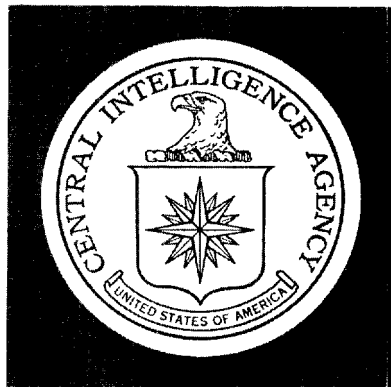


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DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

Petroleum in North Vietnam at the Outset of 1967
(A Review of Developments During 1966)

JCS review completed.

Secret

DIA review(s)
completed.

Nº 138

RR IM 67-9
February 1967

WARNING

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FOREWORD

This memorandum makes estimates of the supply of petroleum in North Vietnam at the beginning and end of 1966 and on 28 June 1966, the day before intensified bombings began. It also estimates storage capacity on these dates. No hard intelligence is available on inventories of petroleum, total petroleum storage capacity, or losses through bombings, but a methodology has been developed to provide the necessary estimates.

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PETROLEUM IN NORTH VIETNAM
AT THE OUTSET OF 1967
(A Review of Developments During 1966)*

Summary

The bombing of petroleum targets during 1966 destroyed an estimated 82,000 tons** of storage capacity and between 41,000 and 62,000 tons of petroleum; the combined replacement value is between US \$4.9 million and \$5.6 million. In addition, the bombing increased the cost and difficulty of importing and distributing petroleum, both for the USSR and North Vietnam. There is no evidence, however, that the bombing of petroleum targets seriously weakened the economy of North Vietnam, produced shortages of petroleum, or diminished North Vietnam's capability to support military activities or the infiltration of men and supplies into the South.

At the beginning of 1967, between 52,000 and 56,000 tons of petroleum are estimated to have been on hand -- the equivalent of between 90 and 100 days' supply. The program for constructing dispersed storage tanks, which is still under way, provided North Vietnam with between 30,000 and 40,000 tons of usable capacity by 1 January 1967. This, together with the residual capacity estimated to be available at the principal storage terminals and a sizable inventory of drums, gives North Vietnam between 87,000 and 97,000 tons of capacity with which to operate its oil economy.

Although present storage capacity is less than that which existed at the beginning of 1966, the North Vietnamese can move petroleum in bulk, principally by water, closer to points of consumption; store it in facilities which are relatively invulnerable to air attack; and disperse it throughout the countryside to a degree not previously possible.

North Vietnam has improved its tanker unloading procedures in the last half of 1966 to the point where it can discharge the cargoes of 10,000-ton tankers, using barges, on a routine basis.

* This memorandum was produced solely by CIA. It was prepared by the Office of Research and Reports; the estimates and conclusions represent the best judgment of the Directorate of Intelligence as of February 1967.

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

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1. Introduction

North Vietnam has no known resources of petroleum and is completely dependent on imports for its supplies. Moreover, it has no refineries and must import all of its petroleum in the form of products.

Historically, most petroleum imports have been delivered to North Vietnam by sea -- mostly in bulk on tankers, but also in packages on dry cargo vessels. Intelligence on sea shipments is good, and imports by sea can be estimated with a high degree of accuracy. In recent years, petroleum has also been imported by rail through Communist China. Intelligence on rail shipments is poor, and estimates of imports by rail are, therefore, subject to considerable margins of error. Fortunately, such shipments have almost certainly been small, except for the probable transshipment of the cargoes of four tankers diverted to Communist China in 1966.

2. Petroleum Storage

a. Principal Storage Terminals

The principal storage terminals are large-capacity installations with conventional above-ground tanks. Figure 1 shows the terminal at Hanoi before and after bombing. On 28 June, the day before the intensified bombings began, nine principal storage terminals, with a total estimated capacity of almost 101,000 tons, were operational in North Vietnam. At the end of the year, about 24,000 tons of residual capacity* remained at seven installations, although the capacity at two of these installations may not in fact have been usable. Table 1 shows the location and capacity of the principal storage terminals on 1 January and 31 December 1966. The locations of the nine principal storage terminals are shown on Figure 2.

b. Dispersed Storage Sites -- Tanks

The dispersed storage tank system was first observed in 1965 and was still being expanded at the end of 1966. The sites consist essentially of small cylindrical tanks placed horizontally in shallow excavations and covered with earth. At some sites the tanks are placed side-by-side in rows, and at others they are placed at random. Individual tanks come

* Residual capacity at JCS fixed targets totals about 26,000 tons, including about 24,000 tons at principal storage terminals and 2,500 tons at Can Thon , a dispersed storage site.

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in three sizes -- 6, 10, and 21 tons -- and individual sites have varying numbers and mixes of the tanks. Figures 3 and 4 show examples of dispersed storage tank sites.

There is no intelligence on which to make an estimate of the capacity of these sites on 1 January 1966. On the basis of photographic intelligence that became available during 1966, it is estimated that their capacity on 28 June was 17,000 tons. By the end of 1966, 89 dispersed tank sites with a total estimated capacity of about 32,000 tons had been identified and analyzed from photography. Pilot and other reports from the field suggest that the number of sites may exceed 100, with an original total capacity of perhaps 35,000 to 45,000 tons. The average (median) capacity of the 89 sites is 226 tons; almost two-thirds have capacities of less than 300 tons, and only about 10 percent have capacities greater than 1,000 tons. Figure 5 shows the general location and dispersal of the 89 sites.

Dispersed tank sites have been bombed in recent months, but damage has been difficult to assess. According to one analysis, almost 5,000 tons of capacity have been destroyed, 1/* and this estimate is considered reasonable. Although the estimate probably does not allow fully for the inflation inherent in pilot and other reports from the field, it also excludes damage to sites for which no assessments are available. Thus, at the end of 1966, these sites, after bombing, may represent between 30,000 and 40,000 tons of capacity.

The tank sites are dispersed throughout the country, and, although many are in urban areas, they are generally remote from densely populated areas. Figure 6 shows a dispersed site in an isolated area near Hanoi. Sixteen sites, having a total capacity of 3,900 tons, have been identified within a 10-mile radius of Hanoi, and 33 sites, with a capacity of about 12,000 tons, within a 30-mile radius. There are 11 sites, with a total capacity of almost 5,000 tons, within a 10-mile radius of Haiphong. This capacity, together with the residual capacity at the remaining principal storage sites in the Hanoi/Haiphong area, enables North Vietnam to discharge (using barges) fully loaded ocean tankers on a routine basis. Figure 7 shows a Soviet tanker with barges alongside in the Haiphong waters.

The North Vietnamese generally have located dispersed tanks at sites accessible to more than one mode of transport and have taken advantage of security inherent in cover, concealment, and dispersal.

* For serially numbered source references, see Appendix B.

