depots -- Hon Gai, Vinh Yen, Haiphong, Bac Giang, and Cam Ly -- were attacked for the first time, and five additional depots were restruck. The cost of restoration of the depot at Cam Ly is estimated at $300,000 and those at Hon Gai and Haiphong at $100,000 each. There was no loss of capacity at the Vinh Yen and Bac Giang depots. By the end of May 1967, about 74 percent of the capacity of North Vietnam's JCS-targeted ammunition storage facilities had been destroyed or was inactive. The cumulative cost of the damage inflicted through May is estimated at about $5.2 million.

The loss of ammunition depots has been inconvenient to the North Vietnamese and probably has resulted in temporary delays in distribution. The loss apparently has not, however, caused prolonged shortages of ammunition in the areas where the depots are located. More than 60 percent of the targeted depots (all of which have been attacked) are inactive, however, airstrikes during the past year apparently have not significantly affected the overall storage of ammunition in North Vietnam.

9. Naval Craft

The destruction of eight North Vietnamese naval craft* has been confirmed as of May 1967: four Swatow-class gunboats in 1965 and three PT boats and one SO-1 subchaser in 1966. The cost of these losses is estimated at $3.8 million. The small North Vietnamese navy currently is estimated to include 12 Swatow-class gunboats, 4 Shanghai-class patrol boats, 15 PT boats, 3 SO-1 subchasers, and 2 unidentified naval craft.

10. Aircraft

The North Vietnamese probably lost 22 MIG-21's and at least 54 MIG-17's through May 1967 from attacks by US aircraft. Sixteen MIG-21's and at least 33 MIG-17's were destroyed during the first five months of 1967. The cost of all aircraft losses is estimated At $28.4 million, of which $7.6 million is attributed to losses during January-March 1967 and $11.8 million to losses during April-May 1967. The MIG inventory of 1 June 1967 included 16 MIG-21's and 71 MIG-15/17's. Thirty of the MIG-15/17's were still being held in China.

The North Vietnamese have made up most of their aircraft losses through the use of reserves in China and the importation of MIG-17's from China. Although North Vietnam's air force has suffered increasingly heavy losses, it has taken an aggressive role in air defense systems when vital targets are attacked. North Vietnam apparently plans to keep the jet fighter inventory at least at the present level or increase it in the future.

D. Miscellaneous Targets of Armed Reconnaissance

Most of the damage resulting from the armed reconnaissance program has been discussed in earlier

Excluding the 8 to 10 naval craft destroyed by the Pierce Arrow attacks in August 1964 following the Gulf of Tonkin incidents.

sections of this memorandum under the major categories of targets. Pilot reports, however, have indicated a variety of miscellaneous targets -- principally transport and military facilities -- as destroyed or damaged and which cannot be included in the major target categories.

Because of the nature of air operations, it is difficult to provide a definitive evaluation of the results of airstrikes based on pilot reports. There is considerable double-counting in the reports and a tendency for pilots to overestimate the amount of destruction or damage inflicted. In addition, the description of the targets is usually imprecise. The cost of damage can thus be based only on an assumed level of damage to a typical target in each category. With these limitations in mind, the total cost of replacement or restoration of the miscellaneous targets destroyed or damaged by armed reconnaissance strikes is estimated at about $9.1 million, as shown in the following tabulation:

	Million US $				
	1965	1966	Jan-Mar 1967	Apr-May 1967	Total
Economic facilities and equipment	N.A.	1.2	0.1	0.2	1.5
Military facilities	0.7	3.1	1.8	2.0	7.6
Total*	0.7	4.3	2.0	2.1	9.1

E. Manpower Effects

The effects of the Rolling Thunder program on North Vietnam's manpower resources are twofold --

*Because of rounding, components may not add to the totals shown.

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the loss of manpower as casualties to airstrikes, and the diversion of substantial amounts of manpower to tasks associated with air defense and civil defense programs and to repair, reconstruction, dispersal, and transport programs.

1. Casualties

Preliminary estimates of casualties for the first five months of 1967 demonstrate the stepped-up rate of the Rolling Thunder program. The monthly casualty rate increased from an average of 2,200 during 1966 to 3,900 in 1967. Markedly greater armed reconnaissance strikes in the more heavily populated northern Route Packages were chiefly responsible for the increase in the casualty/sortie ratio from 0.32 in 1966 to 0.47 in January-May 1967. In addition, fixed targets selected for initial strikes in 1967 were situated in heavily defended areas of greater civilian population density. Estimated casualties during 1965-May 1967 are as follows:

	1965	1966	Jan-May 1967 a/	Total
Civilians				
Fixed targets	2,000	900	1,100	4,000
Armed reconnaissance	4,000	18,100	12,800	34,900
Subtotal	6,000	19,000	13,900	38,900
Military				
Fixed targets	4,300	400	2,200	6,900
Armed reconnaissance	2,900	7,300	3,200	13,400
Subtotal	7,200	7,700	5,400	20,300
Total	13,200	26,700	19,300	59,200

a. Based on Preliminary data.

The estimates of casualties resulting from the bombing of North Vietnam are subject to unknown and conceivably large margins of error. Information from Hanoi has generally been of little value in estimating casualties. Two recent reports, however, make it reasonably certain that our estimates are of the right order of magnitude. The first report, a detailed statement from Hanoi, Report of US War Crimes in Nam Dinh City, released a number of statistics and allegations concerning the US bombing of Nam Dinh during 1965-66. The information presented in this report seemed to be accurate when measured against detailed studies made on the basis of post-strike photography. The casualties claimed by the North Vietnamese were also consistent with independent casualty estimates made by this Agency, using Nam Dinh as a pilot study. A second report in late April 1967 indicated [redacted] that only 20,000 North Vietnamese had been killed by the US bombing from August 1964 to date. This statement closely corresponds to our own estimate. We have previously estimated [redacted] that about 40 percent of the total casualties are killed and the remainder wounded. On this basis, we would estimate that slightly more than 19,000 of the total casualties through March 1967 were killed, [redacted]

Although the monthly rate of casualties continues to increase and to be heavily weighted with civilians, the total casualties are small in relation to total population. North Vietnamese Brig. General Tian Quy Hai recently wrote in Hoc Tap, "Thanks to our good preparatory work in taking precautionary measures against enemy attacks, our losses are insignificant compared with the intensity of enemy strikes." Civilian casualties continue to be primarily those involved in war-supporting activities such as the repair of bomb damage and the operation in maintenance of logistic supply lines.

2. Diversion of Manpower

Airstrikes against North Vietnam have required the services of 575,000 to 700,000 individuals -- about equally divided between full-time and part-time workers.

	Thousand Persons	
Task	Full-Time	Part-Time
LOC repair and reconstruction	72	100 to 200
Transport and dispersal	100 to 120	25
Civil defense		150
Air defense	83	25 to 30
Coast defense	20 to 25	
Total	275 to 300	300 to 405

Most of the full-time workers repairing lines of communication (LOC's) are deployed in the four Route Packages south of Hanoi which have borne the brunt of the Rolling Thunder program. In addition to these Vietnamese workers, up to 34,000 Chinese engineering troops are employed north of Hanoi to repair and reconstruct the two rail lines to China. An additional 19,000 North Vietnamese workers are estimated to be in the Laotian Panhandle expanding and repairing the infiltration corridors to South Vietnam.

Although the total manpower requirements stemming from the air war may have limited somewhat North Vietnam's capability for sustained large-scale operations in South Vietnam and to some degree contributed to a shortfall in agriculture, the diversions have not placed a relevant ceiling on North Vietnam's ability to infiltrate troops into South Vietnam. For example, the full-time requirement for 170,000 to 190,000 civilians for LOC repair and transportation-dispersal operations is only

about 4 percent of the estimated 4.3 million males in the 15 to 49 age group. Only in relatively lightly populated but heavily attacked Route Package 1 does the labor force required to counter the bomb damage account for a significant -- up to one-fourth -- share of the labor force. In this area, substantial numbers of laborers have probably been imported from other areas of North Vietnam to repair roads and speed the transport of goods.

Most of the workers perform only manual labor requiring no special skills, and they can easily be recruited from city evacuees, farms, and fishing villages with a minimum of dislocation to the economy. Other tasks such as the operation of construction machinery, bridge repair, bypass construction, and rail repair do require higher skill levels. Permanent crews to perform these types of functions impose a burden on the economy in two important ways. Because personnel possessing modern skills such as heavy equipment operation are in short supply in North Vietnam, a step-up in the bombing spreads a thin resource even thinner. Second, the logistical needs of the full-time construction personnel place an additional requirement on North Vietnam's economy for food, housing, medical services, and the like.

In addition to skilled and unskilled full-time workers, part-time personnel are used on a stand-by basis to repair LOC's, transport supplies, and serve as civil defense workers. Typically these jobs -- such as repair of craters or transloading a boxcar -- require a low-skill worker and are essentially of a "one shot" nature. The temporary absence of such laborers from their primary jobs for several hours or days causes small losses to the economy.

Although the total number of and the skill requirements for full-time and part-time workers are well within tolerable limits, the shortage of experienced cadre to plan, coordinate, and direct the ambitious and imaginative system of countermeasures which North Vietnam has devised is a more serious problem. The need for experienced and aggressive cadre in the North competes directly

with the need for military cadre in the South. The neutralization of North Vietnam's modern industrial facilities will probably free some of this scarce talent, but accelerating needs for technologically skilled personnel for operating repair services, transportation crews, and civil defense programs will probably worsen the shortage. While the intensification of air operations against transportation targets in the first five months of 1967 has increased the requirement for LOC repair workers, greater North Vietnamese experience at countermeasures and repair techniques has had the opposite effect. As long as morale remains high and imports of necessary equipment continue, North Vietnam will not be faced with a crippling shortage of labor, either skilled or unskilled, unless losses in the South increase sharply.

Table 2

Electric Power Facilities Attacked in North Vietnam
1965, 1966, and January - 12 June 1967

25X1 25X5 25X1

JCS Target Number	Name	Pre-Strike Target Capacity (Kilowatts)	Target Capacity as a Percent of National Capacity a/	Dates of Strikes	Percent of Target Capacity Currently Out of Operation	Percent of National Capacity Currently Out of Operation	Cost of Restoration Attributed to Each Strike (Million US $) b/	Remarks
1965								
	Thanh Hoa	5,000	3	4 Apr			0.2	
				27 Jul				
				29 Jul				
				30 Jul				
				31 Jul				
				4 Aug	100	3	0.9	Further damage in September 1966.
1	Ben Thuy	8,000	5	4 Jun			0.3	Additional strikes in 1966.
				4 Jun	100	5	0.7	
3	Co Dinh	1,500	1	8 Jun			0.2	No attempt to restore plant. Additional strike in 1966.
				10 Jun	100	1	0.2	
5	Nam Dinh	7,500	4	28 Jun			0.2	Reconstruction halted in late 1966 before plant was serviceable. Could be put in partial operation in two months.
				29 Jun			0.3	
				2 Aug			0.3	
				3 Aug	100	4	1.2	
	Ban Thach	1,000	0.5	21 Aug				No attempt to restore plant until first half of 1967. Possibly in operation in April 1967.
				22 Aug			0.1	
				23 Aug	100	0.5	0.2	
	Uong Bi	24,000	14	15 Dec				Out of operation until March 1966. Additional strikes in 1966 and 1967.
				20 Dec				
				22 Dec				
				22 Dec	100	14	1.5	
	Subtotal: 1965						6.3	

Table 2

Electric Power Facilities Attacked in North Vietnam
1965, 1966, and January - 12 June 1967
(Continued)

25X5

JCS Target Number	Name	Pre-Strike Target Capacity (Kilowatts)	Target Capacity as a Percent of National Capacity a/	Dates of Strikes	Percent of Target Capacity Currently Out of Operation	Percent of National Capacity Currently Out of Operation	Cost of Restoration Attributed to Each Strike (Million US $) b/	Remarks
1966								
	Uong Bi	24,000	13	18 Apr			0.1	Smokestack destroyed. Out of operation until [redacted] 25X1
				28 Apr 11 Aug	100	13	4.3	No additional damage. Severe damage to 24,000 kw operating plus an additional 24,000 kw being installed.
				14 Aug 17 Aug				No additional damage. No additional damage. Little evidence of reconstruction in [redacted] 25X1
	Thai Nguyen	24,000	13	6-8 Jul	50	6	0.8	First strike. 12,000 kw of capacity out of operation. Additional strikes in 1967.
	Viet Tri	16,000	9	Prior to 19 Jul	0	0		First strike. Damage negligible. Additional strikes in 1967.
	Ben Thuy	8,000	4	13 Mar 15 Mar	100	4		Plant already out of operation. No additional damage.
				23 Oct 26 Oct 26 Oct 27 Oct 28 Oct 29 Oct	100	4	0.2	Plant restored to partial operation early October 1966. Plant possibly partly serviceable in [redacted] 25X1
	Thanh Hoa	5,000	3	22 Sep 23 Sep 23 Sep 23 Sep	100	3	0.4	Restoration in progress but plant not believed to be operating. Smoke from stack on [redacted] but none on [redacted] indicating probable testing for startup. 25X1 25X1 Additional strike in 1967.

Table 2

Electric Power Facilities Attacked in North Vietnam
1965, 1966, and January - 12 June 1967
(Continued)

JCS Target Number	Name	Pre-Strike Target Capacity (Kilowatts)	Target Capacity as a Percent of National Capacity [a]	Dates of Strikes	Percent of Target Capacity Currently Out of Operation	Percent of National Capacity Currently Out of Operation	Cost of Restoration Attributed to Each Strike (Million US $) [b]	Remarks
1966 (Continued)								
	Trinh Xuyen Substation	N.A.	N.A.	1 Nov				Substation under construction, almost ready for operation in [redacted] Photography not available for post-strike assessment.
[redacted]	Co Dinh	1,500	1	4 Nov	100	1	0.4	Plant out of operation at time of strike. Photography of [redacted] indicates almost total destruction. No evidence of reconstruction.
	Subtotal: 1966						6.2	
Jan-Jun 1967								
[redacted]	Hon Gai	15,000	8	24 Feb				No damage from February strikes.
				25 Feb				
				2 Mar			0.4	Moderate damage.
				10 Mar	100	8	1.8	Heavy damage to boilerhouse, substation, and coal-processing building. Estimate minimum of four months to partial operation, over one year for completed restoration.
				20 Apr				
				22 Apr				Photography not available for post-strike assessment.

Table 2

Electric Power Facilities Attacked in North Vietnam
1965, 1966, and January - 12 June 1967
(Continued)

25X1 25X5 25X1

JCS Target Number	Name	Pre-Strike Target Capacity (Kilowatts)	Target Capacity as a Percent of National Capacity [a]	Dates of Strikes	Percent of Target Capacity Currently Out of Operation	Percent of National Capacity Currently Out of Operation	Cost of Restoration Attributed to Each Strike (Million US $) [b]	Remarks
Jan-Jun 1967 (Continued)								
[redacted]	Bac Giang	12,000	6	24 Feb 26 Feb 11 Mar 16 Mar 24 Mar 5 Apr 10 May 20 May 22 May	100	6	0.5	Cumulative damage: probable moderate damage to boilerhouse, operator hall, and switchyard, and destruction of coal-processing building. No attempt to repair damage and no additional damage apparent since [redacted] Estimated minimum of three months for partial operation and six months more for complete restoration.
	Viet Tri	16,000	9	12 Mar 19 Mar	100	9	2.8	Extent of damage unknown. Probable destruction of 3 of 4 turbines, severe damage to 4 of 6 boilers, and severe damage to coal-processing building. Estimate minimum of 4 months to partial operation, and 2 years for complete restoration.

