

AN ESTIMATE OF ENERGY USE IN THE ARMED FORCES OF THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

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Abstract

In the course of preparing an estimate for 1990 energy supply and demand in the Democratic People's Republic of Korea (DPRK, or North Korea), the authors compiled an estimate of fuel use by the various branches and subsectors of the DPRK military. These include ground forces, the Air Force, naval forces, military-related manufacturing, military buildings and other military end-uses of coal, electricity, and petroleum products. The methods used to prepare these estimates are described. Overall energy use is dominated by coal and electricity used in military buildings and for other end uses. The armed forces, however, are estimated to have consumed a significant portion (19 percent) of the petroleum products used in the DPRK in 1990. Two-and-one-half-tonne trucks are estimated to consume more one-third of the petroleum products used by the military, with patrol boats being the next largest user. Overall, ground forces accounted for just under half (49 percent) of military petroleum products use, with naval forces consuming about 36 percent of petroleum products, and the Air Force the remaining 14 percent.

1. Introduction

In preparing a report entitled The Prospects for Energy Efficiency Improvements In The Democratic People's Republic of Korea: Evaluating and Exploring the Options (Von Hippel and Hayes, 1995), we prepared an estimated 1990 energy supply/demand balance for North Korea (DPRK)¹. This work included a sector-by-sector analysis of energy demand for the North Korean economy. Given the sheer size of the North Korean military², and the importance of the military

¹ Our 1995 analysis has been expanded and updated recently, as reported in Demand for and Supply of Electricity and Other Fuels in the Democratic People's Republic Of Korea (DPRK): Results and Ramifications for 1990 Through 2005; prepared for the Northeast Asia Economic Forum/East-West Center (manuscript in final preparation as of October, 1997). The military-sector assumptions and results for the year 1990 shown here reflect our updated analysis.

² At over one million men, the North Korean military includes on the order of 10 percent of the male population of the entire country.

sector in the North Korean economy³, we decided to undertake a detailed estimate of energy use in this sector. This paper describes the techniques and data that we used to assemble energy use estimates for the sector, and presents the results of our work. Of necessity, the work presented here has involved a large number of assumptions about the DPRK armed forces, and also includes some gaps where we were forced to use order-of-magnitude “placeholder” data in lieu of more detailed estimates. Some of our assumptions and estimates are doubtless in error. If there are readers of this article who can supply additional appropriate information on the DPRK military, we would be happy to use it to update our analysis.

2. Methods Used in Preparing Military Sector Energy Use Estimates

Although we have thus far been able to obtain essentially no direct data on energy use in the military sector in the DPRK, the DPRK military does, of course receive a certain amount of attention from the military community in the United States and elsewhere. For our study, this attention has meant that there are reasonably good data on the stocks of energy-using equipment in the DPRK military. These data on stocks can be used as the basis for estimates of fuels consumption. Our approach to estimating fuel use in the DPRK armed forces has been to use these stock figures together with data and estimates of vehicle/aircraft/vessel fuel capacities and estimates of the amount of "practice time" that each piece of equipment might receive in a year. Of these three types of information, our estimates of the intensity of equipment use are by far the most speculative.

The overall methods and key assumptions that we used in preparing estimates for the different military subsectors are summarized below. Additional details of these methods and the background data that we used to prepare our estimates of fuel use are presented in the Annex to this paper. The results of our analysis are summarized in Section 3.

2.1. Fuel Use by Ground Forces

In order to estimate the energy used by the DPRK *Ground Forces*, we started with estimates of the total number of mobile equipment and vehicles in seven classes:

- Tanks
- Amphibious Vehicles (used for fording rivers and lakes, or operating in wet terrain)
- Armored fighting vehicles
- Truck- and Tank-mounted artillery and missiles
- Jeeps and motorcycles
- 2.5-tonne (freight capacity) trucks
- Other trucks and utility equipment.

³ Estimates of the total fraction of the DPRK government expenditures that go to the military has been estimated at 12 percent (Noland, 1996), although Noland points out that additional defense expenditures may be “hidden” in the economic development budget.