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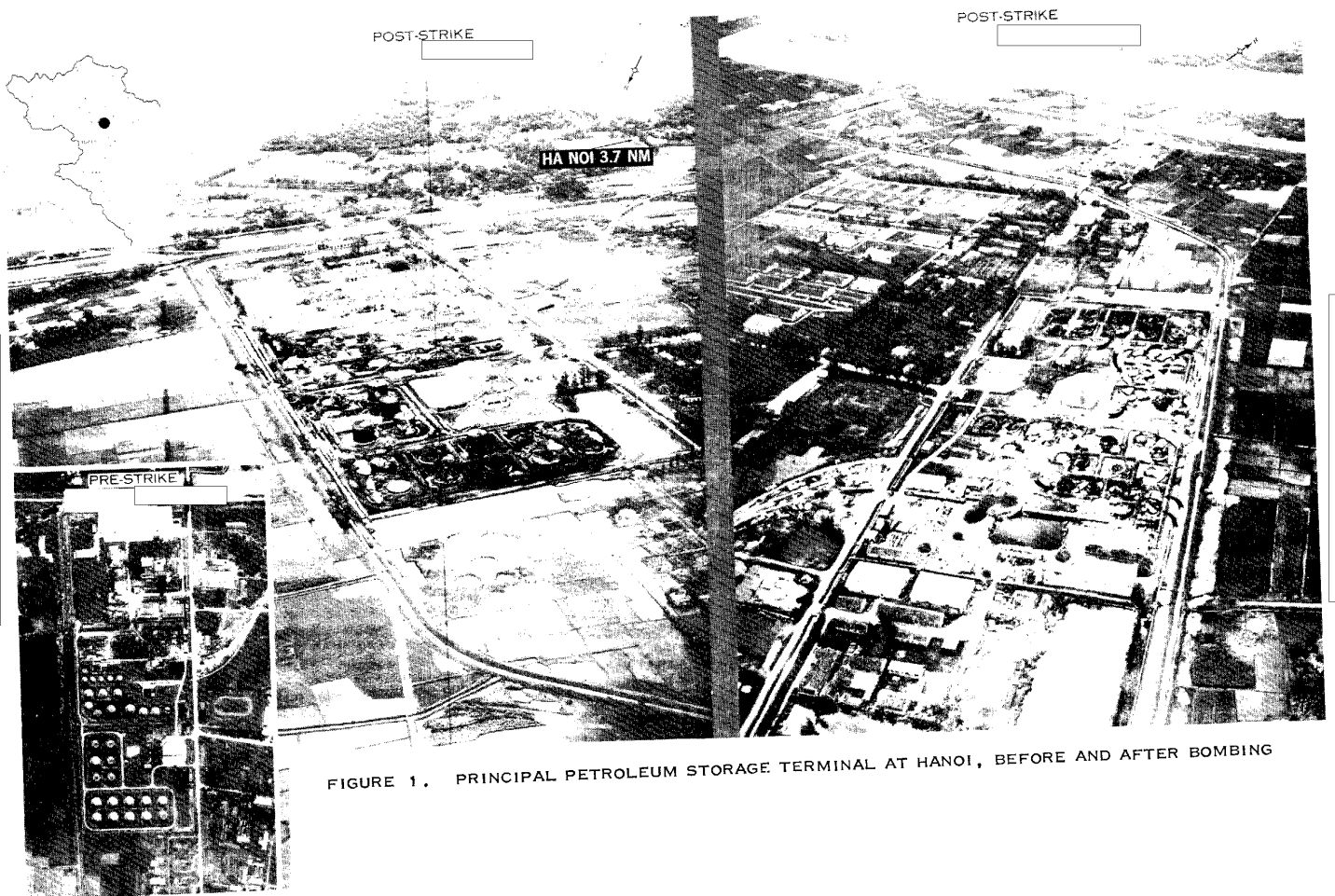


FIGURE 1. PRINCIPAL PETROLEUM STORAGE TERMINAL AT HANOI, BEFORE AND AFTER BOMBING



PRE-STRIKE, [REDACTED]

NOTE UNIFORM PATTERN OF TANK EMPLACEMENT



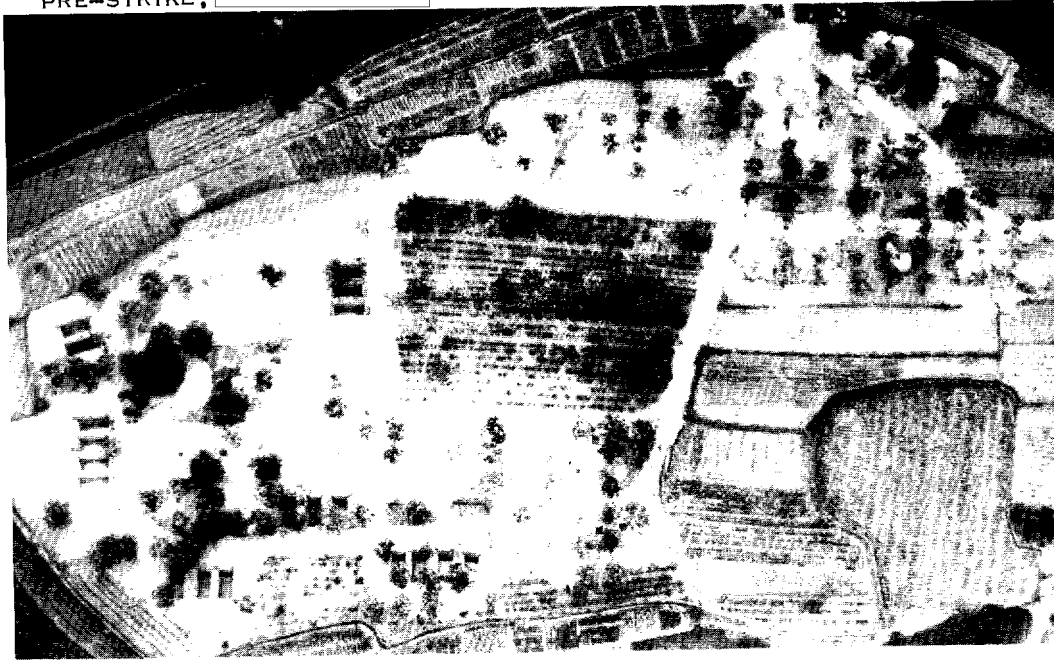
POST-STRIKE, [REDACTED]

FIGURE 3. CU VAN DISPERSED STORAGE TANK SITE, BEFORE AND AFTER BOMBING




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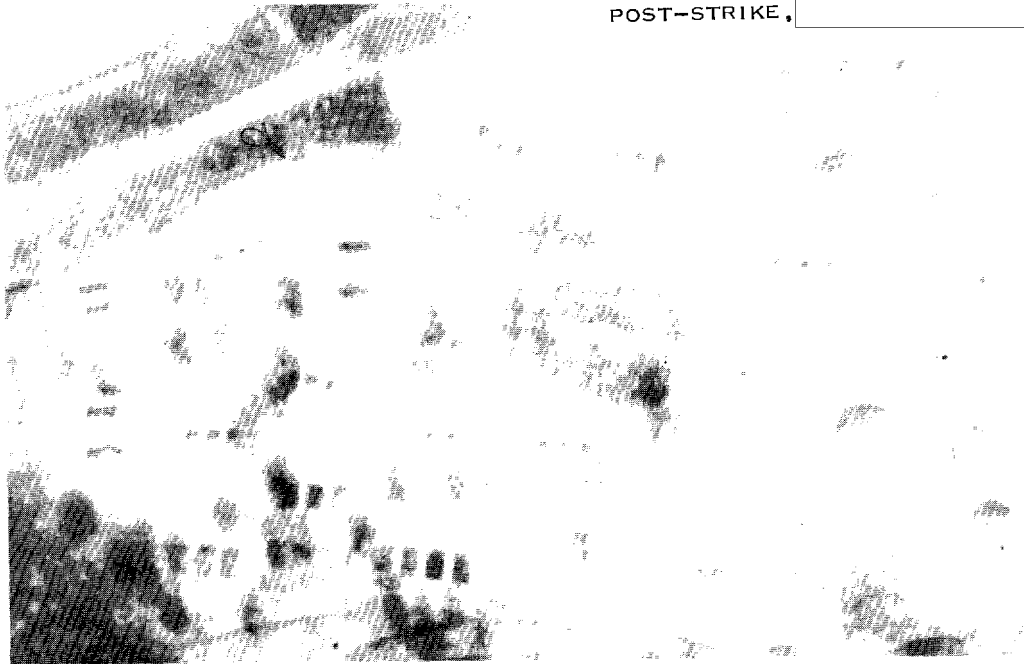
PRE-STRIKE, 