25X1

Table 2

Electric Power Facilities Attacked in North Vietnam
1965, 1966, and January - 12 June 1967
(Continued)

25X5

JCS Target Number	Name	Pre-Strike Target Capacity (Kilowatts)	Target Capacity as a Percent of National Capacity a/	Dates of Strikes	Percent of Target Capacity Currently Out of Operation	Percent of National Capacity Currently Out of Operation	Cost of Restoration Attributed to Each Strike (Million US $) b/	Remarks
Jan-Jun 1967 (Continued)								
	Thai Nguyen	24,000	13	19 Mar 23 Mar 24 Mar	100	13	1.5	Severe damage to 2 boilers, moderate damage to a third. No attempt to repair plant since March. Estimate minimum of 4 months for partial operation, over one year for complete restoration.
	Haiphong West	10,000	5	20 Apr 25 Apr 10 May 20 May 26 May	100	5	1.1 0.5	Damage to cooling tower and support building. Cumulative damage: severe damage to 7 of 9 boilers, probable heavy damage to turbine hall, heavy damage to coal-processing building and cooling towers. Estimate minimum of six months for partial operation and two years for complete restoration.
	Haiphong East	7,000	4	20 Apr 21 Apr 10 May	100	4	1.0 0.3	Destruction of boilerhouse, POL storage, and heavy damage to turbine building. Estimate totally unserviceable for at least one year.

Table 2

Electric Power Facilities Attacked in North Vietnam
1965, 1966, and January - 12 June 1967
(Continued)

25X5

JCS Target Number	Name	Pre-Strike Target Capacity (Kilowatts)	Target Capacity as a Percent of National Capacity a/	Dates of Strikes	Percent of Target Capacity Currently Out of Operation	Percent of National Capacity Currently Out of Operation	Cost of Restoration Attributed to Each Strike (Million US $) b/	Remarks
Jan-Jun 1967 (Continued)								
	Don Anh Substation	N.A.	N.A.	25 Apr 26 Apr			0.2	Part of switchyard destroyed, possible damage to main control building and to transformer. Estimated three to four months to restore to partial service.
				4 May 22 May				No additional damage from 4 May strike. Recent post-strike photography not available.
	Hanoi	32,500	17	19 May 21 May 10 Jun	65	11	0.8	Probably heavy damage to 2 of at least 7 boilers and to control building. Plant rapidly restored to partial operation at about one-third of capacity. Results of 10 June strike not available.
	Uong Bi	24,000	13	26 May 8 Jun 11 Jun	100	13		Negligible damage. Reported heavy damage from last strike; details not available. Probably entire plant out of operation at least temporarily.
	Thanh Hoa	5,000	3	12 Jun				Probable damage. Post-strike photography not available.
	Subtotal: Jan-Jun 1967						10.9	
	Total					80 c/	23.4	

a. Based on national installed capacity of 175,000 kw in 1965 and on 187,000 kw in 1966 and 1967.
b. Lack of an entry indicates either no damage or no information available to make estimate.
c. Because of the uncertain status of several plants, this percentage is provisional.

Table 3

Petroleum Storage Facilities Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967

JCS Target Number	Name	Target as a Percent of Total Targeted Capacity	Dates of Attack	Percent of Target Capacity Destroyed	Percent of Total Targeted Capacity Destroyed	Cost of Restoration (Thousand US $)	Value of Petroleum Destroyed (Thousand US $)
1965							
	Phu Van	Negl.	6 May	100	Negl.	40	20
	Vinh a/	6	24, 26 May	34	2	120	70
			11, 15 Sep	34	2	120	70
			6 Oct	17	1	60	30
	Nam Dinh	9	2, 4 Jul	100	9	500	270
	Phu Qui	6	18 May	100	6	340	0
	Subtotal: 1965				20	1,180	460
1966							
	Haiphong	32	29 Jun	46	14	840	300 to 460
			7 Jul	32	10	600	190 to 310
			2 Aug	21	7	380	80 to 150
	Hanoi	24	29 Jun	100	24	1,380	490 to 760
	Vinh a/		30 Jul				
			7, 8 Aug				
			6 Sep				
			8, 11, 13, 27, 28, 29 Oct				
	Nguyen Khe	6	30 Jun	10			
			19 Jul				
			17, 18, 22 Aug	22	2	112	39 to 60
			4 Sep				
			8 Oct				

Table 3

Petroleum Storage Facilities Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967
(Continued)

JCS Target Number	Name	Target as a Percent of Total Targeted Capacity	Dates of Attack	Percent of Target Capacity Destroyed	Percent of Total Targeted Capacity Destroyed	Cost of Restoration (Thousand US $)	Value of Petroleum Destroyed (Thousand US $)
1966 (Continued)							
	Bac Giang	2	30 Jun 31 Jul 11 Aug 14 Sep	31	0.6	32	11 to 17
	Do Son	2	29 Jun 3 Jul 5, 8, 10, 14, 15, 17, 22 Aug 12, 22 Oct 1 Nov	50	1	64	16 to 35
	Viet Tri	1	30 Jun 19 Jul 14 Aug 5 Sep	97	1	0 2 0 0	0 1 to 2 0 0
	Duong Nham	3	1, 12, 23 Jul 17, 22 Aug 12 Sep	100	3	185	16 to 25 24 to 50
	Ha Gia	8	22 Nov 2, 3, 4, 5, 19, 30 Dec	22	2	99	0
	Can Thon	1	23 Nov 2 Dec 3 Dec	33	0.4	37	20
	Phu Qui b/		8 Aug 11 Oct				
	Subtotal: 1966				65	3,731	1,187 to 1,889
	Total: 1965 and 1966				85	4,911	1,647 to 2,349

Table 3

Petroleum Storage Facilities Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967
(Continued)

JCS Target Number	Name	Target as a Percent of Total Targeted Capacity	Dates of Attack	Percent of Target Capacity Destroyed	Percent of Total Targeted Capacity Destroyed	Cost of Restoration (Thousand US $)	Value of Petroleum Destroyed (Thousand US $)
January-March 1967							
[redacted]	Vinh a/		7 Feb				
	Ha Gia c/		15 Feb				
	Do Son d/	2	5 Mar	50	1	64	35
	Subtotal: First quarter of 1967				1	64	35
April-May 1967							
[redacted]	Vinh a/		13,14, 15, 16 Apr				
	Haiphong e/		26 Apr 2 May				
	Phu Qui b/		20 May				
	Subtotal: April-May 1967				0	0	0
	Total: 1965, 1966, and first five months of 1967				86	4,975	1,682 to 2,384

a. The facility at Vinh was attacked in August 1964, prior to the Rolling Thunder program. Vinh was attacked ten times in 1966 and five times in 1967, but no destruction of storage capacity has been identified since 1965.
b. The facility at Phu Qui was 100 percent destroyed in May 1965 and apparently has been abandoned.
c. Ha Gia has been attacked in 1966; available post-strike photography indicates that the destroyed tankage did not contain petroleum.
d. Do Son had been attacked in 1966; the facility is now 100 percent destroyed.
e. The facility at Haiphong had not been attacked since 2 August 1966. Photography of early 1967 revealed that storage tanks previously considered to be serviceable were being dismantled. For purposes of this table, the dismantled tanks and their contents are considered to have been destroyed in the 2 August attack.

Table 4

Manufacturing Facilities Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967

JCS Target Number	Name	Target as a Percent of National Capacity	Dates of Attack	Percent of Target Capacity Destroyed	Percent of National Capacity Destroyed or Inactive	Cost of Restoration (Thousand US $)
1965						
[redacted]	Lang Chi Explosive Plant	100	24 July 7, 8 August	71	71	370
	Nam Dinh Textile Mill	Cotton Spinning: 70 to 75 Cotton Weaving: 50	28 July	5	Spinning Inactive: 60 Weaving Inactive: 40	800
	Subtotal: 1965					1,170
1966						
	Cam Pha Coal Treatment Plant	N.A.	April November	N.A.	N.A.	75
	Viet Tri Paper Mill	80	Mid-July	100 a/	80 a/	100
	Nam Dinh Textile Mill		Oct-Dec b/	c/	c/	250
	Subtotal: 1966					425
January-March 1967						
	Nam Dinh Textile Mill		January	c/	c/	350
	Cam Pha Coal Treatment Plant	N.A.	February	N.A.	N.A.	Negl.
[redacted]	Bac Giang Chemical Fertilizer Plant	37 d/	24, 25 February 11, 16 March	N.A.	N.A.	240

Table 4

Manufacturing Facilities Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967
(Continued)

JCS Target Number	Name	Target as a Percent of National Capacity	Dates of Attack	Percent of Target Capacity Destroyed	Percent of National Capacity Destroyed or Inactive	Cost of Restoration (Thousand US $)
January-March 1967 (Continued)						
	Hon Gai Calcium Carbide Plant	N.A.	9, 12, 13 March	N.A.	N.A.	100
	Thai Nguyen Iron and Steel Complex	95 e/	10, 11, 18, 21 25, 26, 30 March	N.A.	N.A.	9,500
	Subtotal: January-March 1967					10,190
April-May 1967						
	Thai Nguyen Iron and Steel Complex		7, 10, 18, 23 April 1, 4, 10, 27 May	N.A.	N.A.	500
	Hon Gai Calcium Carbide Plant	N.A.	16, 17 April	75	N.A.	100
	Haiphong Cement Plant	95	20, 25 April 7, 27 May	70 (Inactive)	95	3,050
	Haiphong Enamelware Plant	N.A.	April	35	N.A.	360
	Bac Giang Chemical Fertilizer Plant	37 d/	20, 22 May	2 (Inactive)	37	60
	Subtotal: April-May 1967					4,070
	Total					15,855

a. Restored to operation by the end of 1966, but operation probably was again disrupted in March 1967 by strike on the Viet Tri Powerplant.
b. Two strikes within the period.
c. Unknown. Relocation of much of the mill's equipment is believed to have permitted restoration of perhaps a significant share of national capacity.
d. Percent of chemical fertilizer capacity (excluding apatite and phosphate rock). This plant represents total national capacity for nitrogen fertilizer production.
e. Pig iron only. It is not possible to determine the plant's relative share of fabrication work.

Table 5

Major Railroad Yards and Railroad Shops Attacked Under the Rolling Thunder Program
1965-66, First Quarter of 1967, and April-May 1967

JCS Target Number	Name	Dates of Attack	Damage	Cost of Restoration (Thousand US $)
1965				25X5
[redacted]	Vinh Classification Yard N.W.	26, 27 May	Main line interdicted in four places; four sidings interdicted	
	Nam Dinh Yard	1 Jun 2, 4 Aug 20 Sep	Damage to switching wye, rail sidings, tracks, and buildings	70
	Yen Bai Yard	11, 13, 14 Jul	Damage to rolling stock; lines interdicted in numerous places	
	Ninh Binh	26, 27, 28, 30 Sep 1 Oct	Cratered	
	Subtotal: 1965			70
1966				
[redacted]	Vinh Classification Yard N.W.	18 Feb 4, 24 Apr 1, 22 May 9 Jul 20, 27, 29, 31 Dec	75 percent of capacity destroyed as of the end of 1966	N.A.
	Thai Nguyen Railroad Station Yard and Shops	29 Apr 5, 8, 22 May 10 Jun 2 Aug	20 percent of capacity destroyed as of the end of 1966	400
	Yen Bai Yard	23 Apr 27 Jun 5 Dec	Cratered. At least 20 railroad cars destroyed	N.A.
	Thanh Hoa Yard	12, 13, 19 May 1, 12, 23 Jun 22 Jul 18, 21 Aug 21, 23, 24, 25 Sep 1, 2 Oct 21, 22, 23, 31 Dec	Approximately 50 percent of capacity destroyed at end of 1966	N.A.

25X1

25X1

25X5

Table 5

Major Railroad Yards and Railroad Shops Attacked Under the Rolling Thunder Program
1965-66, First Quarter of 1967, and April-May 1967
(Continued)

JCS Target Number	Name	Dates of Attack	Damage	Cost of Restoration (Thousand US $)
1966 (Continued)				
25X1	Nam Dinh Yard	14, 18, 31 May 12 Jun 9, 24 Aug 14 Sep 26, 29 Oct 10, 13, 23, 28, 29, 31 Dec	Cratered	N.A. 25X1
	Yen Vien Railroad Classification Yard	4, 13, 14 Dec	5 percent of capacity destroyed as of the end of 1966	420
	Hanoi Railroad Car Repair Shops and Classification Yard, Gia Lam	14 Dec	3 support buildings destroyed and 1 severely damaged, 1 warehouse destroyed and 1 severely damaged, 1 possible repair shop destroyed, and 2 unidentified buildings destroyed 6 percent of capacity destroyed as of the end of 1966.	400
	Ninh Binh	14, 16, 18, 24, 25 Sep 25, 27, 28 Oct 22 Nov 18, 19, 20, 31 Dec	Cratered	N.A.
	Subtotal: 1966			1,220
January-March 1967				
	Vinh Classification Yard N.W.	5, 7, 8, 9, 14 Jan 25, 27 Feb 1, 3, 12 Mar	50 percent of capacity destroyed as of 31 March 1967.	N.A. 25X5
	Thai Nguyen Railroad Station Yard and Shops	17, 29 Jan 3 Feb	90 percent of rail yard capacity and 50 percent of repair facility destroyed as of 31 March 1967.	770

Table 5

Major Railroad Yards and Railroad Shops Attacked Under the Rolling Thunder Program
1965-66, First Quarter of 1967, and April-May 1967
(Continued)

JCS Target Number	Name	Dates of Attack	Damage	Cost of Restoration (Thousand US $)
January-March 1967 (Continued)				
	Thanh Hoa Yard	10, 28, 29 Jan 2, 4, 5, 14, 18 Feb 6, 7, 13, 21, 23 Mar	100 percent of capacity destroyed as of 31 March 1967.	N.A.
	Nam Dinh Yard	10, 13, 25 Jan 6, 14, 26 Feb 5, 6, 13, 14, 16 Mar	Cratered	N.A.
	Ninh Binh	5, 6, 14, 21, 22, 26 Jan 18 Feb 12, 16, 23 Mar	Cratered	N.A.
	Subtotal: January-March 1967			770
April-May 1967				
	Vinh Classification Yard	1, 4, 6, 13, 16, 24, 25, 26 Apr 5, 7 May		N.A.
	Thai Nguyen Railroad Station Yard and Shops	18, 30 Apr 2, 21, 24 May		N.A.
	Thanh Hoa Yard	13, 14, 16, 17, 18, 21 Apr 25, 26 May		N.A.
	Nam Dinh Yard	19 Apr 2, 7, 17, 22, 24, 25 May	Approximately 30 percent destroyed as of 31 May. No through capability.	N.A.