Using information on the number of the different types of regiments and other units in the DPRK Army (US Defense Intelligence Agency, 1990?), and on the equipment stocks in each type of unit (US Department of the Army, 1982), we estimated the personnel and equipment totals in the DPRK Army. This exercise yielded a personnel total somewhat lower (936,000 versus 1.066 million) than the total reported personnel active in the Army, so we multiplied the resulting equipment totals by 1.14 to “true-up” to the total reported force strength. Next we used data from two United States sources (US Department of the Army, 1983; US Department of Defense, 1994) that described the various equipment types (size, range, fuel capacity, weight, engine power) to estimate the fuel consumption per kilometer of vehicle travel. We assumed average speeds during maneuvers ranging from 15 to 30 kilometers per hour, and assumed that the vehicles would be active during maneuvers about 50 percent of the time (except for engineering utility vehicles, which were assumed to be active 25 percent of the time). We further assumed that 20 percent of the stock of all types of vehicles and equipment are unusable (due to lack of fuel or spare parts, or just age and decay) at any given time, and that the Army conducts maneuvers approximately 1,000 hours per year. Interestingly, a single type of vehicle--the DPRK's 2 1/2 tonne trucks--dominates both the numbers of vehicles in the DPRK Ground Forces (over 75 percent) and our estimate of fuel used by those forces (two-thirds).

We used our estimates of fuel used by light vehicles, trucks, and utility vehicles in the ground forces to estimate the amount of fuel used by support vehicles in the DPRK Air Force and Navy. We did this by applying simple ratios of the personnel in each branch to the fuel use totals calculated for similar activities in the DPRK Army.

2.2. Fuel Use in Aircraft

For *Aircraft* in the DPRK Air Force, we used estimates of each class of aircraft (supplied in US Defense Intelligence Agency, 1990?) and information on the early-1980's stocks of particular aircraft (Department of the Army, 1982) to estimate the current stocks by model of plane (or helicopter). Most of the DPRK's aircraft are antiquated, with many models dating from the 1960's or before. Of the approximately 1400 aircraft in the DPRK inventory, approximately 750 are fighters, 80 are bombers, 300 are transport aircraft (90 percent of which are smaller single-engine Russian AN-2 biplanes), and the remainder are helicopters.

Information on aircraft range, size, and fuel capacity was gleaned from the US documents mentioned above, from Jane's All the World's Aircraft (Jane's, 1990/91, 1981/82, 1972/73, 1968/69), and from other sources (Chant, 1990; Taylor and Swanborough, 1979). These data were used to estimate the "fuel economy" of the planes and helicopters in the DPRK stock. Based on the assumption that these aircraft receive minimal use—due to their typically advanced age, the scarcity of fuel and parts, and the DPRK's typically ground-oriented military doctrine—we assumed fairly minimal annual operating hours of:

- Fighters and Bombers: 24 hours per year
- Transport Planes: 50 hours per year

- Military Helicopters: 32 hours per year.

It is quite possible that some aircraft receive substantially more use than we have assumed, but probably just as likely that a large number of aircraft are entirely or effectively in “mothballs” (long-term storage) and receive little or no use. For most aircraft, we assumed that their average airspeed while on training or practice missions is about 80 percent of their reported maximum speed.

2.3. Naval Fuel Use

Our estimates of fuel use in *Naval* vessels used a similar approach: figures on current total numbers of ships by class in the DPRK Navy were combined with an older (US Department of the Army, 1982) inventory of numbers of ships by model to yield estimates of the current number of ships by model and type of ship (including submarines). The DPRK's forces include few ships of any size (by Naval standards), consisting mostly of smaller (40 to 400 ton displacement) missile attack boats (40) and patrol craft (over 400), with a number of amphibious craft designed to land troops on beachheads (about 200) and 24 diesel-electric submarines.