NOTE RANDOM PATTERN OF EXCAVATIONS FOR FUTURE TANKS AND TANKS COVERED AND CONCEALED IN PLACE

POST-STRIKE, 

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NOTE THAT EXPANSION HAS BEEN HALTED AND THAT TANKS, PREVIOUSLY COVERED AND CONCEALED, HAVE BEEN REMOVED

FIGURE 4. THUONG THON DISPERSED STORAGE TANK SITE, BEFORE AND AFTER BOMBING



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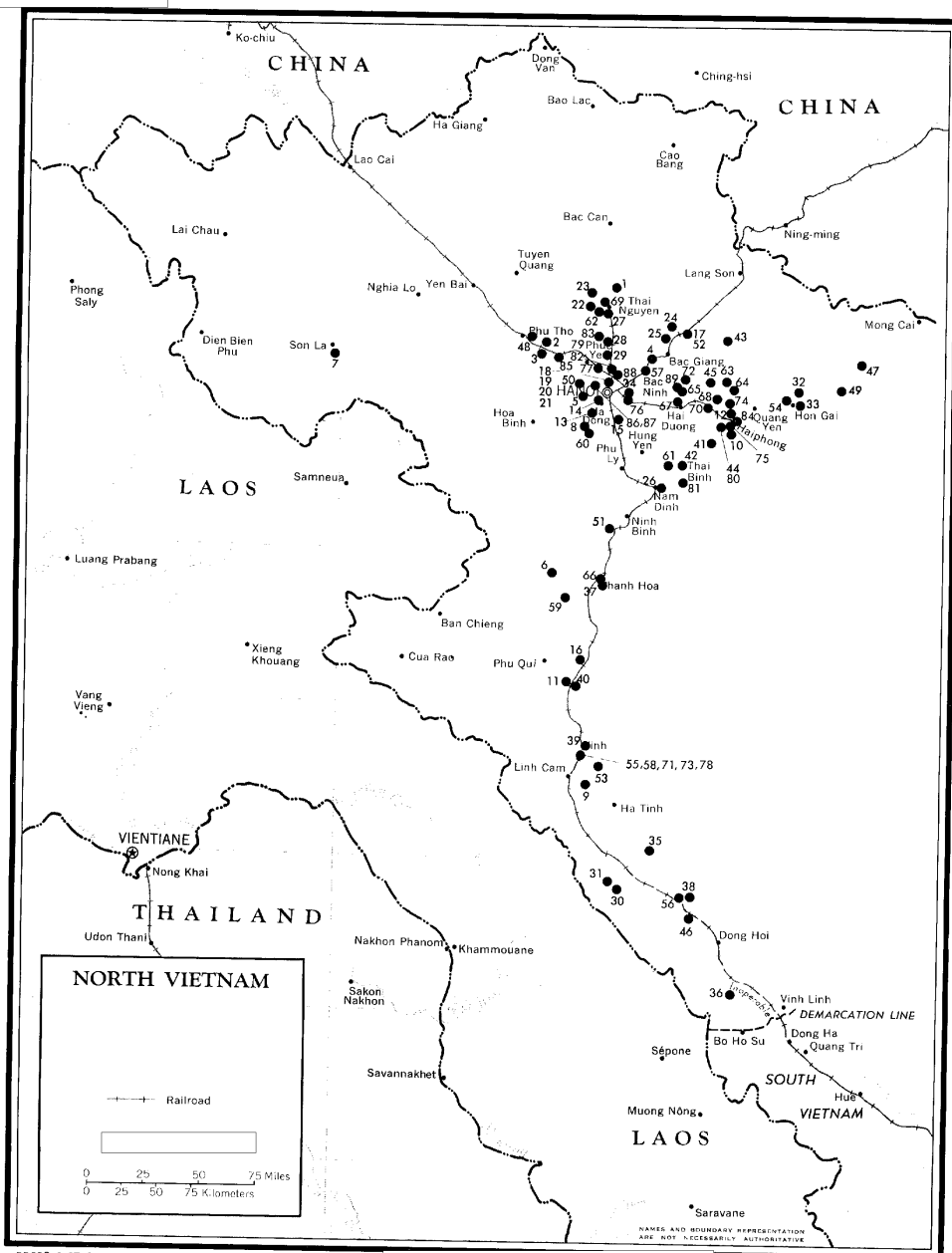


Figure 5
NORTH VIETNAM
DISPERSED PETROLEUM STORAGE SITES-TANKS

- | | |
|--------------------------------|-------------------------------|
| 1. La Danh | 46. Xom Lang |
| 2. Van Lung | 47. Van Hoa |
| 3. Van Lung (West) | 48. Phu Lo |
| 4. Hoang Mai | 49. Jaune Island |
| 5. Hanoi, Thi Cam | 50. Co Nhuc Hoang |
| 6. Bai Thuong, Southeast | 51. Quang Suoi |
| 7. Son La | 52. Trung Phu |
| 8. Thuong Thon | 53. Gia Hoa |
| 9. Ngoc Son | 54. Bai Chay |
| 10. Thai Lai | 55. Vinh Petroleum, Yen Thinh |
| 11. Yen Hieu | 56. Ba Don, West |
| 12. Thanh Lang | 57. Bac Ninh |
| 13. Hanoi, Thanh Liet (Area 1) | 58. Vinh, Xuan Yen |
| 14. Hanoi, Thanh Liet (Area 2) | 59. Tri Binh |
| 15. Bang So | 60. Xuyen Duong |
| 16. Son Chau | 61. Cao Cong |
| 17. Can Thon | 62. Tung Tu |
| 18. Hanoi, Duc Noi (Area 1) | 63. Don Son |
| 19. Hanoi, Duc Noi (Area 2) | 64. Quy Khe |
| 20. Hanoi, Duc Noi (Area 3) | 65. Tran Xa |
| 21. Hanoi, Duc Noi (Area 4) | 66. Thanh Hoa |
| 22. Cu Van | 67. Tram Du |
| 23. Cu Van, East | 68. Luc Nong |
| 24. Dao Quan, East | 69. Thai Nguyen |
| 25. Dao Quan, West | 70. Tien Nong |
| 26. Nam Dinh | 71. Vinh, Ben Thuy |
| 27. Thai Nguyen, South | 72. Chi Linh |
| 28. Phu Yen Airfield, Area 1 | 73. Vinh, Yen Dai |
| 29. Phu Yen Airfield, Area 2 | 74. Hoang Pha |
| 30. Xom Duong Quan, East | 75. Kien An |
| 31. Xom Duong Quan, West | 76. Phu Thi |
| 32. Nui Tap Tinh | 77. Phu Yen |
| 33. Sac Le | 78. Vinh, North |
| 34. Phu Dong | 79. Mach Trang |
| 35. Thuan Le | 80. Tram Bac |
| 36. Phu Lac | 81. Nam Lo |
| 37. Thanh Hoa | 82. Hanoi, Duc Noi (Area 5) |
| 38. Ba Don | 83. Lai Son |
| 39. Phu Loi, Navy | 84. Phu Xa |
| 40. Thu Trang | 85. Hoa Loan |
| 41. Ninh Giang | 86. Tu Hoang |
| 42. Viet Yen | 87. Tay Tuu |
| 43. Kep Ha | 88. Nguyen Khe |
| 44. Tien Hai | 89. Lau Khe |
| 45. Dong Mai | |