Table 5

Major Railroad Yards and Railroad Shops Attacked Under the Rolling Thunder Program
1965-66, First Quarter of 1967, and April-May 1967
(Continued)

JCS Target Number	Name	Dates of Attack	Damage	Cost of Restoration (Thousand US $)
April-May 1967 (Continued)				25X5
25X1				25X1
	Hanoi Railroad Car Repair Shops and Classification Yard, Gia Lam	25, 28 Apr	16 percent of floor plan area of repair facilities and 27 percent of floor plan area of support buildings destroyed	1,440
	Yen Vien Railroad Classification Yard	5, 13, 20 May	47 percent of support floor plan area destroyed/dismantled. 21 percent of SW warehouse area destroyed/dismantled. 6 percent of NE warehouse area destroyed/dismantled.	1,660
	Ninh Binh	16, 28 Apr 8, 12, 14, 17, 20, 25 May		N.A.
	Subtotal: April-May 1967			3,100
	Total			5,160

Table 6

Maritime Ports Attacked Under the Rolling Thunder Program
1965 and 1966
First Quarter of 1967 and April-May 1967

JCS Target Number	Name	Percent of National Maritime Cargo-Handling Capacity	Dates of Attack	Percent of Target Capacity Destroyed	Percent of National Cargo Handling Capacity Destroyed	Cost of Restoration (Thousand US $)
1965						
[redacted]	Ben Thuy	4	5, 6, 8 Jun 9, 10, 11, 17, 19, 21 Jul	61	2.4	470
	Ham Rong	1	14, 16, 18 Jul	15	0.2	190
	Subtotal: 1965					660
1966						
[redacted]	Ben Thuy	4	1 Feb 8 Mar 30, 31 Oct 4, 9 Nov 6 Dec	85	3.4	590
	Cam Pha Port a/	16	24 Apr 8 Nov	21	3.4	160
	Subtotal: 1966					750
Jan-Mar 1967						
[redacted]	Ben Thuy	4	7, 9, 14, 23 Jan b/	85	3.4	N.A.
Apr-May 1967						
	Hon Gai a/		24, 25, 26 Apr b/ 24, 25, 26 May			N.A.
	Total					1,410

a. Strikes were not conducted against port facilities but against related areas such as coal-treatment facilities which affected port operations and resulted in export losses. Estimated cost at Cam Pha is the cost of damage to support areas.
b. Because of incomplete post-strike bomb damage assessment, total damage has not been estimated.

Table 7

North Vietnam: Destruction and Damage of Transport Equipment
1965-66, First Quarter 1967, and April-May 1967

25X1 25X1

Units

Type of Equipment	1965 - 10 Months		1966 - 12 Months		Quarterly Average 1966		First Quarter 1967		April-May 1967	
	Destroyed	Damaged	Destroyed	Damaged	Destroyed	Damaged	Destroyed	Damaged	Destroyed	Damaged
Locomotives	6	6	10	14	2.5	3.5	0	0	0	6
Rail freight cars	227	592	1,101	935	275	234	61	84	84	271
Trucks	318	487	1,935	1,801	484	450	178	172	487	313
Ferries	53	56	67	131	17	33	0	1	0	4
Barges	263	487	2,520	4,289	630	1,072	453	1,313	1,093	1,788
Other watercraft	144	210	867	1,372	217	343	79	234	31	31

25X1

Table 8

25X1

Strikes Against JCS-Targeted Bridges
1965, 1966, and January-May 1967

	1965		1966 a/		January-March 1967 a/		April-May 1967 a/	
	Strikes	Bridges	Strikes	Bridges	Strikes	Bridges	Strikes	Bridges
Rail and Rail/Highway	67	14	110	16	20	6	38	11
Highway	77	30	76	23	28	12	39	14
Total	144	44	186	39	48	18	77	25

a. Including bridges struck initially before the time period.

Table 9

Bomb Damage Assessment of Bridges in North Vietnam a/
1965 - May 1967

25X1

25X1

Type of Bridge	Bridges Damaged			Total Serious Damage Occurrences (Including Initial Hits and Re-hits)		
	Total	Seriously	Moderately	Total	Original Bridge	Bypass Bridge
Total	418	385	33	621	556	65
Highway	306	276	30	424	405	19
Railroad	80	79	1	144	112	32
Combination Railroad-Highway	32	30	2	53	39	14

a. Damage to bridges confirmed by available photography.

Table 10

Barracks Attacked Under the Rolling Thunder Program a/
January-May 1967

JCS Target Number	Name	Percent of Targeted National Capacity	Dates of Attack	Percent of Target Capacity Destroyed as of			Cost of Restoration for Damage Inflicted (Thousand US $)	
				End 1965	End 1966	1 May 1967	Jan-Mar 1967	Apr-May 1967
	Xuan Mai Army Bks SSW	1.2	19 Apr (initial strike), 20 Apr	b/	b/	64	0	950
	Xuan Mai Army Bks NNW, Hoa Muc	0.3	5 Feb (initial strike)	b/	b/	13	220	0
	Son La Army Bks/Hq Mil Reg NW/Sup Dep	2.0	26 Mar; 2, 3, 8, 9, 14 Apr; 3, 7, 9 May	52	61	61	0	0
	Ha Dong Army Bks/Supply Depot	1.1	5 May (initial strike), 12, 14, 22 May	b/	b/	b/	0	N.A.
	Vinh Yen Army Bks/Training Area N	0.7	13 May (initial strike), 25 May	b/	b/	b/	0	1,300
	Chap Le Army Bks NW	0.3	24 Jan; 4, 10, 12, 13, 23, 24, 25, 28 Mar; 4, 9, 21, 27 Apr	36 (inactive)	36 (inactive)	36 (inactive)	0	0
	Ben Quang Army Bks SW	0.5	29 Jan; 2 Feb; 5, 6, 7, 9, 12, 14, 20, 21, 21, 23, 25, 26 Mar; 2, 3, 4, 7, 13, 22, 25 Apr	66 (inactive)	96 (inactive)	96 (inactive)	0	0
	Phu Le Army Bks/Supply Depot	0.3	6 Feb	48 (inactive)	48 (inactive)	48 (inactive)	0	0
	Vinh Linh Army Bks Cent NE	0.3	25, 28 Jan; 1 Feb; 4, 6, 7, 10, 10, 11, 11, 16, 17, 19, 24 Mar; 4, 9, 10, 10 Apr	39 (inactive)	52 (inactive)	52 (inactive)	0	0
	Thanh Hoa Army Bks S	0.3	24, 31 Jan; 2 Feb	36 (inactive)	36 (inactive)	36 (inactive)	0	0

25X1 25X1 25X5

Table 10

Barracks Attacked Under the Rolling Thunder Program a/
January-May 1967
(Continued)

JCS Target Number	Name	Percent of Targeted National Capacity	Dates of Attack	Percent of Target Capacity Destroyed as of			Cost of Restoration for Damage Inflicted (Thousand US $)	
				End 1965	End 1966	1 May 1967	Jan-Mar 1967	Apr-May 1967
25X1	Mu Gia Pass Supply/Staging Point	0.1	6, 31 Jan	74 (inactive)	74 (inactive)	74 (inactive)	0	0
	Xom Bang Army Bks E	0.2	7, 8, 9, 12, 17, 22, 24, 27 Mar; 7, 7 Apr	97 (inactive)	97 (inactive)	97 (inactive)	0	0
	Vinh Army Bks NW/Supply Depot	0.9	29 Apr	53	93 (inactive)	93 (inactive)	0	0
	Kep Army Bks S	0.7	19 May (initial strike), 31 May	b/	b/	b/	0	330
	Chi Ne Army Bks	0.7	1 Mar (initial strike), 24 Mar; 3 May	b/	b/	35	N.A.	1,550 c/
	Quang Khe Army Bks	0.2	21 Feb; 25 Apr; 11, 25, 31 May	0	0	17	165	N.A.
	Vinh Linh Army Bks E, Lien Cong	0.2	7, 11, 11, 19, 24, 29, 29 Mar; 7, 11, 12 Apr	90 (inactive)	90 (inactive)	90 (inactive)	0	0
	Vinh Linh Army Bks NW, Xon Cho	0.3	10, 19, 29, 30 Mar; 30 Apr	87 (inactive)	87 (inactive)	87 (inactive)	0	0
	Van Dien Army Supply Depot	1.9	19 May (initial strike)	b/	b/	b/	0	N.A.
	Subtotal						385	4,130
	Total: January-May 1967							4,515
	Total: 1966							2,545
	Total: 1965							16,000
	Grand total							23,060

25X1 25X5

a. Cost of damage to non-targeted barracks is given under "Miscellaneous Targets of Armed Reconnaissance."
b. Facility not struck.
c. Total damage inflicted, including that from strikes in March.

Table 11

Airfields Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967

JCS Target Number	Name	Target as a Percent of National Targeted Capacity	Dates of Attack	Percent of Target Utility Destroyed	Cumulative Percent of National Targeted Capacity Destroyed or Inactive	Cost of Restoration (Thousand US $)
1965						
[redacted]	Ha San	4	25 Jun; 23 Sep; 24 Oct	45 (inactive)	4	144
	Dien Bien Phu	3	2, 8 Jul	94 (inactive)	3	143
	Dong Hoi	6	30 Mar; 6 Jun; 1 Jul; 17, 22, 23 Sep	53 (inactive)	6	50
	Vinh	6	8 May; 30 Jun; 1 Jul	10 (inactive)	6	43
	Subtotal: 1965				19	380
1966						
[redacted]	Dien Bien Phu	3	6, 11 Feb	94 (inactive)	3	2
	Dong Hoi	6	19 Nov	53 (inactive)	6	Negl.
	Subtotal: 1966				19 a/	2
Jan-Mar 1967						
[redacted]	Dong Hoi	6	29 Mar	67 (inactive)	6	13
	Subtotal: Jan-Mar 1967				19 a/	13

a. Including that capacity destroyed or inactive at airfields not attacked during the time period.
b. Not JCS-targeted.
c. As of the end of April.

Table 11

Airfields Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967
(Continued)

25X1

25X1

JCS Target Number	Name	Target as a Percent of National Targeted Capacity	Dates of Attack	Percent of Target Utility Destroyed	Cumulative Percent of National Targeted Capacity Destroyed or Inactive	Cost of Restoration (Thousand US $)
Apr-May 1967						
b/	Hoa Lac	b/	24 Apr (initial strike), 28 Apr; 1 May	N.A.	b/	6
[redacted]	Dong Hoi	6	16 May	67 (inactive)	6 25X5	Negl.
	Haiphong/Kien An	7	10 May (initial strike); 14, 25 May	N.A.	N.A.	4
	Kep	10	24 Apr (initial strike); 1, 7, 21, 21 May	40	4	236
	Subtotal: Apr-May 1967				23 a/ c/	246
	Total				23 c/	641

Table 12

Naval Bases Attacked Under the Rolling Thunder Program
1965, 1966, and January-May 1967

JCS Target Number	Name	Target as a Percent of National Naval Base Support Capacity	Dates of Attack a/	Percent of Base Utility Destroyed	Cumulative Percent of National Naval Base Support Capacity Destroyed or Inactive	Cost of Restoration (Thousand US $)
1965						
[redacted]	Phuc Loi	10	20 May; 12 Sep	78	8	815
	Quang Khe, Cuu Dinh	15	2 Mar; 28 May; 21, 24, 27, 28 Sep	47	7	400
	Subtotal: 1965				15	1,215
1966						
[redacted]	Hon Gai/Bai Chay Port Naval Complex	17	6 Aug; 28 Oct; 4 Nov	14	2	28
	Phuc Loi	10	4, 5 Apr	78 (inactive)	10	230
	Quang Khe, Cuu Dinh	15	26 Apr; 25 Nov	47	7	100
	Subtotal: 1966				19	358
Jan-Mar 1967						
[redacted]	Phuc Loi	10	15 Mar	78 (inactive)	10	1
	Quang Khe, Cuu Dinh	15	17, 28 Mar	47	7	1
	Subtotal: Jan-Mar 1967				19 b/	2
Apr-May 1967						
[redacted]	Quang Khe, Cuu Dinh	15	3 Apr	47	7	Negl.
	Subtotal: Apr-May 1967				19 b/	Negl.
	Total				19	1,575

a. Dates of attack indicate only assigned strikes; in certain instances more attacks have been made against a specific target than is indicated below.
b. Including that capacity destroyed or inactive at naval base support facilities not attacked during the time period.

25X1

Table 13

Cost of Damage to JCS-Targeted Radar Sites
Inflicted Under the Rolling Thunder Program
1965, 1966, and January-May 1967

JCS Target Number	Name	Radar Model	Total Value (Thousand US $)	Destroyed or Damaged (Thousand US $)
1965				
[redacted]	Vinh Son	1 Track Dish - fire control	245	245
		2 SCR-270 - early warning	270	270
		3 Firecan - fire control	1,000	645
		1 Cross Slot - early warning	135	0
		1 Spoonrest A - early warning	135	0
	Bach Long Vi	1 Cross Slot - early warning	135	135
	Hon Matt	2 Cross Slot - early warning	270	270
	Hon Nieu	1 Cross Slot - early warning	135	135
	My Duc	1 Cross Slot - early warning	135	0
		1 Rus-2 - early warning	135	0
		1 SCR-270 - early warning	135	0
		Subtotal: 1965		1,700
1966				
[redacted]	Vinh Son	1 SCR-270 - early warning	135	0
		1 Firecan - fire control	335	335
		2 Firecan - fire control	670	374
		1 Cross Slot - early warning	135	0
		1 Spoonrest A - early warning	135	135
	Bach Long Vi	1 Cross Slot - early warning	135	80
	Hon Matt	None	0	0
	Hon Nieu	None	0	0

25X5

25X5

25X1

Table 13

Cost of Damage to JCS-Targeted Radar Sites
Inflicted Under the Rolling Thunder Program
1965, 1966, and January-May 1967
(Continued)

JCS Target Number	Name	Radar Model	Total Value (Thousand US $)	Destroyed or Damaged (Thousand US $)
1966 (Continued)				
[redacted]	My Duc	1 Cross Slot - early warning	135	0
		1 Rus-2 - early warning	135	0
		1 SCR-270 - early warning	135	0
		Subtotal: 1966		924
Jan-Mar 1967				
[redacted]	Vinh Son	1 SCR-270 - early warning	135	0
		7 Firecan - fire control	2,355	0
		1 Cross Slot - early warning	135	0
		2 Unidentified	N.A.	0
	Bach Long Vi	1 Cross Slot - early warning	135	0
	Hon Matt	None	0	0
	Hon Nieu	1 Kniferest B - early warning	135	0
	My Duc	2 Cross Slot - early warning	270	0
		1 Rus-2 - early warning	135	0
		1 SCR-270 - early warning	135	0
		1 Kniferest B - early warning	135	0
		1 Beamtrack - searchlight control	70	0
		1 Rock/Stonecake - height finder	320	0
		6 Firecan - fire control	2,010	0
		1 Whiff - fire control	335	0
		2 Unidentified	270	0
		Subtotal: Jan-Mar 1967		0 a/

a. There were no scheduled attacks and no known damage to these targets in the first quarter of 1967.

Table 13

Cost of Damage to JCS-Targeted Radar Sites
Inflicted Under the Rolling Thunder Program
1965, 1966, and January-May 1967
(Continued)

JCS Target Number	Name	Radar Model	Total Value (Thousand US $)	Destroyed or Damaged (Thousand US $)
Apr-May 1967				
[redacted]	Vinh Son	1 SCR-270 - early warning	135	0
		7 Firecan - fire control	2,355	0
		1 Cross Slot - early warning	135	0
		2 Unidentified	N.A.	0
	Bach Long Vi	1 Cross Slot - early warning	135	0
	Hon Matt	1 Bar Lock - early warning, ground controlled intercept	1,800	0
	Hon Nieu	1 Kniferest B - early warning	135	0
	My Duc	2 Cross Slot - early warning	270	0
		1 Rus-2 - early warning	135	0
		1 SCR-270 - early warning	135	0
		1 Kniferest B - early warning	135	0
		1 Beamtrack - searchlight control	70	0
		1 Rock/Stonecake - height finder	320	0
		7 Firecan - fire control	2,355	0
		1 Whiff - fire control	335	0
		5 Unidentified	N.A.	0
		Subtotal: Apr-May 1967		0
		Total		2,624

II

Effectiveness of Countermeasures

II. Effectiveness of Countermeasures

The major effect of the air attacks against North Vietnam has been to force Hanoi to cope with extensive disruption to normal economic activity. The greatest effort has been required in the fields of transportation and distribution, in order to keep supply lines open to the South and to maintain the distribution of essential economic and military supplies. A considerable effort has also been required to maintain the essential level of output from North Vietnam's limited industrial capacity in order to counter the effects of air attack and to sustain a capability to support the war in the South. These programs have forced significant reallocations of manpower and rapid increases in the flow of military and economic aid from other Communist countries.