We then compiled information on the engine power for each model in this inventory of ships, and used a benchmark figure of 0.38 lb. of diesel fuel per horsepower (hp)-hr of operation⁴ (Chapman, 1942), plus an assumption that at cruising speed, naval ships operate at approximately half-throttle (that is, they are using half of the total horsepower available). For submarines, we used a figure of 0.50 lb. of diesel per hp-hr (Freedman, 1984). These data were used to estimate the fuel consumption for each vessel per hour of operation. We assumed that all of the vessels in the DPRK navy are diesel-fueled except for the single frigate that the DPRK reportedly has, which we assume uses heavy fuel oil.

We assumed, based primarily on conjecture, that amphibious naval vehicles would be in operation only 50 hours per year, submarines would operate 100 hours per year, and that all other vessels would operate 800 hours per year. The reasons for assuming these low operating levels (the US Naval fleet reportedly has had an operating tempo upwards of 60 percent, or over 5000 hours per year) are the same as those cited above for the low number of operating hours per aircraft. These operating assumptions were multiplied by the per-unit fuel consumption figures and the number of ships of each type and summed to yield overall fuel consumption by the Navy.

2.4. Fuel Use in Manufacturing of Military Equipment

⁴ While this value is derived from a reference that dates back to WWII, it is apparently not unreasonable. Conversations with a US dealer of large marine engines indicates that even the best current diesels are not vastly more efficient (0.32 to 0.33 lb./hp-hr), and that the value we are using would be justified (perhaps even low) for the older (1960's and 1970's) engines that likely make up the bulk of the DPRK fleet.

In an additional exercise, we estimated the amount of fuel used in *Manufacturing Military Equipment*. This was done by estimating the total weight of iron and steel in the Army and Navy equipment inventories (aircraft were assumed to be all imported), applying estimates of the average of lifetimes of each equipment type (assumed to be 20 years for large Ground Force equipment, 10 years for small armaments, and 30 years for ships and boats), and using these figures to derive an average amount of iron and steel needed per year in military manufacturing. A Chinese figure of 250 kg coal equivalent per tonne of steel (Ross and Feng, 1991), multiplied by an efficiency inflator of 1.1, was assumed to be required for each of the approximately two meltings required to fabricate military equipment (P. Zimmerman, personal communication, 1995). It was further assumed that the fuel (assumed to be coal) used in melting iron and steel for military goods represents roughly 60 percent of the total coal needed for military manufacturing. An estimate of the electricity requirements by this sector was prepared by applying the ratio of electricity to coal consumption estimated for the civilian iron and steel industrial subsector to the coal use estimate for military manufacturing.

2.5. Fuel Use in Military Buildings and Other Military Fuel Use

Armed forces of 1.2 million people do not exist without a substantial stock of military buildings. Sadly, as in other sectors, we currently have no information on energy use in these structures. To compile estimates of fuel use in military buildings, we have assumed that there are 20 million square meters of floor space in such buildings (about 17 square meters per active member of the armed forces), and that they are heated with the same type of coal-fired equipment (and at the same efficiency) used for residential and public/commercial buildings. Electricity consumption per square meter in these buildings was assumed to be twice that in civilian public and commercial building (55 kWh/m²-yr).

We have included a placeholder value of an additional 5 million GJ to account for other uses of electricity in the military. End-uses covered by this assumed allotment could include fixed radar sites and the DPRK's nuclear research program (nominally a civilian operation), which we estimate may have an electricity demand of approximately 5 MW net of electricity production by the DPRK's 25 MW thermal (5 MW electric) research reactor. An additional 20 million GJ placeholder allotment was assumed for other uses of coal in the military, along with an additional 100,000 GJ for other uses of petroleum products.

3. Results: Estimates of Energy Use by the DPRK Military

Figures 1, 2, and 3 show the fraction of estimated total DPRK use of petroleum products, coal, and electricity that is estimated to be consumed in the Armed Forces. Overall, we estimate that the DPRK military used (as of 1990) a relatively modest 4.2 percent of total energy demand in the country, including 17.1 percent of refined products, 3.9 percent of coal, and 8.1 percent of electricity demand.