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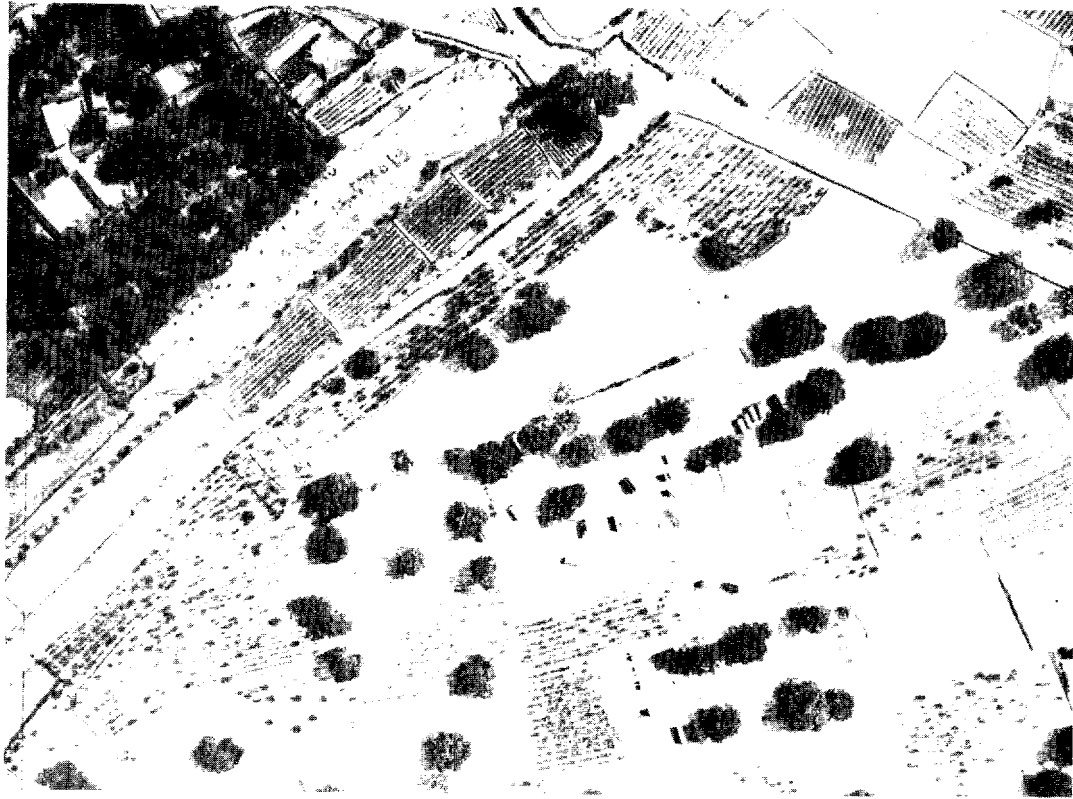


FIGURE 6. HANOI (DUC NOI) DISPERSED STORAGE TANK SITE. NOTE NATURE AND STAGES OF CONSTRUCTION, TANK SIZE MIX, AND LOCATION REMOTE FROM POPULATION AREA.

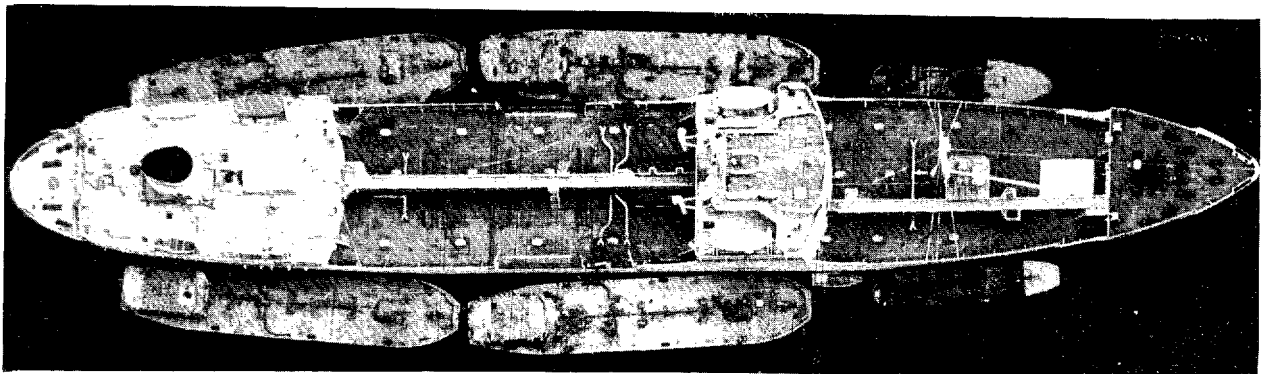


FIGURE 7. SOVIET TANKER IN HAIPHONG WATERS WITH BARGES AND TUGS ALONGSIDE

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All of the identified sites are served by road: 38 are served by road, rail, and waterways; 30 others by road and waterway, 16 more by road and rail, and the remaining 5 by road only. The waterways that serve these sites are shallow, however, thus limiting the type of craft that can approach. Table 2 shows the location and capacity of the 89 identified sites and indicates the kind of transportation routes available.

The dispersed storage tank system provides North Vietnam with a new and greater capability to distribute petroleum internally. Although the estimated capacity of this system is far less than the capacity destroyed at the principal storage terminals, the flexible and reasonably secure routes of communication that serve the dispersed sites and the ability to move and store sizable quantities of petroleum in bulk closer to points of consumption are offsetting influences. Moreover, the dispersed tank sites are relatively invulnerable to bombing. Figure 8 illustrates the latter characteristic. More than 400 airstrikes were mounted against 39 dispersed tank sites, where an estimated 5,000 tons of capacity were destroyed.* Only 85 airstrikes were mounted against principal storage terminals, destroying an estimated 77,000 tons of capacity.

c. Dispersed Storage Sites -- Drums

North Vietnam has accumulated a sizable inventory of various types of small petroleum containers. It is not possible to identify the number or size of these containers; for purposes of this memorandum, estimates are expressed in terms of 55-gallon-drum equivalents. A drum-equivalent inventory has been estimated from the tonnages of packaged petroleum shipped to North Vietnam on dry cargo vessels during the period 1 January 1963 through 31 December 1966 by converting at the rate of six drums per metric ton. A loss factor of 10 percent per year was applied to the estimated drum inventory at the end of 1963, 1964, and 1965, and 5 percent was applied as of mid-1966. It is estimated that by mid-1966 there may have been about 130,000 drums in North Vietnam. An additional 49,000 drums were received during the last half of 1966. A loss factor of 5 percent was applied to the total to account for normal losses in the last half of 1966. On this basis, 170,000 drums -- equivalent to about 28,000 tons of storage capacity -- may have been on hand in North Vietnam on 31 December 1966.