Through the skillful and sometimes ingenious use of a number of countermeasures, the North Vietnamese have met with considerable success in withstanding the pressure of US air power. These countermeasures are discussed in the following sections.

A. Civil Defense

The North Vietnamese have developed and continue to improve an extensive civil defense system characterized by increased precautions to minimize casualties, an extensive shelter system, the dispersal of large parts of the urban population, and radical adjustments in school, work, and marketing hours to avoid large concentrations of people during daylight hours. This system was an important factor in reducing the casualty level during the recently intensified attacks against Hanoi and Haiphong.

Of the measures employed to limit casualty numbers, the North Vietnamese regard shelters as especially effective. In May of this year, an official of the Ministry of Defense asserted that 95 percent of all of North Vietnam's air raid casualties were people outside of shelters. Substandard shelter construction was blamed for three of the 5 percent of casualties sustained in shelters. During the third quarter of 1966 there was an intensified program to refurbish

and to expand the shelter system. According to the North Vietnamese press, some 55,000 shelters were built in Haiphong during one ten-day period. In the city of Vinh, it is claimed that every family has its own shelter. Almost every area of the country reports the construction of thousands of shelters and many kilometers of trenches. Although the number of shelters and protective facilities cannot be quantified, a new intensification of the program occurred during the first quarter of 1967. Aerial photography and reports of foreign observers make it obvious that the program is extensive.

In addition to the shelter program, North Vietnam has vigorously pursued a program of urban evacuation and industrial dispersal.* Urban evacuation was accelerated after the airstrikes on petroleum storage facilities near Hanoi and Haiphong in mid-1966 and has acquired a new momentum after the strikes in these areas during the past months. Most cities appear to have evacuated a substantial portion of their population. Foreign observers and the North Vietnamese press agree that Hanoi and Haiphong have probably evacuated half their population. Ninety percent of the population of Hai Duong city is reported to have been evacuated, and only 2,000 of Thai Binh's 19,000 residents are reported to remain. Nam Dinh reportedly has reduced its population of 95,000 to 20,000 or 30,000.

The urban evacuation that has been achieved probably approximates the desired level. In fact, recent North Vietnamese newspaper accounts of evacuation appear to be more concerned with migitating the problems encountered in resettling than with encouraging further evacuation. Unsanitary conditions, separations among families, and a cool reception by residents in resettlement areas continue to have an adverse effect on evacuees. Moving people out of cities, the mayor of Hanoi has conceded, is less a problem than providing them with supplies, housing, schools, and means for earning a livelihood. Despite the difficulties of the program, the reduction of urban populations is regarded by the regime as a prudent measure and has been credited with limiting the number of casualties.

Industrial dispersal is discussed in C.

The North Vietnamese population is apparently well disciplined and responsive to civil defense measures. The intensification of US air attacks has meant, however, that routine activities have become increasingly disrupted. In an attempt to minimize the disruptive effect of air raid alerts -- reported to number as many as 18 a day -- North Vietnam has modified alert procedures for port workers in Haiphong and Hon Gay.

stevedores are required to continue working after air alerts are signaled, taking cover only at the sound of antiaircraft fire. Similar steps have been taken in Hanoi to reduce the harassing effect of air raids. Reportedly, no alarm is sounded in the capital city until hostile aircraft have entered within a radius of 20 to 30 kilometers of the city. In some instances, foreign observers in Hanoi have noted that air raid alerts have coincided with the first bursts of antiaircraft artillery or the sound of exploding bombs.

B. Air Defense Countermeasures

During the past three years the Hanoi regime has developed North Vietnam's air defenses from a relatively rudimentary state into a complex, sophisticated system. The system now includes an integrated network of radar sites, interconnected by filter centers and communications facilities, and a widespread deployment of SAM missiles, MIG aircraft, and conventional antiaircraft guns. The number of antiaircraft guns of all calibers increased from about 1,200 in February 1965 to about 6,000 two years later.

Since the introduction of the Soviet-supplied SAM system into North Vietnam in mid-1965, at least 180 SAM sites have been constructed. SA-2 missile battalions currently are deployed in from 28 to 32 of these sites, with the remainder of the sites adding to the overall flexibility of the system. North Vietnam's radar order of battle has increased in size from 24 pieces of equipment in 1962 to 434 pieces in February 1967. Electronic equipment of higher quality and sophistication has added further to the coverage provided. North Vietnam's current inventory

as of the end of May of nearly 90 MIG aircraft* was lower than the 1966 inventory of about 110 aircraft because of losses inflicted by US forces. Stepped-up employment of MIG's in their air defensive role, however, has been noted in recent periods in the Hanoi/Haiphong area. Although enemy aircraft have not yet inflicted major losses on US air forces, their presence has posed a threat which has sometimes caused US pilots to jettison ordnance short of the assigned targets.

The growing threat presented by North Vietnam's air defense system is illustrated by defensive activities encountered by US forces while carrying out attacks against the Hanoi Transformer Station during a nine-day period in April and May of this year. Enemy air defense operations over this target, which is about seven miles north of Hanoi, included multiple SAM firings, harassing flights of MIG's, and heavy antiaircraft fire. US forces, made up of a minimum of 56 strike aircraft, suffered damage amounting to five aircraft lost; one mission was forced to abort short of the target; and several aircraft had to jettison their ordnance in order to react to MIG attacks.

As shown in the tabulation below, the primary cause of US losses over North Vietnam is conventional ground fire. The threat imposed by SAM missiles, however, presumably accounts indirectly for an unknown percentage of these losses because it forces US aircraft to fly at lower altitudes lying within the range of the antiaircraft guns.

*Including approximately 30 MIG's believed to be filling a reserve role at bases in Communist China.

Cause	US Aircraft Losses	Percent
Ground fire/other	493a/	85
SAM	64b/	11
MIG	23b/	4
Total	580	100

a. Including nine GVN aircraft, which were lost to ground fire in 1965.

b. Including possible/probable downings from these causes.

In view of the buildup in the enemy's air defense system, US losses over North Vietnam have remained surprisingly low, and the overall rate actually has declined as the hostilities have progressed. The lower trend in US losses has been especially apparent since the spring of 1966. A comparison of US and VNAF loss rates by year for operations over North Vietnam is shown below:

Year	Total Attack Sorties	Combat Losses a/	Losses as a Percent of Total Attack Sorties
1965	25,940	173	0.67
1966	82,170	284	0.35
1967b/	40,840	123	0.30

a. Excluding operational losses due to equipment failure.

b. January-May.

There are some indications, however, that the favorable decline in the loss rate may be reversed if there is continued escalation in the number of US attacks against industrial and military targets in the densely populated northern areas of North Vietnam.

The loss rate for attacks on JCS-designated fixed targets within a 10-mile radius of Hanoi and a similar area around Haiphong during the 41-day period from April 20, 1967 to May 31, 1967 was 3.1 percent, compared with the 1967 average for all areas of about 0.30 percent. About 60 percent of US combat losses during the period January-May 1967 were over Route Packages 5 and 6, although only about 15 percent of total attack sorties were flown over these areas. These route packages are defended by almost 67 percent of the enemy's inventory of 37 to 57 millimeter guns and more than 90 percent of the inventory of 85 to 100 millimeter guns. Furthermore, an increasing threat from SAM defenses is apparent from the following tabulation which gives SAM missiles fired by North Vietnam per 100 attack sorties flown over Route Packages 5 and 6.

Year and Month	Attack Sorties[a/]	Missiles Fired	Missiles Fired Per 100 Sorties
1966			
March-April	900	64	7.1
May-June	770	65	8.4
July-August	2,900	389	13.4
September-October	2,350	144	6.1
November-December	2,030	384	18.9
1967			
January-February	1,430	394	27.6
March-April	2,650	558	21.1
May	2,048	556	27.1

a. Rounded to the nearest 10.

As shown above, in the first five months of this year, more than 20 SAM missiles were launched

by the North Vietnamese for every 100 attack sorties flown over the northern route packages by US air forces. The effectiveness of the SAM response to US attacks should be increased by the recent indications that Soviet personnel have assumed more control over SAM operations.

C. Decentralization of Industry

Although North Vietnam asserted the importance of local industry and called for its continued growth long before the country was subjected to US bombing, the country's main industrial objective before 1965 was to establish a heavy industrial base consisting of large capital-intensive plants. The advent of US air-strikes in 1965 forced an admitted reversal of these priorities and resulted in a renewed and sharply increased emphasis on local industry, which was to be expanded through the dispersal of industry from potential urban target areas as well as through the construction of small facilities supplied with new equipment.

Dispersal of existing facilities reportedly began early in 1965, just before the start of the Rolling Thunder program. It is estimated that most dispersal has involved those facilities -- small factories and cooperatives -- with easily moved machines and easily divisible production processes. Dispersal has been applied both to facilities in urban areas and to those near probable targets in the rural provinces.

The extent of dispersal of even small facilities in 1965 and 1966, however, is unclear. Several conflicting reports have been received on dispersal of industry in Hanoi and Haiphong, some suggesting almost total economic dispersal of industry, others emphasizing the large numbers of facilities still operating. The mayor of Hanoi, in an interview with a Czechoslovak reporter in January 1967, said that, although several enterprises were evacuated from the city, there were still more than 200 industrial enterprises of various sizes remaining. The North Vietnamese press also has periodically criticized the slow pace of dispersal. On the other hand, there is little doubt that many small facilities have been dispersed, and the movement

probably has been stepped up since the heavy raids in the vicinity of Hanoi and Haiphong in the spring of 1967. One Czechoslovak report from Haiphong, dated 29 April, said that production in several industrial plants has been stopped and will be transferred elsewhere.

Only two large industrial facilities -- both textile plants which accounted for about 75 percent of the national weaving capacity -- are known to have been extensively dispersed. Evacuation of the Nam Dinh Textile Mill probably began even before it was unintentionally damaged by an airstrike in July 1965, and all spinning and weaving equipment probably was dispersed by the spring of 1966. Photography confirms the absence of equipment in a sizable area of the plant. North Vietnamese films show that the 8 March Textile Mill in Hanoi also had a large part of its capacity removed by early 1966. The Hanoi Engineering Plant is the only large plant reported to have dispersed some equipment, but this plant also has had new equipment installed at the original site.

North Vietnam's heavy industrial plants generally are not easily dispersed because of technological considerations and/or because of the size of equipment involved. Photography has even shown recent construction activity at the 8 March Textile Mill in Hanoi, at the Hanoi Chemical Fertilizer Plant, and adjacent to the Hanoi Engineering Plant. This activity remains unexplained and conceivably is not associated with industrial expansion. The phychological effects of the recent strikes near urban areas cannot be discounted, however, and a determined effort may be under way or in planning to disperse parts of heavy industrial plants -- perhaps machine shops from the large engineering plants and batch operations at the large chemical plants -- which may not have been affected before. Nevertheless, such industrial processes as the blast furnace operations at Thai Nguyen, chlorine production at Viet Tri, and the kiln operations at the Haiphong Cement Plant still would not lend themselves to dispersal.

Little is known about the locations to which the evacuated equipment is taken. Most North Vietnamese

commentary refers to movement to the "countryside." The return to Hanoi at night of many evacuees from the city suggests that the facilities dispersed from the city may not have been moved very far. Some facilities, however, have been moved to the mountainous northwest, reportedly to take advantage of the power potential presented by the presence of numerous small streams. This movement also fits in with North Vietnam's longstanding interest in settling and cultivating the land in the northwest. Several locations have been reported as sites for dispersed equipment from the Nam Dinh Textile Mill, ranging from near Nam Dinh to 50 to 100 miles distant. Caves, jungle, and other natural protection or camouflage are utilized whenever possible in order to provide maximum protection against air attack.

On balance the decentralization program probably has been successful from North Vietnam's standpoint. Efficiency of production and some production per se certainly has been lost in the evacuation process as well as in the installation of equipment in less than ideal circumstances. Probably more important, though, has been the accelerated establishment of new machinery and repair shops, new food-processing facilities, new irrigation facilities, and new handicrafts, all of which have added to the economy of the rural areas without detracting from the economy elsewhere.

D. Countermeasures on Lines of Communication (LOC's)

1. Construction and Repair Activity

The main effect of the Rolling Thunder program against LOC's in North Vietnam has been a strenuous and successful effort by the North Vietnamese to keep all important transportation routes open to traffic. Besides diversifying the means of transport to include greater use of inland waterways and porter trails, the North Vietnamese have constructed multiple bypasses at road and railroad bridges on all

important stream crossings, built alternate roads, and upgraded the rural road system to provide alternatives to heavily bombed routes. The program of counter measures has had equal priority on LOC's in North Vietnam and the Laos Panhandle and has been accomplished at relatively low cost because of a willingness and ability to use primitive methods and materials. The net effort in terms of logistic supply capability has been to make North Vietnamese transport more flexible than before the bombing by offering more choices of possible crossings and routes by which to supply the Communist war effort in South Vietnam. Added routes, moreover, further reduce a rather low average daily tonnage requirement per LOC.

The success of the North Vietnamese in outpacing the damage inflicted on LOC's by airstrikes can be measured by the change in the number of bypasses built over stream crossings.* A comparison of the period from the start of the bombing through September 1966 with the period from October 1966 through May 1967 shows that the average number of separate bypasses for damaged bridges increased from 0.98 to 1.19 per highway bridge and from 0.51 to 0.87 per railroad and combination railroad/highway bridges.** In addition, the Communists are in a less vulnerable position because they have had time to put in alternative crossings even at points not yet struck. In addition to the construction of bypasses, the North Vietnamese often repair the original bridge if the damage is not too

Bypasses include temporary bridges, fords/culverts, ferries, and pontoon and cable bridges.

**A study of the Dong Dang to Hanoi line and the lines to Haiphong and to Vinh shows a ratio of 1.64 bypasses per rail and combination bridge or almost twice as high as for all rail lines.*

extensive, if the bridge is not too long, or if the terrain is too rugged to rapidly construct multiple bypasses.

Greater speed in repairs during 1966-67 can be directly attributed to an extensive development of bypasses and to a variety of deception techniques. To augment traditional bypasses such as fords, ferries, and timber bridges, more use was observed in 1966 of prefabricated movable spans, steel cable bridges, and camouflage. The use of a variety of multiple stream crossings suggests that the only effective way for airstrikes to render a crossing unserviceable is to destroy the original bridge and all bypasses simultaneously -- a very difficult and costly tactic.

A slightly different but equally effective pattern of countermeasures emerges in the Laos Panhandle where an interdicted bridge or ford is usually bypassed by construction of a short road around the entire chokepoint. Crossings that have been repeatedly bombed take on a cobweb pattern of bypass roads, of which one is serviceable most of the time.

New road construction and the upgrading of rural roads and trails also provides the North Vietnamese with additional supply routes to counteract the effects of the bombings and reduce the tonnage per road. In North Vietnam during 1966 a system of alternative roads was built to bypass the main coastal route 1A between Thanh Hoa and Quang Khe, while a new border crossing road into Laos was built as a supplement to route 15 through Mu Gia Pass. The pattern of road construction in the Laos Panhandle during the 1967 dry season has emphasized many short bypasses around heavily interdicted points on the existing road system that was so greatly expanded during 1966. The extension of route 922 east into the A Shau Valley of South Vietnam has been the most strategically important new road built thus far in 1967 and the first time a part of the Ho Chi Minh Trail has been made into

a motorable road across the border into South Vietnam (see the map, Figure 5).