FIGURE 1:

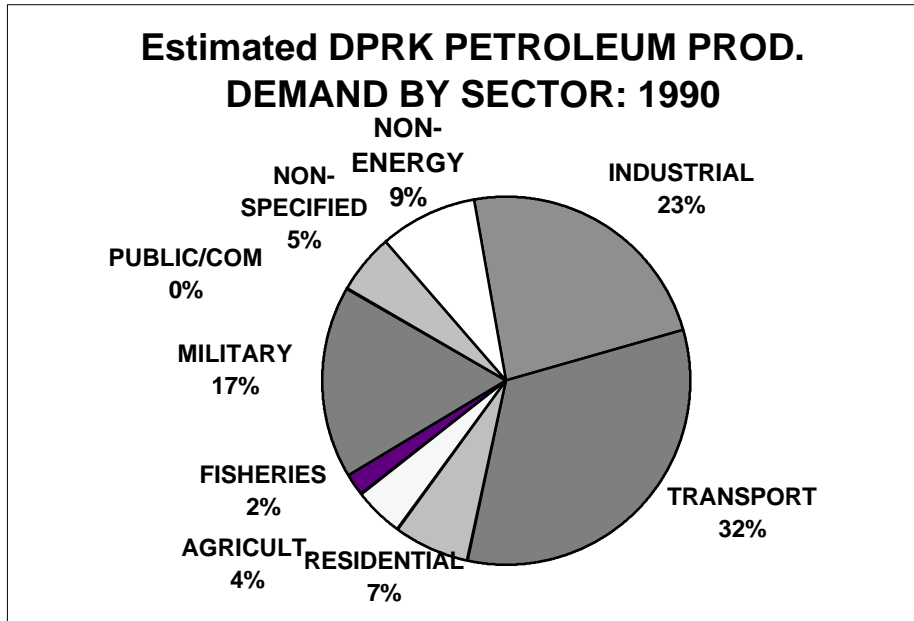


FIGURE 2:

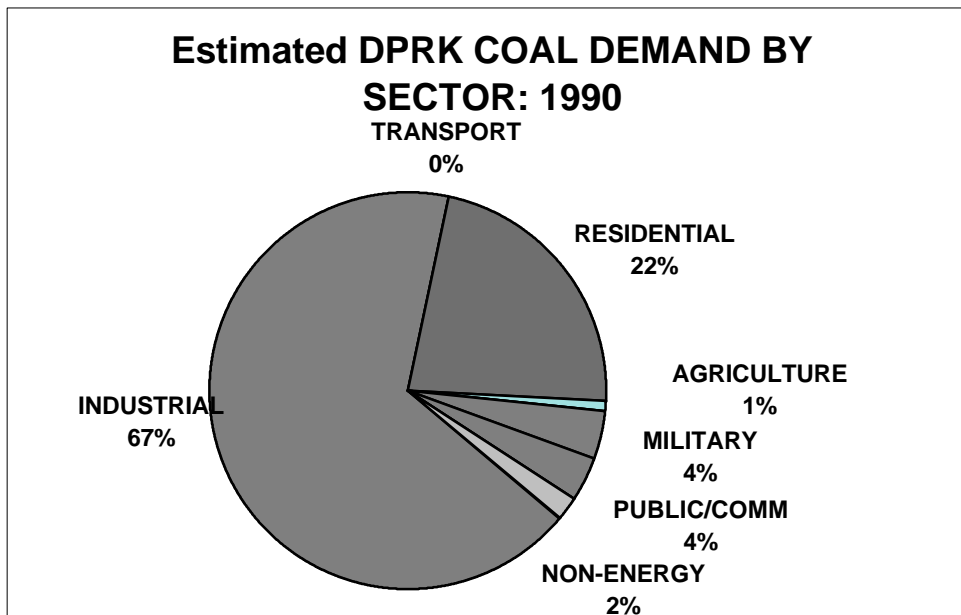


FIGURE 3:

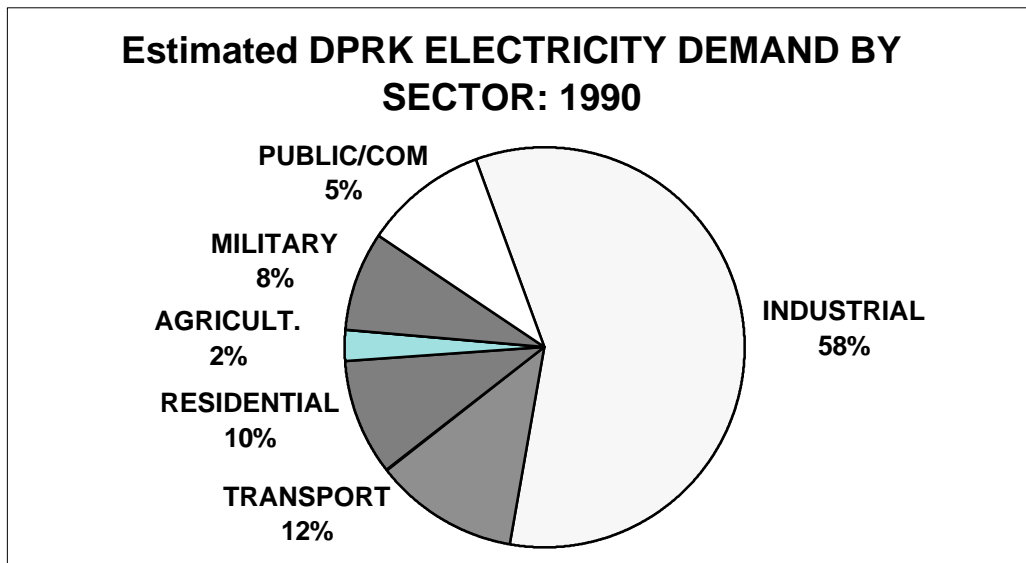


Table 1 presents energy demand estimates by subsector and fuel for the branches of the military, military manufacturing, and military buildings and other uses⁵. Coal and electricity provide 48 and 30 percent of overall military energy use. Our estimates of the use of coal and electricity, however, are dominated by placeholder estimates for “other” uses of these fuels. The remaining 22 percent of fuels demand is supplied by petroleum products. The breakdown of our estimate of petroleum products use in the military (Army, Air Force, and Navy only) is shown in Figure 4. Demand for petroleum products by vehicles and armaments in the ground forces consume just under half of the total, followed by the Navy and the Air Force. The ubiquitous two-and-a-half tonne military trucks—when summed across the military branches—are estimated to use about 35 percent of total military petroleum products demand.

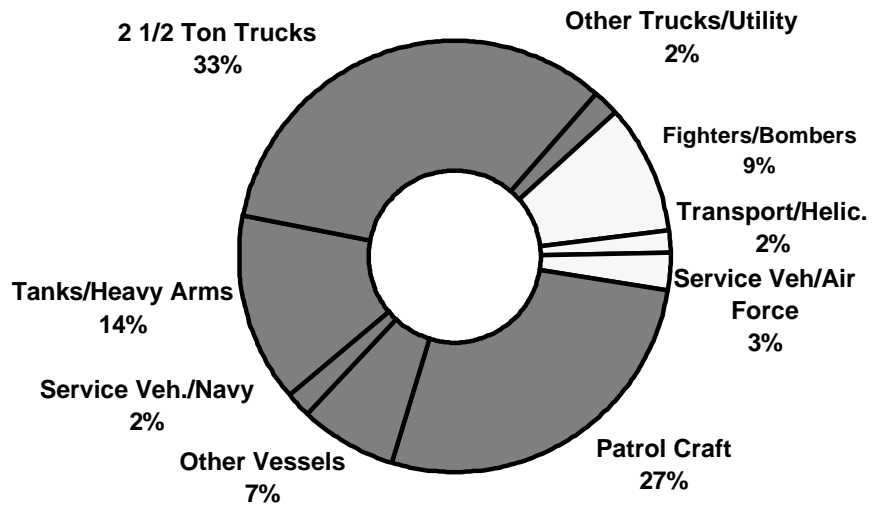
TABLE 1:
Estimated Energy Demand in the DPRK Military in 1990,
By Fuel and by Military Subsector (Thousand Gigajoules)