* In addition, almost 800 strikes were made against identified or suspected dispersed tank and drum storage sites for which no damage assessment is available.

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Not all of these drums are filled at any one time. A reasonable drum use cycle can be postulated as follows:

- (a) Drums in reserve supply depots - filled
- (b) Drums at fill and repair sites - empty
- (c) Drums at points of consumption - one-half filled, one-half empty
- (d) Drums en route to points of consumption - filled
- (e) Drums en route to fill and repair sites - empty

In the absence of the intelligence necessary to make a more definitive estimate, each phase of this cycle is considered to require an equal share of the drum inventory. Overall, therefore, 50 percent of the drums are estimated to be filled and 50 percent empty at any given time.

Drums, too, have been the targets of air attacks, but it is not possible to make a realistic estimate of losses. Losses probably have been small because drums are dispersed among woods, in foliage along roads, and in trenches and thus are difficult to identify and destroy.

d. Other Storage Sites

Other bulk petroleum storage facilities have been identified at industrial and military installations. These facilities are for the exclusive use of the installation they serve, whereas the facilities discussed above store and distribute petroleum for a variety of consumers. It is estimated that total capacity represented by these limited-use facilities -- about 5,000 tons -- did not change during 1966.

e. Capacity at the End of the Year

Petroleum storage capacity as of the end of 1966 may be summarized as follows:

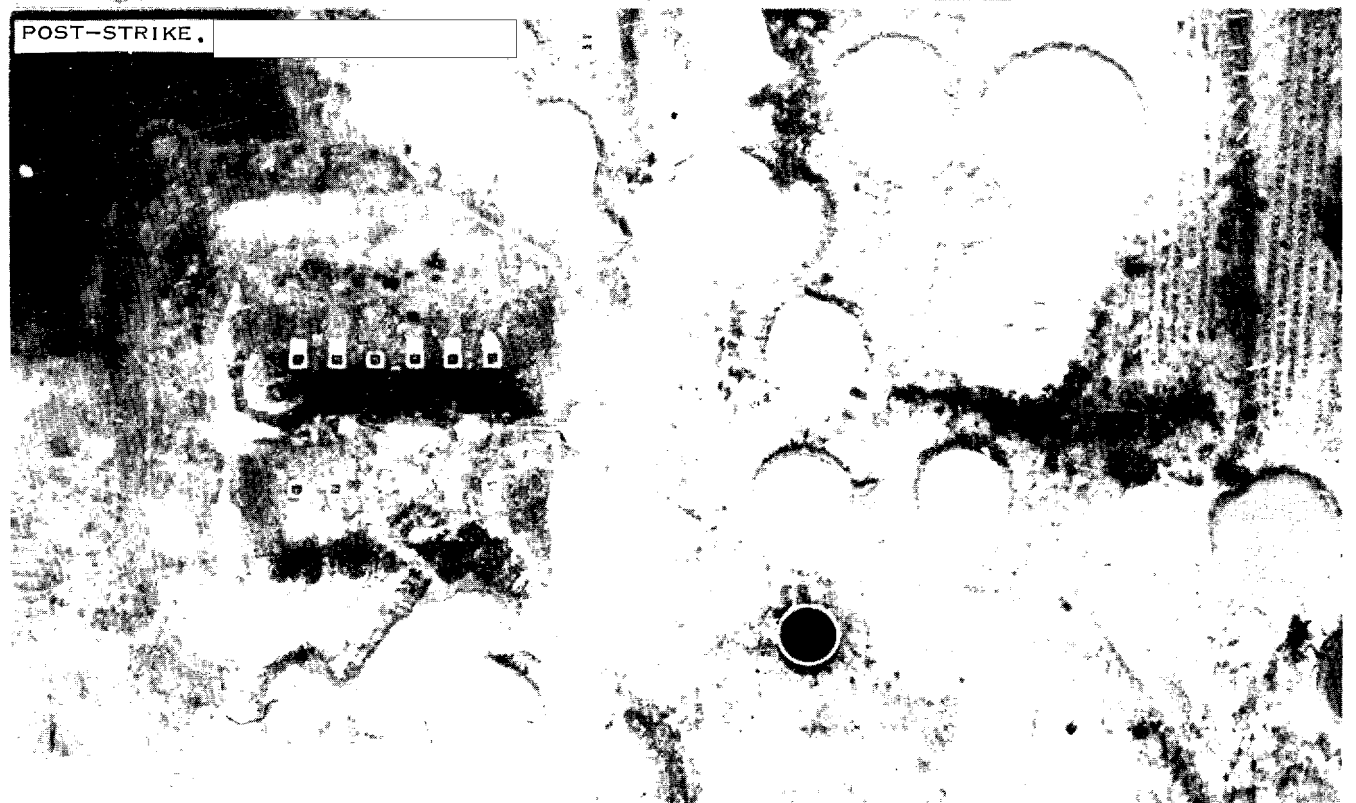
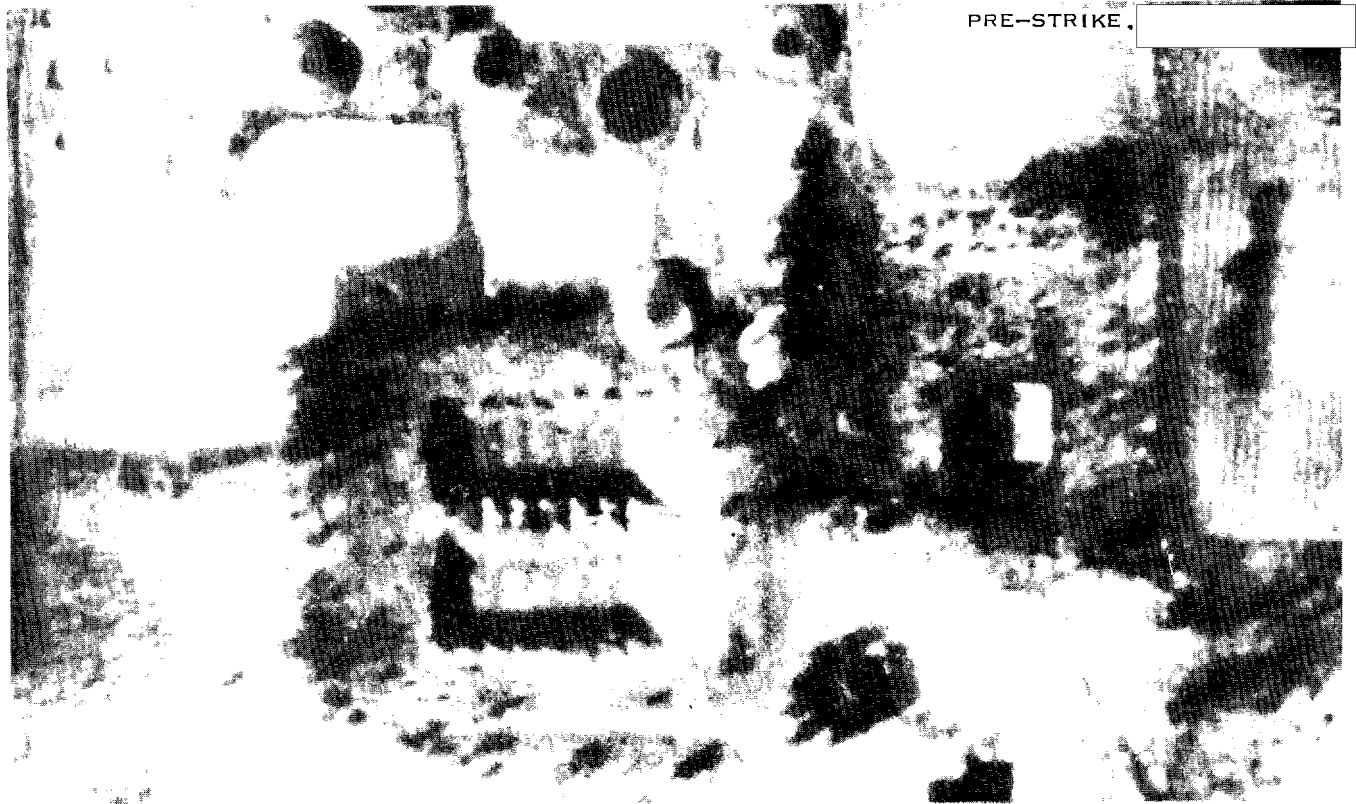