2. Manpower Involved in Countermeasures

The most important resources employed by the North Vietnamese in their countermeasures on lines of communication have been mass labor and local materials. It is estimated that up to 125,000 workers and Chinese engineering troops, the latter north of Hanoi, are currently engaged in the full-time repair of LOC's in North Vietnam and in the Laos Panhandle (72,000 North Vietnamese, up to 34,000 Chinese engineering troops north of Hanoi, and 19,000 North Vietnamese Army troops and Pathet Lao in the Laos Panhandle). The use of part-time workers primarily from the agricultural sector has added at least 100,000 to 200,000 additional day laborers for road, rail, and bridge repair work as needed. About 40 percent of the workers in North Vietnamese repair crews are women.

3. Effectiveness of Bombing Bridges

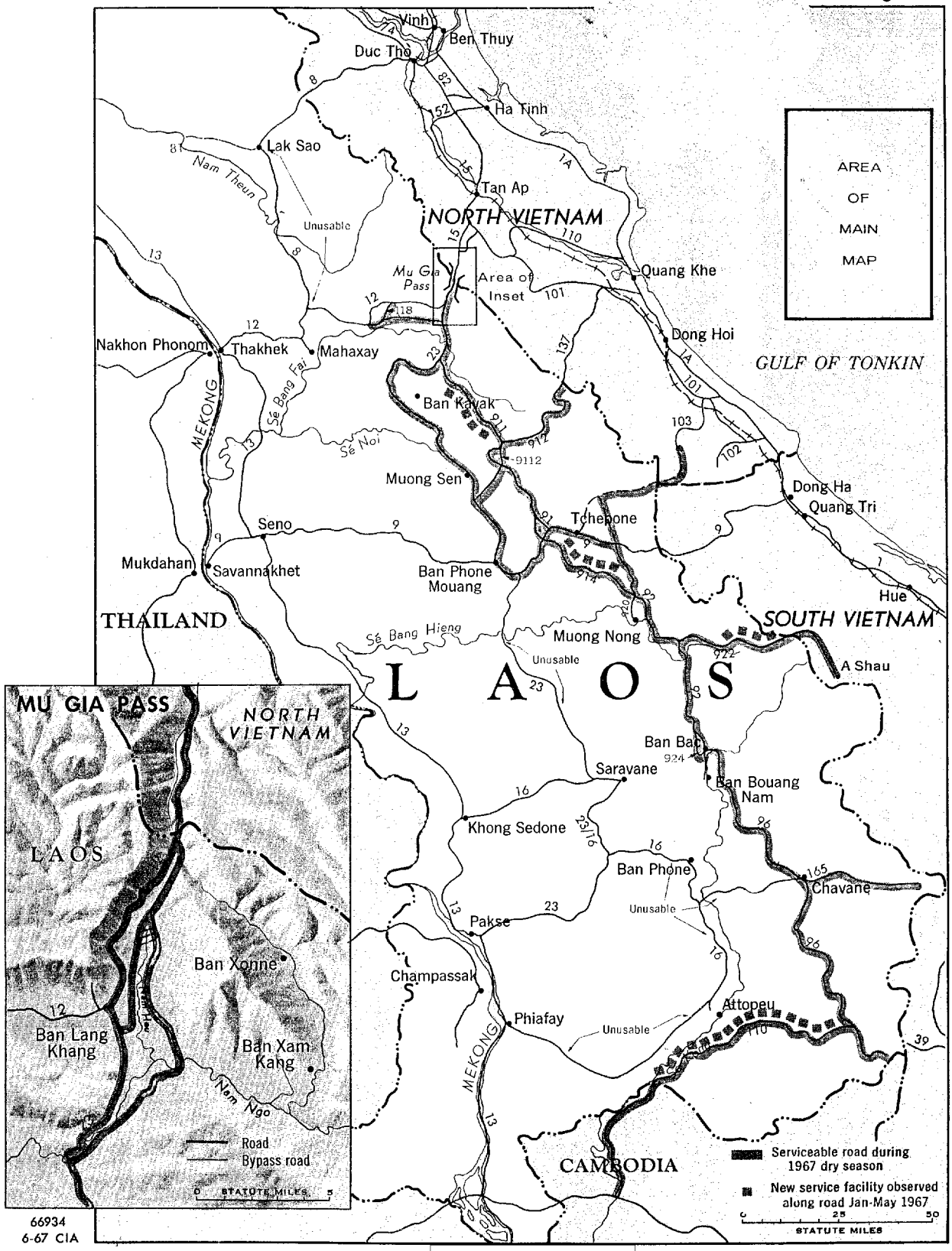
The bombing of bridges in North Vietnam has been unsuccessful in reducing the flow of men and material toward South Vietnam. Moreover, bridge targets have been very costly in terms of planes lost and have been effectively and quickly bypassed when they were destroyed.

A sample of 49 JCS-numbered bridges has been analyzed in detail to determine the effectiveness of bombing bridges in North Vietnam as a tactic to interdict traffic. Since the start of the Rolling Thunder program in February 1965, the US and the South Vietnamese have bombed 49 out of a total of 61 JCS-targeted bridges in North Vietnam. During the numerous strikes and restrikes against these bridges, at least 37 planes were lost with a total value of about $74 million.

The North Vietnamese have been able to offset the effects of bomb damage to bridges by constructing multiple bypasses for every chokepoint bridge in the country. (For an example of this type

THE LAOS PANHANDLE

Figure 5



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6-67 CIA

25X1

of activity, see the photograph, Figure 6). Available photography shows that they have been able to build 99 separate bypasses within the immediate vicinity of 46 of the 49 JCS-targeted bridges or an average of slightly more than two bypasses per bridge.* A single bridge is a very difficult target to destroy by aerial bombardment, and construction of multiple bypasses at a crossing site further reduces the probability of effectively interdicting a LOC. The following tabulation shows a breakdown of the North Vietnamese countermeasures used to bypass 46 JCS targeted bridges:

Type of Bypass	Number
Alternative bridges	26
Pontoon bridges	15
Cable bridges	9
Ferries	31
Fords	18
Total	99

The construction of multiple bypasses, in addition to ensuring a flow of traffic for the North Vietnamese, greatly increases the cost of the bombing program to the US. In general it takes as many sorties and as much ordnance to interdict bypasses as to interdict the original bridge.** The cost to the US of

Adequate photography is not available for the remaining three bridges.

***If it is assumed, for example, that 10 tons of supplies each day are moving over a LOC containing one bridge, past performance suggests that one hit on the bridge will be scored and traffic interdicted if 47 bombs are dropped. The average ordnance load carried by aircraft over North Vietnam is just under 2 tons. If the load consists of 500-pound bombs, it takes approximately six sorties to interdict a bridge. To interrupt the same 10 tons of traffic which can be handled by three possible crossings -- the original bridge or each of two separate bypasses -- 141 bombs in the 500-pound class must be expended and 18 sorties flown.*

bombing, therefore, increases at a much more rapid rate than the cost to the North Vietnamese because the majority of the bypasses are low-cost expedients which can be repaired rapidly. This cost relationship is illustrated graphically in Figure 7.

E. Contingency Planning

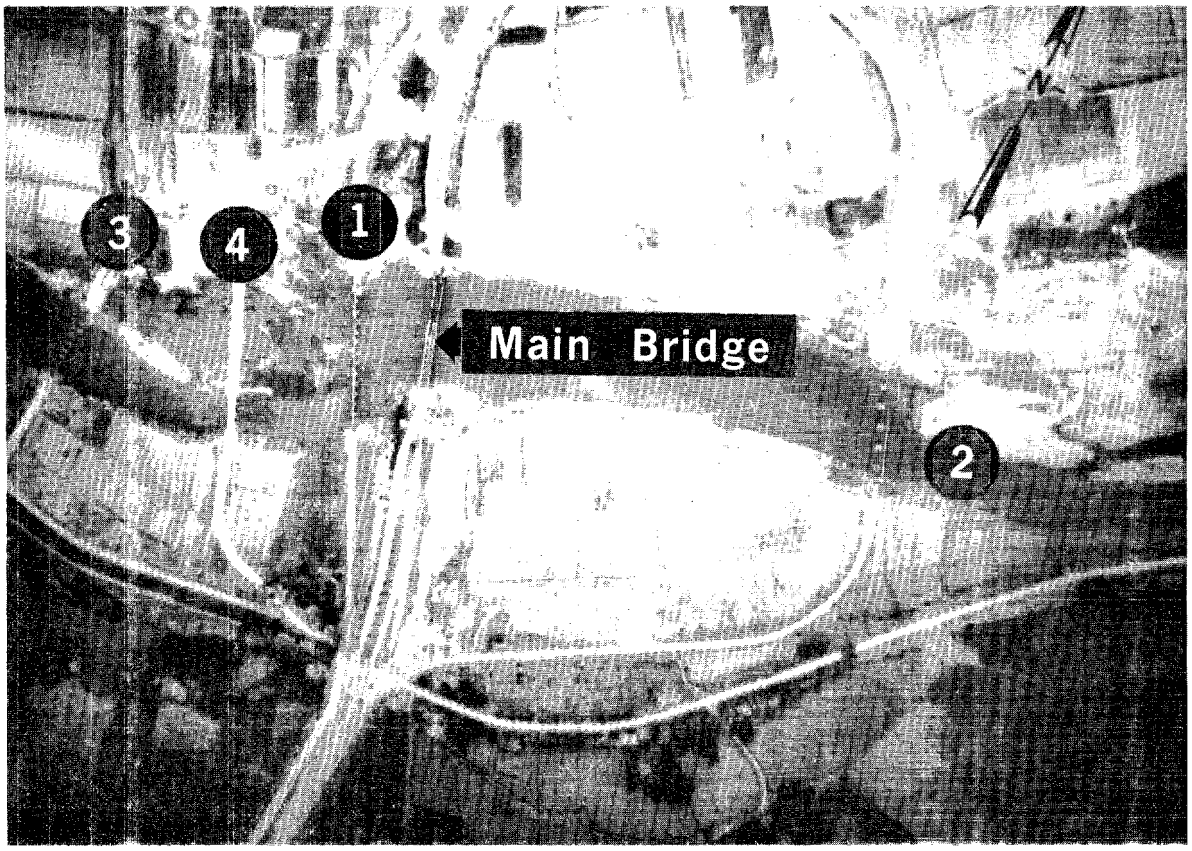
Along with reacting to existing bomb damage, the North Vietnamese have, since the inception of the bombing, developed contingency plans -- countermeasures taken before bombing occurs -- to cope with escalation and shifts in emphasis of the Rolling Thunder program. These contingency plans are difficult to separate from other reactions to existing bomb damage and thus often not easily recognizable. In addition, contingency plans and countermeasures to existing bomb damage must compete for the same scarce resources.

The civil defense evacuation system in effect in Hanoi and Haiphong before these areas were intensively attacked and the elaborate system of bridge bypasses are examples of ambitious contingency planning. The effective civil defense evacuation system in the Hanoi-Haiphong area which was nearly complete in early 1967 is credited with keeping civilian casualties at remarkably low levels during the recently intensified attacks against areas. A number of unstruck North Vietnamese bridges have highway and rail bypasses already in place in anticipation of future possible strikes. Before the Hanoi Highway and Rail Bridge over the Canal des Rapides (JCS 13) was struck in late April, piers for a bypass span had been in place for a number of months, and bridge decking was stored on the river bank. A 7.3-mile rail bypass and rail ferry skirts the unstruck Hanoi "Doumer" Bridge [redacted] 25X5

Despite an ability to transport an adequate level of supplies to the South with its existing although constantly attacked transportation network, North Vietnam has continued to expand the capacity of the network. For example, the Don Dang rail line has been dual gauged and extended from Kep to Thai Nguyen. An alternative road network to

[redacted]

BY-PASSES FOR THE DESTROYED PHUONG DINH RAILROAD & HIGHWAY BRIDGE



NAME: Phuong Dinh Combination Railroad and Highway Bridge.
JCS # none. [redacted] 25X1

LOCATION: 0.5 Nautical Miles North of Yen Vuc Thuong on the Hanoi/Vinh Rail Line and Route 1A.

COORDINATES: 1951N/10548E

FIRST STRUCK: Sometime between July 1965 and September 1966 By September 1966, however, the bypasses were either operational or under construction. Main bridge is dropped and is unserviceable.

TYPE OF BYPASSES:

No. 1 - Timber bridge serviceable to rail traffic
No. 2 - Timber bridge for rail traffic, under construction
No. 3 - Timber bridge: spans removed as a deception technique but still serviceable for highway traffic
No. 4 - Probably a timber bridge, serviceable for highway traffic

25X1

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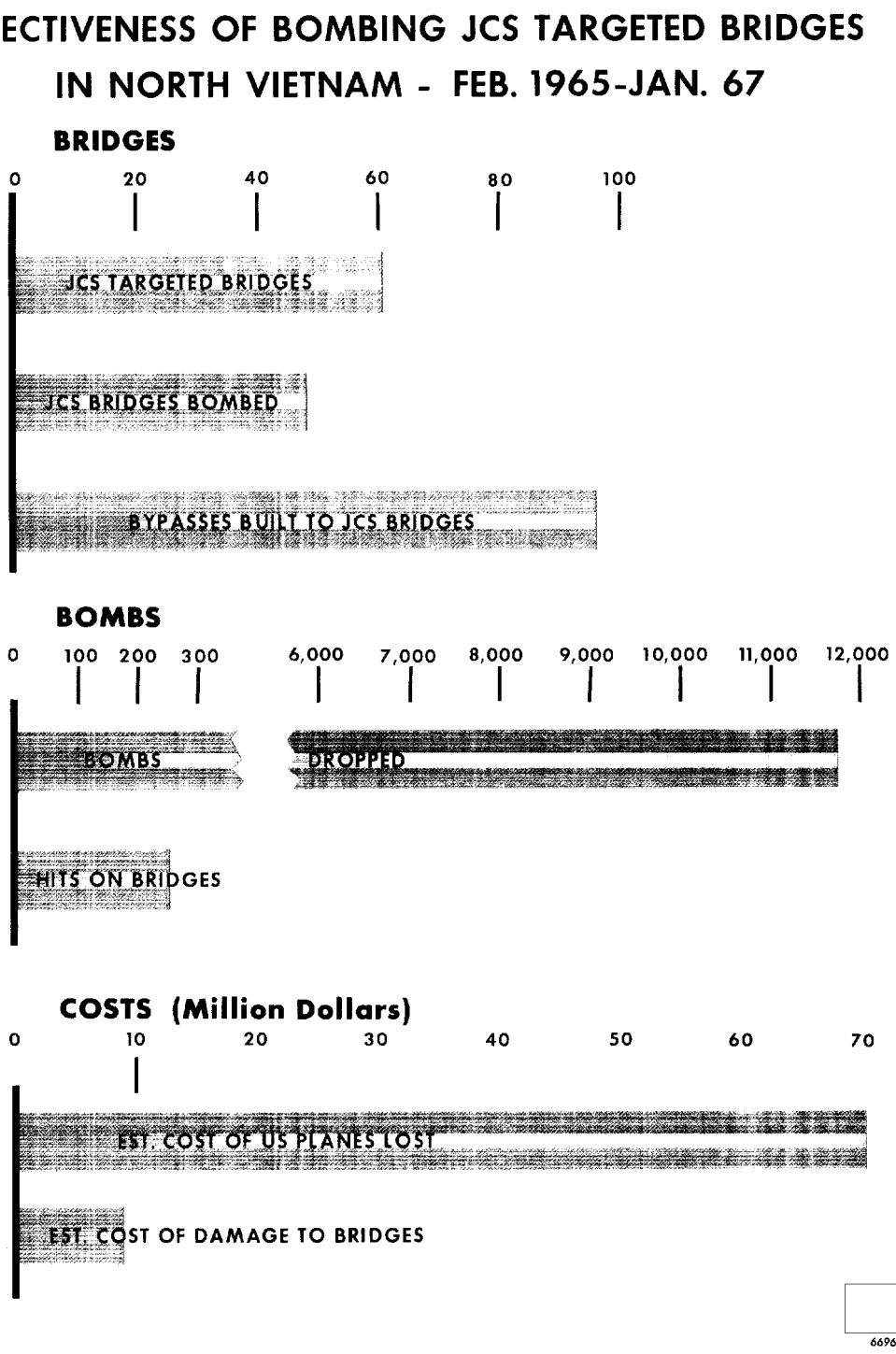
[redacted]

Figure 6. By-passes for the Destroyed Phuong Dinh Railroad and Highway Bridge



25X1

Figure 7. Effectiveness of Bombing JCS Targeted Bridges in North Vietnam - February 1965 - January 1967

Route 1A is nearing completion south from Thanh Hoa. Presumably Hanoi is preparing for the contingency that the US will greatly escalate the LOC campaign or mine Haiphong harbor, necessitating the use of this extra capacity.