	COAL	PETROLEUM PRODUCTS					SUBTOTAL	ELECTRICITY	OVERALL TOTAL
		GASOLINE	DIESEL	HEAVY OIL	KEROSENE & JET FUEL	AVIATION GAS			
MILITARY SECTOR	38,467	7,794	8,765	45	1,798	356	18,758	9,008	66,233
Trucks and other Transport	-	6,477	109	-	-	-	6,586	-	6,586
Armaments	-	452	2,179	-	-	-	2,632	-	2,632
Air Force	-	494	-	-	1,798	356	2,648	-	2,648
Naval Forces	-	371	6,377	45	-	-	6,792	-	6,792
Military Manufacturing	887	-	-	-	-	-	-	48	935
Buildings and Other	37,580	-	100	-	-	-	100	8,960	46,640

⁵ The energy unit used in Table 1, gigajoules (GJ), is equal to 10¹² (one million million) joules. By way of comparison, a tonne of crude oil (one tonne of oil equivalent) has a heating value equal to approximately 41.8 GJ, thus one thousand GJ is the energetic equivalent of approximately 24 tonnes of oil.

FIGURE 4:

DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 1990



REFERENCES

- Chant, C., (1990), Air Forces of the World. Brian Trodd Publishing House, Ltd.
- Chapman, L.B. (1942), The Marine Power Plant. McGraw-Hill, N.Y., N.Y., USA.
- Freedman, N. (1984), Submarine Design and Development. Naval Institute Press, Annapolis, MD, USA.
- Jane's (1990/91, 1981/82, 1972/73, 1968/69), Jane's All the World's Aircraft. 1990/91, 1981/82, 1972/73, and 1968/69 editions. Jane's Publishing Co., N.Y., NY, USA
- Jane's (1987/88), Jane's Fighting Ships, 1987-88. Edited by J. Moore. Jane's Publishing Co., N.Y., NY, USA.
- Noland, M., (1996), "The North Korean Economy". Joint U.S.-Korean Academic Studies, Vol. 6, 1996.
- Ross, M. and L. Feng (1990), "The Energy Efficiency of the Steel Industry of China". Energy. V. 16, No. 5, pp. 833-848, 1991.
- Taylor, J.W.R., and G. Swanborough (1979), Military Aircraft of the World. Ian Allen Ltd., UK (1979).
- US Department of Defense (1994), North Korea Handbook. US Department of Defense, Washington, DC, USA.
- US Department of Defense (1993), Point Paper, Republic of Korea/North Korea: Military Capabilities (with Military Balance). JICPAC (ONK), Sept. 1993.
- US Defense Intelligence Agency (1990?), North Korea, The Foundations for Military Strength. US Defense Intelligence Agency, Washington, DC, USA.
- US Headquarters Department of the Army (1982), Opposing Force Training Module, North Korean Military Forces. Department of the Army, Washington, DC, USA. February, 1982. Field Manual No. 34-21.
- Von Hippel, D., and P. Hayes (1995), The Prospects for Energy Efficiency Improvements in the Democratic People's Republic of Korea: Evaluating and Exploring the Options. Nautilus Institute Report, Nautilus Institute for Security and Sustainable Development, Berkeley, California, USA. Final Draft Report.