FIGURE 8. PHUC LOI DISPERSED STORAGE TANK SITE, BEFORE AND AFTER BOMBING

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	<u>Thousand Metric Tons</u>	
Principal storage terminals	24	
Dispersed storage sites (tanks)	30 to 40	
Dispersed storage sites (drums)	28	
Military and industrial sites (tanks)	5	
Total	<u>87 to 97</u>	25X1

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4. Petroleum Supply and Demand in 1966

It is estimated that supplies of petroleum in North Vietnam on 1 January 1966 were between 46,000 and 71,000 tons. The lower limit represents 90 days' supply at the then-current rate of consumption. It is reasoned that North Vietnam would maintain a minimum of 90 days' supply. Seaborne deliveries from the Black Sea normally take about 30 days. In the event of abnormal delays in resupply, stocks of petroleum in North Vietnam might otherwise decline to a dangerously low level for a country on a wartime footing.

The upper limit of the range was derived from a supply/demand balance calculated (in reverse) from the estimated supply of petroleum on 28 June 1966. It is estimated that the supply of petroleum on the latter date was 103,000 tons. This estimate is based on the assumption that all the bulk petroleum storage was filled to 75 percent of capacity and drums to 50 percent of capacity. Information from the US oil industry suggests that, in the absence of definitive information, bulk storage normally may be considered to be filled to 75 percent of capacity on the average. Moreover, other considerations suggest that stocks on hand were this great on 28 June.

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bombings. This was probably necessary because there was insufficient unused storage capacity in the Hanoi/Haiphong area. High stock levels were created, in turn, because imports in the ten-month period -- September 1965 through 28 June 1966 -- were substantially in excess of estimated demand.*

It is estimated that consumption of petroleum for the year 1966 was about 190,000 tons. This total reflects a moderate increase from slightly less than 15,000 tons per month (500 tons per day) at the outset of 1966 to 16,400 tons (about 550 tons per day) at the end of the year. Consumption from 28 June to the end of the year was estimated to have been 99,000 tons. Table 5 shows the estimated normal monthly consumption of petroleum, by sector, for the last half of 1966.

The estimated loss of petroleum through bombings before 28 June was 1,000 tons and after 28 June between 40,000 and 61,000 tons. The range of these losses is a function of the inventory of petroleum on 28 June, the inventory of petroleum in specific storage sites at the time of the bombing, and destruction of storage capacity at the specific sites.

* For details of the methodology used in deriving these estimates, see Appendix A.

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Using these data, estimates of petroleum supply and demand during 1966 are summarized as follows:

	<u>Thousand Metric Tons</u>	
	<u>Lower Limit</u>	<u>Upper Limit</u>
Supply, 1 January	<u>46</u>	<u>71</u>
Plus		
Imports, 1 January - 28 June	124	124
Minus		
Consumption, 1 January - 28 June	91	91
Losses, 1 January - 28 June	1	1
Supply, 28 June	<u>78</u>	<u>103</u>
Plus		
Imports, 29 June - 31 December	113	113
Minus		
Consumption, 29 June - 31 December	99	99
Losses, 29 June - 31 December	40	61
Supply, 31 December	<u>52</u>	<u>56</u>

5. Effects of the Bombings of Petroleum Targets

The principal effects of the bombing of petroleum targets in North Vietnam during 1966 are as follows:

a. The destruction of an estimated 77,000 tons of storage capacity at the principal terminals and 5,000 tons at the dispersed tank sites plus related support facilities, with a total replacement value of about \$3.6 million.

b. The destruction of between 41,000 and 62,000 tons of petroleum valued at between \$1.3 million and \$2 million.

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c. The loss of the normal use of the principal petroleum terminal at Haiphong and the complete destruction of the principal storage and distribution terminal at Hanoi, as well as the loss of considerable capacity at principal storage terminals elsewhere.

d. Additional costs and inconvenience to both the USSR and North Vietnam for the import and internal distribution of petroleum.

There is no evidence, however, that the loss of petroleum or petroleum storage facilities has seriously weakened the economy. There is no evidence of widespread shortages of petroleum, of dislocations in any sectors of the economy, or of inability to infiltrate men and supplies into the South that is attributable to the loss of petroleum or petroleum storage facilities.

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Table 1

North Vietnam: Location and Estimated Capacities of Principal Petroleum Storage Terminals
1 January and 31 December 1966

JCS Target Number ^{a/}	Name	Coordinates		Metric Tons	
		North	East	1 January ^{b/}	31 December
	Haiphong	20 52	106 39	40,620	4,330
	Hanoi	21 03	105 53	30,620	0
	Vinh	18 40	105 43	1,350	1,350
	Nguyen Khe	21 10	105 51	7,500	5,000
	Ha Gia ^{c/}	21 16	105 50	9,910	9,910
	Bac Giang	21 16	106 11	2,260	1,560
	Do Son	20 42	106 47	2,860	1,430
	Viet Tri	21 17	105 26	1,400	40
	Duong Nham	21 01	106 30	4,130	0
Total				<u>100,650</u>	<u>23,620</u>

a. Can Thon (), because of the nature of its construction and location, is considered as a dispersed tank site and is excluded from this table.

b. These capacities existed also on 28 June, the day before the intensified bombings began.

c. Ha Gia was attacked in late December, but information available at the end of the year disclosed no damage.