In other areas, Hanoi's contingency plans have been less ambitious because of the strain placed on resource availability by countermeasures to existing bomb damage. Although small portable diesel electric power generators were received from the USSR in small number during 1964 (22 in 1964) purchases did not pick up to their present high rate until the US had begun attacking thermal powerplants in the southern route packages in mid-1965. Although partial dispersal of several textile mills and some handicraft industry took place in 1965, other major, unstruck plants appear to be in full operation despite their vulnerability.

Some dike and road interdiction contingency plans appear to have been put into operation. Steel mesh for repairing breaches has been reported in storage along dikes. Piles of stone and earth have been observed along roadsides; local village "volunteer" crews are ready to fill crater holes.

F. Imports and Foreign Aid as Countermeasures

1. Economic Aid

The sharp and continuing rise in economic aid to North Vietnam in the form of imports from the other Communist countries has been an important countermeasure to the bombing effort in North Vietnam. (See Table 14 for the estimated volume of imports and Table 15 for a listing of major imports from the USSR; both tables following P. 19). This aid has risen from an estimated $150 million in 1965 to $275 million in 1966, and it seems to be increasing again in 1967. Most of the aid extended through 1964 was for North Vietnam's economic development program. The more recent aid agreements make it clear that the Communist countries have implicitly guaranteed to finance the economic

losses incurred by North Vietnam in its war effort. An unconfirmed report following the Warsaw Pact meeting in November 1966 stating that the Pact countries had pledged $1 billion to support Hanoi's war effort seems an indication of the effort that the Communist countries seem willing to make.

The value of this aid can be seen principally in the rise in imports in the 1965 and 1966, particularly the rise in imports of those goods supporting the war effort.

The Communist countries have provided substantial quantities of equipment for transportation, construction, power, communications, and maintenance programs. Furthermore, machinery and equipment apparently have been made available for both new and continuing aid projects which are not military associated, although this category of aid goods seemed to decline in 1966, and seems likely to decline even further in 1967.

There have been sharp increases in imports of machinery and equipment -- machine building shops, repair shops, small manufacturing enterprises, vehicles (road, rail, and water), heavy transport and roadbuilding equipment, machine tools, small diesel generators, and volumes of spare parts -- all related to the repair and replacement of parts in the transportation and power sectors of the economy and to repair and reconstruction programs. The power sector is particularly dependent on diesel generators because the regular electric power industry has been so heavily damaged by the bombing and because of the decentralization of industry. Telecommunications imports are another valuable but small-volume category, with most military communications equipment supplied by Communist China, probably by rail.

Petroleum products are an extremely large volume import -- imports by sea increased to 200,000 tons in 1966 compared with 170,000 tons in 1965. Early 1967 reports show another large increase.

Petroleum imports are essential to the transportation, construction, and power sectors of the economy, particularly to the power sector since it has become so dependent on diesel generators.

Almost all iron and steel products must be imported because North Vietnam makes no steel, although it produced pig iron at the Thai Nguyen Iron and Steel Complex until recently. Products related to the war effort -- such as barges, POL storage tanks, pontoons, building members, possible bridge trusses, and other structured shapes -- are fabricated at Thai Nguyen and at other locations. Most of these metal products come from the USSR and Japan by ship, although Communist China probably ships some steel products by rail. Imports of these metals by sea during 1966 were double the volume in 1965.

Bulk foodstuffs imported by sea have increased sharply in 1967. This increase parallels the reports of losses of rice production in North Vietnam in 1966, and it may also reflect internal distribution problems. Food imports could become important if the seeming food shortage worsens. Another factor in the food supply has been the large and increasing imports of fertilizers. Maintenance of the food supply may be more difficult if the fertilizers are not received and distributed properly.

The relative backwardness of North Vietnam's economy, however, makes it less vulnerable than its dependence on imports might suggest. The economy of North Vietnam is still basically one of subsistence agriculture, with an essentially self-sufficiency in food, although continuation of the shortages reported in late 1966 could bring about a critical situation if imports are cut off. Denial of imports to North Vietnam otherwise would have minimal effect on the nonindustrial economic organization generally. Even the loss of transport equipment could be compensated for in the domestic economy by the extensive use of manpower for the transportation of necessary goods.

2. Military Aid

In addition to increasing their deliveries of economic goods, the USSR and Communist China responded

to the Rolling Thunder program by increasing sharply the levels of military assistance, as shown in the following tabulation:

	Million US $a/					
Country	1953-64	1965	1966	Jan-Mar 1967	Apr-May 1967	Total
USSR	70	200	360	90	93	813
Communist China	70	45	85	27	23	250
Total	140	245	445	117	116	1,063

a. These values are based on Soviet foreign trade prices (prices charged for similar equipment sold to less developed countries), which are believed to most closely approximate the true value of this equipment.

Deliveries of military equipment, which previously had been on a very small scale, reached an estimated $245 million in 1965 and $445 million in 1966. Deliveries in the first five months of 1967 have been at a slightly higher rate than that observed during 1966, and may increase even more during the remainder of 1967.

Soviet and Chinese military aid programs follow well-established lines which reflect the capabilities of the donors. The USSR has provided heavier and more advanced equipment such an antiaircraft guns, radar, tanks, artillery, SAM systems, and most of the advanced fighter aircraft. The Chinese have been the major suppliers of trucks, small arms and ammunition, and equipment for the ground forces. A breakdown of the major items of Soviet and Chinese deliveries of military equipment is shown in Tables 16 and 17, following P. 19.

In addition to deliveries of military equipment, the USSR and Communist China have provided military advisers and technicians to North Vietnam.

The Chinese contribution in this area is far greater than that of the USSR. Up to 48,000 Chinese support troops are presently in North Vietnam working on the construction, repair, and defense of transportation facilities. In contrast, the number of Soviet military technicians ranged between 2,500 and 3,000 during 1965 and currently is estimated at from 1,000 to 1,500.

Table 14

North Vietnam: Estimated Volume of Imports a/
1965, 1966, and January-March 1967

Thousand Metric Tons

	1965	1966	January-March 1967
Rail	320	420	N.A.
Seaborne	847	1,082	340
Total	1,167	1,502	N.A.

a. Estimated trade moving by rail and oceangoing transport. Only a small amount moved by road and inland waterway routes.

Table 15

North Vietnam: Imports from the USSR a/
1965, 1966, and January-March 1967

	1965			1966			January-March 1967		
	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons
Electronic Equipment	513			40		40	9		6
Transportation, Construction, and Agricultural Equipment	8,735			34,961		18,875	2,007	917	1,041
Transportation	6,961			21,797		12,433			
Automotive	2,970	6,297		4,714		4,146	713	783	641
Bicycles	82	5,500		392		654	12	680	19
Motorcycles				462	700	313			
Trucks	2,412	517		3,866	633	3,123	673	103	617
GAZ-63 b/				1,060	212	709			
ZIL-130 b/				258	43	179			
Dump trucks b/				1,673	239	1,193	288	48	320
Fire trucks				240	12	93			
Other	2,412	517		635	127	949	385	55	297
Jeeps and light vehicles	476	280		94	34	56			
GAZ-69 (jeep) b/				43	17	27			
UAZ-450A (ambulance) b/				51	17	29			
Rail (principally rails, new and used)				841		6,372			
Air (parts and Mi-6 helicopters in 1966)	189			12,000	6	454	28		5
Sea (small craft and equipment)	788			35	6	92			
Spare parts	3,014			4,107		1,369			
Construction and Agricultural Equipment	1,774			13,164		6,442	1,294	131	400
Construction	861			8,570	348	4,412	69	20	59
Bulldozers				4,422	201	2,690			
Scrapers				1,152	36	496	69	13	59
Graders				490	35	393			
Cranes				700	35	350		7	
Road rollers				140	7	29			
Excavators	861			1,666	34	454			

Table 15

North Vietnam: Imports from the USSR a/
1965, 1966, and January-March 1967
(Continued)

	1965			1966			January-March 1967		
	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons
Other	62			480		250	100		124
Agricultural (tractors)	851			4,114	374	1,772	1,125	111	217
Chemicals, Pharmaceuticals, and Minerals and Metals	13,217			19,261		212,250	3,407		21,151
Minerals and Metals	9,254			11,808		80,235	28		110
Aluminum	477			69		123			
Iron				159		1,868			
Steel (bars, sheets, and shapes) c/	4,133		25,000	3,737		33,976			
Bolts				376		627			
Miscellaneous and unspecified				1,888		17,159			
Cable	568			1,669		1,192			
Electrical				298		213			
Other				1,371		979			
Pipe	201			611		2,442	28		110
Wire	1,582			2,099		2,560			
Sulfur pyrites				248		19,098			
Miscellaneous nonferrous metals	1,993			952		1,190			
Pharmaceuticals	1,329			486		243	282		141
Instruments	933						2		1
Medicines	396			486		243	280		140
Chemicals	2,634			6,967		131,772	3,097		20,900
Fertilizer	1,543		39,100	4,861		121,516	760		19,000
Ammonium sulfate				3,984		99,605	760		19,000
Potassium chloride				877		21,911			

Table 15

North Vietnam: Imports from the USSR a/
1965, 1966, and January-March 1967
(Continued)

25X1

	1965			1966			January-March 1967		
	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons
DDT				100		2,261			
Soda				431		6,536	50		749
Tires	627	8,800		1,351		819	2,286	33,132	1,145
Miscellaneous	464			224		640	1		6
Consumer Goods	8,466			11,162		18,648	5,821		38,856
Textiles	6,415			8,420		5,261			2,801
Cotton	1,872			4,954		3,096			2,635
Yarn	1,183			661		413			166
Textiles (million meters)	3,360			2,805		1,752		34	
Food	483			942		6,775	5,795		36,029
Flour	148			858		5,361	5,760		36,000
Milk	320			59		1,344			
Miscellaneous	15			25		70	35		29
Paper Products	764			1,135		5,340	26		126
Paper bags				294		1,306			
Newsprint				841		4,042	26		126
Miscellaneous	804			665		1,264			26
Rubber boots (pairs)				40	40,060	141		405	1
Shovels				330	330,000	380		80,000	8
Miscellaneous, unknown, and unspecified	804			295		743			17
POL	5,322		119,800	8,787		209,471	2,795		65,000
Benzine				329		10,294			
Diesel	1,398			3,174		79,500			

Table 15

North Vietnam: Imports from the USSR a/
1965, 1966, and January-March 1967
(Continued)

	1965			1966			January-March 1967		
	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons	Value (Thousand US $)	Number	Metric Tons
Diesel fuel (AK-15)	1,398		43,200	1,777		57,325			
Diesel oil (DP-14)				1,397		22,175			
Gasoline	1,534		42,100	2,455		76,727			
Kerosene	970		26,800	481		15,500			
Aviation oil (MK-22, MS-20)	1,117		7,700	164		1,950			
Miscellaneous oil (spindle oil, machine oil)				235		3,737			
Grease				1,175		1,175			
Magor				7		225			
Paraffin				150		454			
Miscellaneous and unspecified	303			617		19,909			
Industrial Goods and Equipment	37,930			5,158		12,028	33		231
Compressors	341			132	33	199			
Marine diesels				262		436	6	5	5
Diesel motors				90		88		120	54
Diesel generators				114		194			
Electric power units	1,329			236		394	7	7	3
Stern gears				20		33			
Repair shops				56		44			
Welding machines				77	77	86			
Winches				35	35	50	20	16	36
Transformers				372	12	93			
Dredges (suction)				218		216			
Oil tanks				20	15	120			
Miscellaneous and unspecified	36,260			3,526		10,075			133
Unknown and General	711			13,065		37,333			
Total	74,894			92,434		508,645			

a. The 1965 data is taken from the 1965 Soviet Statistical Handbook. The 1966 data is taken from shipping reports and includes no goods transported by rail; all values are at least partially estimated for 1966. The 1967 data [redacted] includes both sea and rail shipments, and covers items either shipped or loaded in the first quarter of 1967. Some values are estimated.
b. These vehicles are listed in "Identification Handbook: Soviet and Satellite Ordnance Equipment".
c. In 1965 this item includes the categories Iron, Bolts, and Miscellaneous and Unspecified which are itemized separately for 1966 and 1967. The value figure for 1966 is undoubtedly understated because of the volume listed for Miscellaneous and Unspecified in that year.

25X1

Table 16

Soviet Military Aid to North Vietnam a/
1965, 1966, and January-May 1967

	1965		1966		January-March 1967		April-May 1967	
	Quantity (Units)	Value (Million US $)	Quantity (Units)	Value (Million US $)	Quantity (Units)	Value (Million US $)	Quantity (Units)	Value (Million US $)
Total value		200.0		360.0		90.0		93.0
Surface-to-air missile systems		72.0		77.0		40.0		25.5
Firing battalions	15	66.0	10	44.0	5	22.0		
Replacement missiles	200	6.0	1,100	33.0	600	18.0	850	25.5
Aircraft	54	16.2	85	44.5	0	0	6	6.0
Il-28 light jet bomber	8	2.8						
MIG-21 jet fighter	11	8.8	26	20.8			5	4.0
MIG-15/17 jet fighter	32	4.2	42	5.5				
Mi-6 helicopter			6	12.0				
Mi-4 helicopter			7	1.4				
U-MIG-15 jet trainer	3	0.4						
An-24 medium transport			3	2.8				
Il-18 heavy transport			1	2.0			1	2.0
Armor	20	0.5	20	0.5	0	0	196	11.4
T-54 medium tank							60	5.2
T-34 medium tank							70	3.6
PT-76 amphibious tank	5	0.3	5	0.3			42	2.2
SU-76 assault gun	5	0.1	5	0.1			4	0.1
BTR-40 APC	10	0.1	10	0.1			20	0.3
Artillery	1,250	37.9	3,549	75.9	150	3.5	575	15.1
100-mm AAA	100	5.2	75	3.9				
85-mm AAA	315	12.4	620	25.0			150	6.0
57-mm AAA	485	17.0	800	27.9	75	3.0	200	7.0
37-mm AAA	250	2.2	1,949	17.5	75	0.5	200	1.8
Field artillery (76-152-mm)	100	1.1	105	1.6			25	0.3
Radar	23	4.4	160	30.1	60	11.0	50	9.0
Trucks and vehicles	1,000	5.0	1,000	5.0	300	1.5	600	3.0
Small arms and infantry weapons		2.0		4.0		1.0		1.0
Ammunition	17,000 tons	62.0	33,000 tons	123.0	9,000 tons	33.0	6,000 tons	22.0

a. Estimate does not include value of military infrastructure and facilities. Subtotals may not add because of rounding.