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Table 2

North Vietnam: Location, Capacities, and Routes of Communication
for Dispersed Petroleum Storage Tank Sites a/
31 December 1966

Location	Site Number	Name	Capacity (Metric Tons)	Road	Rail	Water
North of 21°	1	La Danh	1,230	X	X	
	2	Van Lung	282	X	X	X
	3	Van Lung, West	71	X	X	X
	4	Hoang Mai	252	X	X	X
	5	Hanoi, Thi Cam	141	X		X
	7	Son La	323	X		
	17	Can Thon	2,520	X	X	
	18	Hanoi, Duc Noi No. 1	385	X	X	X
	19	Hanoi, Duc Noi No. 2	713	X	X	X
	20	Hanoi, Duc Noi No. 3	252	X	X	X
	21	Hanoi, Duc Noi No. 4	111	X	X	X
	22	Cu Van	1,827	X	X	
	23	Cu Van, East	1,092	X	X	
	24	Dao Quan, East	373	X	X	
	25	Dao Quan, West	302	X	X	
	27	Thai Nguyen, South	1,109	X	X	
	28	Phuc Yen, Airfield, No. 1	252	X	X	
	29	Phuc Yen, Airfield, No. 2	202	X	X	
	32	Nui Tap Tinh	20	X	X	X
	34	Phu Dong	353	X		X
	43	Kep Ha	81	X		
	45	Dong Mai	232	X		X
	47	Van Hoa	121	X		X
	48	Phu Lo	192	X		X
	49	Jaune Island	40	X		X
	50	Co Nhue Hoang	151	X		X
	52	Trung Phu	141	X	X	
	57	Bac Ninh	171	X		X
	62	Tung Tu	315	X	X	
	63	Don Son	625	X		X
	64	Quy Khe	1,129	X		X
	65	Tran Xa	1,050	X		X
69	Thai Nguyen	71	X	X	X	
72	Chi Linh	1,452	X		X	
76	Phu Thi	302	X	X	X	
77	Phuc Yen	60	X	X	X	
79	Mach Trang	94	X	X	X	
82	Hanoi, Duc Noi No. 5	219	X	X	X	

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Table 2

North Vietnam: Location, Capacities, and Routes of Communication
for Dispersed Petroleum Storage Tank Sites a/
31 December 1966
(Continued)

Location	Site Number	Name	Capacity (Metric Tons)	Road	Rail	Water
North of 21° (Continued)	83	Lai Son	555	X	X	X
	85	Lung Ngoai	91	X	X	X
	86	Tu Hoang	147	X		X
	87	Trung Tu	273	X		X
	88	Nguyen Khe	30	X	X	X
	89	Lau Khe	181	X	X	X
Subtotal			<u>19,533</u>			
Between 20° and 20°59'	8	Thuong Thon	383	X		X
	10	Thai Lai	101	X		X
	12	Thanh Lang	373	X		X
	13	Hanoi, Thanh Liet No. 1	433	X	X	X
	14	Hanoi, Thanh Liet No. 2	101	X	X	X
	15	Bang So	196	X	X	X
	26	Nam Dinh	222	X		X
	33	Sac Le	141	X		X
	41	Ninh Giang	272	X		X
	42	Viet Yen	1,210	X		X
	44	Tien Hoi	393	X		X
	51	Quang Suoi	81	X	X	
	54	Bai Chay	42	X		X
	60	Xuyen Duong	81	X		X
	61	Cau Cong	322	X		X
	67	Tram Du	882	X		X
	68	Luc Nong	605	X	X	X
	70	Tien Nong	353	X	X	X
	74	Hoang Pha	202	X	X	X
	75	Kien An	242	X		X
80	Tram Bac	1,071	X		X	
81	Nam Lo	840	X	X	X	
84	Phu Xa	168	X	X	X	
Subtotal			<u>8,714</u>			

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Table 2

North Vietnam: Location, Capacities, and Routes of Communication
for Dispersed Petroleum Storage Tank Sites a/
31 December 1966
(Continued)

<u>Location</u>	<u>Site Number</u>	<u>Name</u>	<u>Capacity (Metric Tons)</u>	<u>Road</u>	<u>Rail</u>	<u>Water</u>
Between 19° and 19°59'	6	Bai Thuong, Northeast	1,159	X		X
	11	Yen Hau	333	X	X	X
	16	Son Chau	282	X	X	X
	37	Thanh Hoa, No. 1	99	X	X	X
	40	Tho Trang	202	X	X	
	59	Tri Binh	40	X		
	66	Thanh Hoa, No. 2	71	X	X	X
Subtotal			<u>2,186</u>			
Between 18° and 18°59'	9	Ngoc Son	292	X		X
	35	Thuan Le	229	X		
	39	Phuc Loi	252	X	X	X
	53	Gia Hoa	111	X	X	X
	55	Vinh, Yen Thinh	111	X	X	X
	58	Vinh, Xuan Yen	59	X		
	71	Vinh, Ben Thuy	141	X	X	X
	73	Vinh, Yen Dai	60	X	X	
	78	Vinh, North	81	X	X	
Subtotal			<u>1,336</u>			
Between 17° and 17°59'	30	Xom Duong, East	N.A.	X	X	X
	31	Xom Duong	20	X	X	
	36	Phu Loc	131	X	X	X
	38	Ba Don	161	X	X	X
	46	Xom Lang	262	X	X	X
	56	Ba Don, West	71	X	X	X
Subtotal			<u>645</u>			
Total			<u>32,414</u>			

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Table 3

North Vietnam: Estimated Imports of Petroleum, by Carrier
1964-66

	Thousand Metric Tons		
	<u>1964</u>	<u>1965</u>	<u>1966</u>
Tanker	138	160	186
Cargo vessel	4	10	15
Rail	8	7	36 <u>a/</u>
Total	<u>150</u>	<u>177</u>	<u>237</u>

a. Including 33,900 tons of petroleum aboard tankers diverted to Communist China and considered to have been transhipped by rail to North Vietnam.

Table 4

North Vietnam: Estimated Monthly Imports of Petroleum, by Carrier
1966

	Thousand Metric Tons			
<u>Month</u>	<u>Tanker</u>	<u>Cargo Vessel</u>	<u>Rail <u>a/</u></u>	<u>Total</u>
January	21.0	0.3	0.8	22.1
February	9.7	0.2	0	9.9
March	21.3	1.6	0.2	23.1
April	31.9	2.4	0.2	34.5
May	31.8	1.0	0.3	33.1
June	10.0 <u>b/</u>	1.1	0.2	11.3 <u>b/</u>
July	0	0.9	0.5	1.4
August	10.8	1.4	10.4 <u>c/</u>	22.6
September	11.0	3.1	12.0 <u>c/</u>	26.1
October	4.0	1.1	11.8 <u>c/</u>	16.9
November	11.9	0.1	Negl.	12.0
December	22.6	1.6	0	24.2
Total	<u>186.0</u>	<u>14.8</u>	<u>36.4</u>	<u>237.2</u>

a. Except for the months August, September, and October (see footnote c, below), imports by rail include only observed shipments and, therefore, are considered to be a minimum.

b. A tanker with a cargo of 10,000 tons arrived in the Haiphong harbor before 28 June. However, it was not completely discharged until mid-August, and the cargo is considered as an import during the last half of 1966.

c. Immediately before and after the bombings began in mid-1966, a total of 33,900 tons of petroleum consigned to North Vietnam by tanker was delivered to ports in Communist China. This petroleum was considered to have been delivered subsequently to North Vietnam by rail as follows: August, 10,400 tons; September, 12,000 tons; and October, 11,500 tons.

Table 5

North Vietnam: Estimated Average Monthly Consumption of Petroleum a/
 July-December 1966

	<u>Metric Tons</u>	<u>Percent</u>
Military		
Aircraft	1,106	6.7
Naval vessels	281	1.7
Wheeled vehicles	2,690	16.4
Armored vehicles	75	0.5
Generators	2,272	13.8
Subtotal	<u>6,424</u>	<u>39.1</u>
Civil transport		
Trucks	3,852	23.5
Coastal and inland waterway vessels	1,314	8.0
Port vessels	33	0.2
Cars, buses, and administrative vehicles	297	1.8
Fishing fleet and merchant vessels	487	3.0
Subtotal	<u>5,983</u>	<u>36.5</u>
Industry	<u>1,833</u>	<u>11.2</u>
Agriculture	<u>84</u>	<u>0.5</u>
Household	<u>2,083</u>	<u>12.7</u>
Total	<u>16,407</u>	<u>100</u>

a. 3/. Estimates shown are intended to reflect a "normal" pattern without taking into account interruptions resulting from the intensified bombings of petroleum storage sites or other targets. Estimates for civil transport were derived from indicated activity during the first half of 1966; estimates of military consumption were based on the inventory of petroleum consuming equipment on hand as of 1 August 1966 and the observed or calculated use of such equipment during 1966; estimates of industry, agriculture, and household consumption are rough calculations based on probable consumption in 1965.

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APPENDIX A

METHODOLOGY

The limits of the range of the estimate of petroleum supplies in North Vietnam on 1 January 1966 were derived from two approaches:

1. The Lower Limit

The 46,000 tons represents 90 days' supply at rates of consumption estimated for the end of 1965. This level was considered to be a minimum. Tanker deliveries to North Vietnam from the Black Sea take about 30 days. It was reasoned that if a tanker became disabled only a few days before arrival at Haiphong and a substitute tanker were ordered from the Black Sea, another 30 days would elapse before re-supply to North Vietnam would be possible. If levels of petroleum supply in North Vietnam were maintained at less than 90 days, inventories (under the above thesis) would decline to a dangerously low level for a country on a wartime footing. Imports of petroleum from 1 January through 28 June were added to the supply estimated for 1 January, and consumption and modest losses (from bombing isolated dispersed storage) were deducted. The remainder represented the estimated supply on 28 June, the day before the bombing attacks on petroleum storage began.

2. The Upper Limit

The 71,000 tons was derived from the supplies estimated to have been in North Vietnam on 28 June -- 103,000 tons. A reverse supply/demand balance was calculated to yield the estimate for 1 January. The estimate for 28 June was based on the belief that all the bulk storage facilities were filled to 75 percent of their total capacity and that 50 percent of the inventory of 55-gallon drums estimated for mid-1966 was filled. Several factors supported the basis for considering the bulk storage to be 75 percent full:

a. Information from the US oil industry suggests that, in the absence of definitive information, it is reasonable to consider bulk storage to be about 75 percent full on the average.

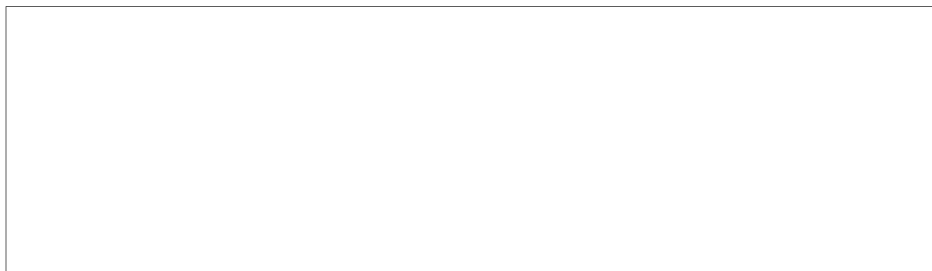
b. The calculated upper limit of the range for 1 January 1966, derived from the 75-percent factor for 28 June,

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compares closely with data derived from a supply/demand balance starting on 1 September 1965. Imports in the last four months of 1965 were at an average monthly rate of almost 21,000 tons, compared with an estimated average monthly consumption rate of only 15,000 tons.

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d. The development of dispersed tank storage sites was well advanced by mid-June, and it is reasoned that imports and inventories were high in order to fill that storage. Moreover, the drum inventory had grown, and this storage medium probably also was being exploited.

e. There was worldwide speculation that the petroleum storage sites might be bombed. The North Vietnamese probably calculated that, with large inventories of petroleum on hand, there was a good probability that a sufficient amount would survive any bombing to support their needs until post-bombing supply procedures were established.

f. Examination of post-bombing photography suggests that the storage tanks probably contained sizable quantities of petroleum.

It was estimated that the following petroleum storage capacity was available on 28 June (rounded to the nearest 1,000 tons):

Principal storage terminals	101,000
Dispersed storage sites (tanks)	17,000
Dispersed storage sites (drums)	22,000
Military and industrial sites (tanks)	5,000

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It was reasoned that the North Vietnamese would exploit, to the optimum, the capacity at facilities other than the principal terminals. Thus under both approaches the dispersed tank and industrial sites were considered to be filled to 75 percent of capacity; the drum inventory to 50 percent (one-half the drums were considered to be filled).

Under the lower limit the petroleum represented by the derived difference between the petroleum stored at the dispersed facilities and the total estimated supplies on 28 June was allocated to the principal storage terminals in the relative share which each terminal represented of the total of such storage capacity. Under the upper limit, the capacities at the principal storage terminals were considered to be 75-percent full on 28 June.

a. Imports

Stocks in the dispersed tanks, industrial sites, and drums were maintained at the levels described above by allocating sufficient imports to these storage facilities. During those periods when imports exceeded the amount necessary to maintain these stock levels, the excess was allocated to each principal storage terminal in shares corresponding to the capacity that each terminal represented of the total storage capacity at these terminals.

b. Consumption

Estimated withdrawals from stocks were made from each terminal or category of storage on a pro rata basis.

c. Losses of Petroleum from Bombings

The percentage destruction of capacity at each terminal or in each category of storage was estimated from photography. This percentage was applied to the stocks estimated to have been in storage at the site at the time of the bombing to calculate the losses of petroleum.

The Defense Intelligence Agency (DIA) has prepared independent estimates of the petroleum situation in North Vietnam during 1966. The DIA approach involved the use of a combination of supply/demand calculations and the allocation of stocks to dispersed storage on a percentage basis. Selected estimates for 1966 by DIA and CIA are as follows:

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	Metric Tons	
	DIA <u>a/</u>	CIA
Supply, 1 January	52,500	46,000 to 71,000
Imports	233,700	237,200
Consumption	190,600	190,600
Losses	51,500	41,000 to 62,000
Supply, 31 December	44,100	52,000 to 56,000
Storage capacity, 31 December		
Principal terminals <u>b/</u>	23,750	23,620
Dispersed sites	49,320	63,000 to 73,000
Tanks		30,000 to 40,000
Drums		28,000
Other		5,000

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a. 4/

b. Capacity at Can Thon , normally included by DIA in its list of "major" installations, is included in dispersed sites in this tabulation.

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