25X1

25X1

Table 17

Chinese Communist Military Aid to North Vietnam a/
1965, 1966, and January-May 1967

	1965		1966		January-March 1967		April-May 1967	
	Quantity (Units)	Value (Million US $)	Quantity (Units)	Value (Million US $)	Quantity (Units)	Value (Million US $)	Quantity (Units)	Value (Million US $)
Total Value		45.0		85.0		27.0		23.0
Aircraft	8	1.0	0	0	0	0	16	2.0
MIG-15/17 jet fighter	8	1.0					16	2.0
Naval craft	0	0	4	4.0	14	7.0	6	3.3
Shanghai-class PTF			4	4.0				
P-6 class MTB							6	3.3
Light cargo ship					14	7.0		
Artillery	300	5.3	100	3.5	0	0	100	2.2
57-mm AAA	100	3.5	100	3.5			50	1.7
37-mm AAA	200	1.8					50	0.5
Radar	33	3.7	112	9.0	10	1.0	10	1.0
Trucks and vehicles	1,000	5.0	100	0.5	200	1.0	200	1.0
Small arms and infantry weapons		10.0		30.0		8.0		6.0
Ammunition	8,000 tons	20.0	15,000 tons	38.0	4,000 tons	10.0	3,000 tons	7.5

a. Estimate does not include value of military infrastructure and facilities.

III

Air Operations, January - May 1967

III. Rolling Thunder Operations, January-May 1967*

A. Scale of Attack

The increasing intensity of the air war in the first five months of 1967 resulted in more than 76,000 sorties of all types against targets in North Vietnam. At this rate, sorties over a full year would number approximately 180,000 -- a 22-percent increase over 1966 and a 226-percent increase over 1965.**

The Rolling Thunder program accounted for about one-third of the total number of sorties flown over Southeast Asia in the first five months of 1967, compared with slightly more than 34 percent in 1966. Sorties against targets in North Vietnam and Laos combined accounted for more than one half of the sorties flown in Southeast Asia -- approximately the same share as in 1966. The total number and percentage shares of sorties of all types in each area of operation are shown in the following tabulation:

**See Tables 18 through 24, following P. 10.*

***Yearly projections cannot be precise, because sortie rates have fluctuated between North Vietnam and Laos, especially when winter weather conditions have dictated that missions that normally would be targeted to North Vietnam be diverted to Laos. Data based on only the first three months of this year would have projected only an 8-percent increase for sorties over North Vietnam for 1967 over 1966, compared with the 22-percent projection given above.*

Area of Operation	1965 Number of Sorties	1965 Percent of Total	1966 Number of Sorties	1966 Percent of Total	Jan-May 1967 Number of Sorties	Jan-May 1967 Percent of Total
North Vietnam	55,210	30	147,850	34	76,280	33
Laos	16,030	9	76,110	18	44,350	20
North Vietnam and Laos Combined	71,240	39	223,960	52	120,630	53
South Vietnam	110,310	61	204,120	48	108,390	47
Total Southeast Asia	181,550	100	428,080	100	229,020	100

Beginning in March of this year, attacks against heretofore immune industrial JCS designated fixed targets have received increasing emphasis within the Rolling Thunder program. Armed reconnaissance strikes, however, continue to account for an overwhelming percentage of activity. The shares of sorties flown and ordnance delivered against JCS fixed targets in North Vietnam are shown below:

	Percent a/			
	1965	1966	January-February 1967	March-May 1967
Sorties	25	1.8	1.6	4.1
Ordnance	37	2.8	4.0	7.6

a. All sorties flown and ordnance delivered over North Vietnam equal 100 percent in each case.

During the period March-May 1967 larger tonnages of ordnance were delivered against JCS targets than the quarterly averages in both 1965 and 1966. As a result of the employment of new aircraft capable of carrying heavier loads, higher ordnance delivery rates were also achieved during March-May of this year than in any preceding three-month period. The number of sorties flown against JCS targets in this period was more than three times the number in 1966, although still well below 1965. A comparison of sorties flown and ordnance delivered against JCS targets by three-month period is shown in the following tabulation:

	1965 a/	1966 a/	January-March 1967	March-May 1967
Sorties	3,470	655	980	2,120
Ordnance (tons)	3,200	890	2,070	3,780

a. Figures are quarterly averages.

In addition to the increased number of sorties flown against JCS targets, the Rolling Thunder program during 1967 has been marked by an increasing share of the armed reconnaissance effort being flown as pre-planned strikes against fixed targets. During 1966, for example, armed reconnaissance strikes against non-JCS designated fixed targets accounted for about one-fourth of the total armed reconnaissance program. During the January-May 1967 period, however, roughly one-half of the armed reconnaissance sorties were flown against these fixed targets.

During January-May 1967, almost 41,000 attack sorties, or 54 percent of total Rolling Thunder sorties, were flown against targets in North Vietnam. Attack sorties as a percentage of total sorties dropped slightly in North Vietnam, compared with 1966. This same trend is identifiable in both South Vietnam and Laos. In North Vietnam and Laos it reflects the need for

greater numbers of support aircraft to counter the increasingly efficient Communist air defense system. The percentages of total sorties made up by attack sorties in each area are shown in the following tabulation:

	Percent a/		
	1965	1966	January-May 1967
North Vietnam	47	56	54
South Vietnam	85 b/	79	77
Laos	68	64	58
Total Southeast Asia	70 b/	68	66

a. Total sorties equal 100 percent in every case.
b. US sorties only. Distribution of sorties by the South Vietnamese Air Force over South Vietnam in 1965 is not available.

The air effort against North Vietnam continued to be primarily a US undertaking, with sorties flown by the South Vietnamese Air Force accounting for a negligible percentage of the total. The share of total sorties flown by each service over North Vietnam is presented in the following tabulation:

	Percent		
	1965	1966	January-May 1967
US Air Force	44	53	50
US Navy	53	42	45
US Marine Corps	2	4	5
Total US	99	99	100
Vietnamese Air Force	1	1	Negl.
Total	100	100	100

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B. Ordnance

Total ordnance delivered over North Vietnam during January-May 1967 amounted to about 71,450 tons. This amounted to 22 percent of total ordnance delivered by all air operations in Southeast Asia, compared with 27 percent in 1966. As with sorties, the share of total ordnance that is delivered over North Vietnam increases as more favorable weather develops during the summer months. A rise in the share of ordnance delivered over North Vietnam from 20 percent at the end of the first quarter of 1967 to 22 percent for the first five months indicates a recurrence of this trend. The tabulation below compares the share of ordnance delivered in Southeast Asia in 1966 and the first five months of 1967, by area of operation:

	1966		January-May 1967	
Area of Operation	Tons	Percent	Tons a/	Percent
North Vietnam	128,070	27	71,450	22
Laos	74,120	15	59,300	18
North Vietnam and Laos combined	202,190	42	130,750	40
South Vietnam	278,050	58	194,310	60
Total Southeast Asia	480,240	100	325,060	100

a. Tonnages for April and May are estimated.

The weight of ordnance delivered over North Vietnam during January-May 1967 was almost 2.5 times the amount delivered during the same period in 1966. The rising trend results from increases both in the numbers of sorties flown and in the average loads of ordnance delivered per sortie. A comparison of the

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average tonnage of ordnance delivered per attack sortie in 1966 and in January-May 1967 is shown below:

Area of Operation	1966 Average Tonnage per Attack Sortie	Jan-May 1967 Average Tonnage per Attack Sortie
North Vietnam	1.6	1.8
Laos	1.5	2.3
South Vietnam	1.7	2.3
Total Southeast Asia	1.6	2.2

C. Losses

The rate of losses sustained by aircraft participating in the Rolling Thunder program continued to show the decline noted during 1966. Total aircraft losses over North Vietnam for the five months of 1967 totaled 142. This amounts to 3.5 downed aircraft per 1,000 attack sorties flown, compared with 3.9 in 1966 and 7.4 in 1965. Losses due to combat (excluding operational losses due to equipment failure) were even lower, totaling 3.0 per 1,000 attack sorties, compared with the 1966 and 1965 rates of 3.5 and 6.7, respectively. A comparison of aircraft losses as a percent of attack sorties is as follows:

Year	Attack Sortie	Total Losses	Total Losses as a Percent of Attack Sorties	Combat Losses	Combat Losses as a Percent of Attack Sorties
1965	25,940	192	0.74	173	0.67
1966	82,170	318	0.39	284	0.35
Jan-May 1967	40,840	142	0.35	123	0.30

A combination of factors probably has contributed to the continuing improvement in the loss rate in the face of North Vietnam's increasingly intense employment of surface-to-air missile, MIG aircraft, and conventional antiaircraft defenses. An increased degree of pilot familiarization with terrain and defenses apparently has resulted from assignment of primary areas of responsibility to each US service. Moreover, improved US electronic countermeasure equipment and greater experience by US forces in executing evasive tactics undoubtedly have degraded the accuracy of North Vietnam's antiaircraft gunners and SAM personnel.

Current figures indicate, however, that the favorable trend noted in the loss rate during 1966 and the first part of 1967 has had a slight reversal in the period March-May of this year. Specifically, loss rates during May of 4.1 per 1,000 attack sorties based on total losses and 3.8 based on combat losses were higher than corresponding figures of 3.9 and 3.5, respectively, for the year 1966. This trend is shown in the following tabulation.

Year and Month	Attack Sorties	Total Losses	Total Losses as a Percent of Attack Sorties	Combat Losses	Combat Losses as a Percent of Attack Sorties
1966	82,170	318	0.39	284	0.35
1967					
Jan-Feb	12,050	37	0.31	28	0.23
March	8,500	28	0.33	23	0.27
April	8,960	31	0.35	29	0.32
May	11,330	46	0.41	43	0.38

As noted previously, attacks against targets in the immediate vicinity of Hanoi and Haiphong in late April and May have had loss rates as high as 31 per 1,000 sorties flown (see II,B, above).

Reports covering three-fourths of the losses suffered by Rolling Thunder aircraft during the 1967 period to date indicate that 60 percent of these losses due to combat damage were suffered over Route Packages 5 and 6, despite the fact that only about 15 percent of total attack sorties were flown over these areas during January-May 1967. This is attributable to the great concentration of North Vietnam's air defenses in these locations. The percent of total losses and the percent of total sorties flown, by Route Package during January-May 1967, are as follows:

Locations of Combat Losses Over North Vietnam
January Through May 1967

	Percent						
Route Packages	I	II	III	IV	V	VI	Total
Losses	18	Negl.	14	8	10	50	100
Attack sorties	49	10	14	11	4	12	100

Losses per 1,000 attack sorties flown over North Vietnam continued to be substantially higher than for other areas of operation in Southeast Asia. However, this rate decreased in all three areas compared with 1966. The comparable figures are as follows:

Aircraft Lost Per 1,000 Attack Sorties Flown

Area of Operation	1966	Jan-May 1967
North Vietnam	3.9	3.5
South Vietnam	1.6	0.6
Laos	1.5	0.9
All areas of operation in Southeast Asia	2.2	1.5

During the period January-April 1967, over 130 US pilots and aircraft crewmen were downed over North Vietnam. About 30 percent were recovered, a smaller share than during 1966 when 40 percent were recovered. A high percentage of the downings took place over heavily populated industrial areas where search and rescue operations are hampered by a hostile environment. Personnel losses and recovery rates, by year are as follows:

Year	Personnel Downed	Percent Lost	Percent Recovered
1965	206	70	30
1966	446	60	40
Jan-April 1967	132	70	30

D. Costs

The direct operational cost of air operations over North Vietnam during the first five months of 1967 is estimated at about $608.6 million. This amount includes the production cost of aircraft lost, valued at about $283.5 million; direct operational costs of sorties flown, estimated at $174.8 million; and ordnance costs of about $150.3 million. Increased costs for 1967 are noted by comparing corresponding averages for 1966 (see the following tabulation).

Million US $

	1966	Average for 5 Months During 1966	January-May 1967
Aircraft lost	605.6	252.5	283.5
Sorties overhead	330.4	137.5	174.8
Ordnance	311.5	130.0	150.3
Total	1,247.5	520.0	608.6

The measurable costs to North Vietnam for the reconstruction or repair of bomb-damaged facilities and other indirect losses attributable to the bombing during January-May 1967 have been estimated at about $84.4 million. The trend of the cost of inflicting one dollar's worth of damage on North Vietnam is as follows:

	Cost of Damage[a]	Operational Cost[a]	Damage/Operational Cost
1965	68.7	460.0	$1/$6.70
1966	112.4	1,247.5	$1/$11.10
January-May 1967	84.4	608.6	$1/$7.20

a. *Million US $.*

The increase in the cost per dollar of damage in 1966 was attributable primarily to the increasing costs of a greatly accelerated air interdiction program that concentrated on low-yield target systems. The improved cost trend evident so far in 1967 reflects the increasing number of attacks that have been made against significant economic targets. There is little prospect for improved cost effectiveness in the future, however, because the number of significant targets is decreasing rapidly.

Table 18

Sorties Against North Vietnam, by Mission and Nationality a/
1965 and 1966

Year and Month	By US Services			By South Vietnamese Air Force			Total		
	Attack Sorties b/	Support Sorties	Total Sorties	Attack Sorties b/	Support Sorties	Total Sorties	Attack Sorties b/	Support Sorties	Total Sorties
1965									
January	0	0	0	0	0	0	0	0	0
February	130	70	200	60	0	60	190	70	260
March	530	240	770	120	Negl.	120	650	240	890
April	1,500	1,360	2,860	100	10	110	1,600	1,370	2,970
May	1,510	2,710	4,220	100	20	120	1,610	2,730	4,340
June	2,310	1,530	3,840	90	10	100	2,400	1,540	3,940
July	3,160	2,960	6,120	70	10	80	3,230	2,970	6,200
August	3,420	3,790	7,210	30	10	40	3,450	3,800	7,250
September	3,990	4,230	8,220	20	Negl.	20	4,010	4,230	8,240
October	3,460	4,550	8,010	10	Negl.	10	3,470	4,550	8,020
November	3,120	4,180	7,300	10	Negl.	10	3,130	4,180	7,310
December	2,170	3,570	5,740	30	20	50	2,200	3,590	5,790
Total 1965	25,300	29,190	54,490	640	80	720	25,940	29,270	55,210
1966									
January	130	2,890	3,020	0	0	0	130	2,890	3,020
February	2,810	3,710	6,520	0	0	0	2,810	3,710	6,520
March	4,480	4,940	9,420	10	10	20	4,490	4,950	9,440
April	5,310	5,090	10,400	140	0	140	5,450	5,090	10,540
May	4,360	4,250	8,610	110	0	110	4,470	4,250	8,720
June	7,520	5,430	12,950	270	0	270	7,790	5,430	13,220
July	9,960	6,240	16,200	240	0	240	10,200	6,240	16,440
August	11,790	7,030	18,820	20	0	20	11,810	7,030	18,840
September	12,340	6,880	19,220	10	0	10	12,350	6,880	19,230
October	8,700	6,060	14,760	Negl.	0	Negl.	8,700	6,060	14,760
November	7,250	6,180	13,430	10	0	10	7,260	6,180	13,440
December	6,710	6,970	13,680	Negl.	0	Negl.	6,710	6,970	13,680
Total 1966	81,360	65,670	147,030	810	10	820	82,170	65,680	147,850
Total 1965-66	106,660	94,860	201,520	1,450	90	1,540	108,110	94,950	203,060

a. Rounded to nearest 10 sorties. Negl. includes less than 5 sorties.
b. Attack sorties include strike and flak suppression sorties.

Table 19

Sorties Against North Vietnam, by Mission a/
January-May 1967

Year and Month	By US Services		
	Attack Sorties b/	Support Sorties	Total Sorties
1967			
January	6,580	7,160	13,740
February	5,470	5,620	11,090
March	8,490	6,880	15,370
April	8,960	7,150	16,110
May	11,310	8,630	19,940
Total	40,810	35,440	76,250 c/

a. Rounded to the nearest 10 sorties. Negl. includes fewer than 5 sorties.
b. Attack sorties include strike and flak suppression sorties.
c. In addition, the South Vietnamese Air Force flew 30 attack sorties against North Vietnam in January-May.

Table 20

Sorties Against North Vietnam, by Program and by Service
1965, 1966, and January-May 1967

Year and Month	On Fixed Targets		On Armed Reconnaissance				Services			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
							United States			South Vietnamese
	Total on Fixed Targets (Col. 2 & 3)	By Fixed Target Strikes	By Armed Reconnaissance Strikes	Armed Reconnaissance Not on Fixed Targets	Total on Armed Reconnaissance	Total (Col. 1 & 4)	Air Force	Navy	Marine	Air Force
1965										
January	0	0	0	0	0	0	0	0	0	0
February	0	0	0	260	260	260	80	120	N.A.	60
March	850	850	0	40	40	890	360	410	N.A.	120
April	1,800	1,460	340	1,170	1,510	2,970	1,200	1,660	N.A.	110
May	1,790	1,300	490	2,550	3,040	4,340	2,280	1,940	N.A.	120
June	1,410	1,360	50	2,530	2,580	3,940	1,840	2,000	N.A.	100
July	1,910	1,590	320	4,290	4,610	6,200	2,380	3,600	140	80
August	1,900	1,390	510	5,350	5,860	7,250	3,030	4,030	150	40
September	1,600	1,440	160	6,640	6,800	8,240	3,890	4,160	170	20
October	770	570	200	7,250	7,450	8,020	3,480	4,370	160	10
November	1,040	570	470	6,270	6,740	7,310	3,330	3,830	140	10
December	820	530	290	4,970	5,260	5,790	2,630	2,980	130	50
Total	13,890	11,060	2,830	41,320 a/	44,150 a/	55,210 a/	24,500	29,100	890	720
1966										
January	0	0	0	3,020	3,020	3,020	1,570	1,220	230	0
February	170	0	170	6,350	6,520	6,520	3,190	3,160	170	0
March	180	0	180	9,260	9,440	9,440	4,600	4,630	190	20
April	390	50	340	10,150	10,490	10,540	4,850	5,410	140	140
May	160	0	160	8,560	8,720	8,720	4,060	4,420	130	110
June	320	240	80	12,900	12,980	13,220	7,340	5,420	190	270
July	360	50	310	16,080	16,390	16,440	9,520	6,100	580	240
August	280	20	260	18,560	18,820	18,840	9,660	8,120	1,040	20
September	150	0	150	19,080	19,230	19,230	10,110	8,090	1,020	10
October	150	0	150	14,610	14,760	14,760	8,410	5,670	680	Negl.
November	140	30	110	13,300	13,410	13,440	7,130	5,490	810	10
December	320	30	290	13,360	13,650	13,680	8,150	4,820	710	Negl.
Total	2,620	420	2,200	145,230	147,430	147,850	78,590	62,550	5,890	820

Table 20

Sorties Against North Vietnam, by Program and by Service
1965, 1966, and January-May 1967
(Continued)

Year and Month	On Fixed Targets		On Armed Reconnaissance				Services			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Total on Fixed Targets (Col. 2 & 3)	By Fixed Target Strikes	By Armed Reconnaissance Strikes	Armed Reconnaissance Not on Fixed Targets	Total on Armed Reconnaissance	Total (Col. 1 & 4)	United States Air Force	United States Navy	United States Marine	South Vietnamese Air Force
1967										
January	200	0	200	13,540	13,740	13,740	7,500	5,750	490	0
February	200	80	120	10,890	11,010	11,090	5,590	4,860	640	0
March	580	170	410	14,800	15,210	15,380	7,680	6,790	900	10
April	750	350	400	15,360	15,760	16,110	7,760	7,470	880	Negl. b/
May	790	110	680	19,170	19,850	19,960	9,710	9,340	890	20
Total for first five months of 1967	2,520	710	1,810	73,760	75,570	76,280	38,240	34,210	3,800	30

a. Also includes 645 miscellaneous sorties such as leaflet drops, gift drops, and photo reconnaissance sorties not accompanying a strike mission.
b. Negl. includes fewer than 5 sorties.

Table 21

Distribution of Attack Sorties
over North Vietnam, by Route Package a/
January 1966 - May 1967

Year and Month	Route Package 1	2	3	4	5	6	Unknown	Total
1966								
January	17	18	30	4	3	0	28	100
February	31	24	15	3	5	0	22	100
March	34	31	13	5	11	0	6	100
April	37	29	17	3	6	3	5	100
May	30	19	26	10	6	4	5	100
June	49	19	14	8	1	4	5	100
July	47	18	12	5	4	8	6	100
August	35	16	11	9	1	12	16	100
September	39	16	12	17	5	8	3	100
October	45	8	15	13	5	7	7	100
November	43	12	16	13	6	7	3	100
December	50	9	7	5	7	9	13	100
Average 1966	37	15	13	9	4	7	15	100
1967 b/								
January	44	6	15	21	4	10	0	100
February	63	7	9	12	3	6	0	100
March	59	9	12	8	4	8	0	100
April	49	11	14	7	5	14	0	100
May	39	13	18	11	3	16	0	100
Average 1967	49	10	14	11	4	12	0	100

a. North Vietnam is divided, for operations, into six geographic areas, known as Route Packages. Percentage data shown are approximate, due to the effects of multiple-route-package sorties and coastal sorties.
b. A more detailed data base, available for 1967 figures, dispensed with the unknown factor.

Table 22

Ordnance Delivered by Air on North Vietnam, by Month and by Program
March-December 1965, 1966, and January-May 1967

Tons

Year and Month	On JCS Fixed Targets (1) Total on JCS Fixed Targets (Col. 2 & 3)	On JCS Fixed Targets (2) By Fixed Target Strikes	On JCS Fixed Targets (3) By Armed Reconnaissance Strikes	On Armed Reconnaissance (4) Armed Reconnaissance Not on Fixed Targets	On Armed Reconnaissance (5) Total on Armed Reconnaissance (Col. 3 & 4)	Total (6) Total (Col. 1 & 4)
1965						
March	1,130	1,130	0	0	0	1,130
April	1,830	1,620	210	430	640	2,260
May	1,420	1,420	0	380	380	1,800
June	1,900	1,900	0	1,430	1,430	3,330
July	1,490	1,410	80	1,980	2,060	3,470
August	1,470	1,280	190	3,200	3,390	4,670
September	1,790	1,780	10	3,730	3,740	5,520
October	700	590	110	4,390	4,500	5,090
November	620	480	140	3,900	4,040	4,520
December	450	350	100	2,060	2,160	2,510
Total 1965	12,800	11,960	840	21,500	22,340	34,300
1966						
January	0	0	0	270	270	270
February	270	0	270	4,510	4,780	4,780
March	220	0	220	7,520	7,740	7,740
April	460	80	380	8,580	8,960	9,040
May	220	0	220	7,330	7,550	7,550
June	280	190	90	10,680	10,770	10,960
July	440	60	380	15,900	16,280	16,340
August	460	40	420	16,870	17,290	17,330
September	260	0	260	17,500	17,760	17,760
October	220	0	220	13,500	13,720	13,720
November	240	10	230	10,930	11,160	11,170
December	490	60	430	10,920	11,350	11,410
Total	3,560	440	3,120	124,510	127,630	128,070

Table 22

Ordnance Delivered by Air on North Vietnam, by Month and by Program
March-December 1965, 1966, and January-May 1967
(Continued)

Tons

Year and Month	On JCS Fixed Targets (1) Total on JCS Fixed Targets (Col. 2 & 3)	On JCS Fixed Targets (2) By Fixed Target Strikes	On JCS Fixed Targets (3) By Armed Reconnaissance Strikes	On Armed Reconnaissance (4) Armed Reconnaissance Not on Fixed Targets	On Armed Reconnaissance (5) Total on Armed Reconnaissance (Col. 3 & 4)	Total (6) Total (Col. 1 & 4)
1967						
January	450	0	450	11,050	11,500	11,500
February	430	200	230	10,000	10,230	10,430
March	1,190	340	850	14,690	15,540	15,880
April a/	1,350	450	900	13,770	14,670	15,120
May a/	1,240	160	1,080	17,280	18,360	18,520
Total for first five months of 1967 a/	4,660	1,150	3,510	66,790	70,300	71,450

a. Columns 2-6 for the months of April and May are estimates derived from sorties flown to ordnance delivered ratios computed from data compiled during the period February 1966 through February 1967.

Table 23

Attack on JCS Fixed Targets in North Vietnam
1965, 1966, and January-May 1967

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Year and Program	Sorties Flown				Ordnance Delivered	
	Strike and Flak Suppression	Support	Total Number	Total Percent	Tons	Percent
1965						
Fixed Target	6,930	4,130	11,060	80	11,960	93
Armed Reconnaissance	1,780	1,050	2,830	20	840	7
Total January-December 1965	8,710	5,180	13,890	100	12,800	100
1966						
Fixed Target	270	150	420	16	440	12
Armed Reconnaissance	1,830	370	2,200	84	3,120	88
Total January-December 1966	2,100	520	2,620	100	3,560	100
1967						
Fixed Target	640	70	710	28	1,150	25
Armed Reconnaissance	1,730	80	1,810	72	3,510	75
Total January-May 1967	2,370	150	2,520	100	4,660	100

25X1

Table 24

Aircraft and Personnel Losses in Attack on North Vietnam, by Service 1965, 1966, and January-May 1967

	Service	Aircraft	Personnel Lost	Personnel Recovered
1965				
	USAF	78	62	30
	USN	86	76	30
	USMC	0	0	0
	VNAF	9	6	2
Total		173 a/	144	62
1966				
	USAF	174	165	85
	USN	139	96	86
	USMC	4	8	2
	VNAF	0	0	0
	US Army	1	0	4
Total		318 b/	269	177
1967				
	USAF	68	40	18
	USN	72	50	21
	USMC	2	2	1
	VNAF	0	0	0
Total		142 c/	92 d/	40 d/

a. Excluding operational losses.
b. 284 combat losses and 34 operational losses.
c. 123 combat losses and 19 operational losses in January-May.
d. Data are for the period January-April.

IV

Prospects of an Effective Bombing Program

IV. Prospects of an Effective Bombing Program

A. The Success To Date

The objectives of the bombing program are stated currently to be twofold:

1. To limit,or raise the cost of, the movement of men and supplies to South Vietnam

2. To make North Vietnam pay a price for its aggression against the South.

To the extent that any degradation of enemy capabilities or any penalties imposed on his aggressive conduct in South Vietnam are indicative of successful achievement of US objectives, the US bombing program must be judged to be meeting with some success. But the degree of success is limited. The bombing program has undoubtedly raised the cost and increased the burdens of maintaining the aggression in South Vietnam. These exactions appear to be within acceptable limits to the Hanoi regime. Given a continuing flow of economic and military aid from Communist China and the USSR, North Vietnam remains capable of maintaining and supplying its forces in South Vietnam at both present and higher levels of combat. The price of its aggression, with the exception of manpower losses, and the general economic and social disruption in North Vietnam is largely being assumed by its Communist allies.

Despite the increased weight and broadening of the air attack, North Vietnam nas expanded its support of the insurgency in South Vietnam. There was a threefold increase in the level of personnel infiltration in 1966, and additional thousands of troops have been positioned in and around the DMZ. The flow of material supplies to the Viet Cong and North Vietnamese forces in South Vietnam during the current dry season is at least equal to and may well exceed the volume made available last year.

The North Vietnamese economy has suffered increasing damage, but this has had no decisive effect on the attitude of the regime toward the war, nor has it caused a deterioration of popular morale to the point where the regime has lost the support of its people. The performance of the domestic transportation system exceeds that achieved

before the Rolling Thunder program; imports both by sea and by rail have moved to increasingly high levels. Deficiencies in domestic food supply are being met by the USSR and Communist China, and food shortages have not attained serious proportions. The vital petroleum storage system, as currently dispersed, has survived the destruction of more than 85 percent of its major bulk storage capacities, and petroleum stocks have been maintained at essentially early 1966 levels. The neutralization of about 80 percent of the country's electric power generating capacity has created severe shortages of power and disrupted much of North Vietnam's modern industrial economy. It is unlikely, however, that the loss of electric power can have a significant impact on military operations.

B. Outlook

The outlook for marked success of the US bombing program in limiting communist support to the forces in the South is not bright. By the end of April the US bombing program had attacked 209 targets, or more than three-fourths of the targets on the JCS list. About 13 of these struck targets (11 bridges and 2 ammunition depots) received only minor damage, so that their pre-strike capacity is relatively intact. The 53 unstruck targets are grouped, by category, as follows:

Target System	Number
Bridges	10
Airfields	5
Military barracks headquarters and storage depots	12
Powerplants	5
Locks	6
Industry	4
Mineable areas	4
Miscellaneous	7
Total	53

In addition, there are seven non-targeted industrial facilities that are significant to the North Vietnamese economy and its war-supporting activities.

The returns that can be realistically expected from the neutralization of the remaining economic, military, and land transport JCS targets are small. The two most promising target systems -- locks and mineable areas -- have been unacceptable to date on humane grounds or because of the political problems their neutralization would create. The enemy's success in countering attacks on bridges and in sustaining traffic movement is too well catalogued to warrant further discussion. Attacks on military installations would have only limited effects. Many of these facilities are inactive, and contingency plans to counter their loss are undoubtedly well-developed. Even if North Vietnam were denied complete access to its airfields, this alone would be unlikely to significantly alter the regime's attitude toward the war because it would have only a marginal effect, through increasing costs, on the flow of men and supplies to the South.

The neutralization of North Vietnam's remaining industry would extract a high price in terms of the elimination of the results of years of economic development and the displacement of the urban labor force and would add to the burden of aid from other Communist countries. There is no apparent reason why such losses would force Hanoi to the negotiating table. The loss of its modern industrial sector is apparently a tolerable burden in a country that has an overwhelmingly agrarian economy. The contribution of North Vietnam's modern economy to the war effort is small, and its loss can be countered as long as essential economic and military supplies can be obtained from the USSR and China.

The greatest possible impact on Hanoi would result from a US strike program which would include mining the major ports and inland waterways, to which the remaining JCS transport targets, other than the locks, would make a useful addition. It has previously been estimated that such a program would be a matter of serious concern to the Hanoi leadership, particularly if accompanied by more extensive attacks on the supply routes from Communist China. Some import programs would have to be forgone and problems of supply and distribution would be acute. However, even this program's successful execution would be unlikely to dampen down the continued movement of men and supplies from North Vietnam to the South.

C. Costs to the United States

The United States would probably pay increasing costs -- both political and military -- in choosing any of the available options for escalation of the air war. The political costs in terms of both domestic US and international reactions would vary with the options chosen. Losses of US aircraft from combat causes during attacks on JCS targets located within a 10-mile radius of Hanoi and a similar area around Haiphong during the 41-day period April 20, 1967 to May 31, 1967 were inflicted at a rate of 3.1 percent, about 10 times the corresponding rates experienced during the 1966 campaign and in attacks on more isolated targets during 1967. The preponderance of the targets yet unstruck are in the more heavily defended areas of North Vietnam. More than 90 percent -- 49 targets -- are in Route Packages 5 and 6. Of these four are in Route Package 5, 36 are in Route Package 6, which includes Hanoi and Haiphong, and nine targets are in the buffer zone along the Chinese-North Vietnamese border.

[redacted]

Top Secret