ANNEX TO
***“AN ESTIMATE OF ENERGY USE IN THE ARMED FORCES OF THE
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA”:***
**SUMMARY RESULTS, AND DETAILS OF DATA AND ASSUMPTIONS
USED IN CALCULATING DPRK MILITARY SECTOR ENERGY USE**

**ESTIMATES AND PROJECTIONS OF ANNUAL FUEL USE
BY THE MILITARY SECTOR IN THE DPRK
SUMMARY: FUEL USE IN EQUIPMENT AND
MILITARY MANUFACTURING, 1990**

MILITARY BRANCH Equipment	Est. Number in Service	1990		
		Fuel Cons GJ	Fraction of Branch	Fraction of Total
GROUND FORCES				
Tanks	5,832	2.05E+06	22.2%	10.5%
Amphibious Vehicles	900	1.04E+05	1.1%	0.5%
Armored Fighting Vehicles	4,015	4.50E+05	4.9%	2.3%
Truck/Tank-Mounted Guns, Missiles	516	2.64E+04	0.3%	0.1%
Jeeps and Motorcycles	9,045	2.15E+05	2.3%	1.1%
2 1/2 Ton Trucks	72,403	6.23E+06	67.6%	31.8%
Other Trucks and Utility Equipment	1,632	1.44E+05	1.6%	0.7%
TOTAL: Ground Forces	94,343	9.22E+06	100.0%	47.0%
AIR FORCE				
Fighters	748	1.76E+06	66.4%	9.0%
Bombers	82	3.96E+04	1.5%	0.2%
Transport	308	2.76E+05	10.4%	1.4%
Helicopters	275	8.03E+04	3.0%	0.4%
TOTAL: Aircraft	1,413	2.15E+06	81.3%	11.0%
Service (Ground) Vehicles	6,235	4.94E+05	18.7%	2.5%
TOTAL: Air Force		2.65E+06	100.0%	13.5%
NAVY				
Frigates	1	4.48E+04	0.7%	0.2%
Corvettes	2	1.79E+04	0.3%	0.1%
Missile Attack Boats	39	1.07E+06	15.8%	5.5%
Patrol and Mine Craft	411	5.06E+06	74.5%	25.8%
Amphibious Craft	194	1.76E+05	2.6%	0.9%
Submarines	24	4.71E+04	0.7%	0.2%
TOTAL: Naval Vessels	671	6.42E+06	94.5%	32.8%
Service (Land) Vehicles	4,077	3.71E+05	5.5%	1.9%
TOTAL: Naval Forces		6.79E+06	100.0%	34.7%
MILITARY MANUFACTURING: Coal Use		8.87E+05	GJ/yr	4.5%
MILITARY MANUFACTURING: Electricity Use		4.75E+04	GJ/yr	0.2%
TOTAL, ALL MILITARY ENERGY USES ABOVE		1.96E+07	GJ/yr	100%

**BACK-UP CALCULATIONS AND DATA:
ENERGY USED IN MILITARY BUILDINGS AND OTHER FACILITIES**

Sources/Notes:

Coal Use: Military Sector			
Military Installation Floor Space:	2.00E+07	sq.m.	1
Coal Use intensity	30	kgce/sq.m.	2
Conversion Factor	0.0293	GJ/kgce	
Total Coal Use, Military Buildings	1.76E+07	GJ	
Coal Use, Military Manufacturing	8.87E+05	GJ	5
Other Coal Use: Military Sector	2.00E+07	GJ	1
Total Coal Use, Buildings and Other	3.85E+07	GJ	
Oil Use: Military Sector			
Oil Use, Military Transport Vehicles	6.58E+06	GJ	5
Oil Use, Heavy Armaments	2.63E+06	GJ	5
Oil Use in Air Force	2.65E+06	GJ	5
Oil Use in Navy	6.79E+06	GJ	5
Oil Use, Buildings and Other	1.00E+05	GJ	1
Total Oil Use, Military Sector	1.88E+07	GJ	
Electricity Use: Military Buildings and Other			
Electricity Use intensity, Buildings	55	kWh/sq.m.	4
Conversion Factor	0.0036	GJ/kWh	
Other Electricity Use	5.00E+06		1
Total Electricity Use, Buildings and Other:	8.96E+06	GJ	
Electricity Use, Military Manufacturing	4.75E+04	GJ	5
Total Electricity Use, Military:	9.01E+06	GJ	

Sources/Notes:

- 1 Placeholder Estimate
- 2 For centrally heated Commercial/Public buildings. From "Energy Use and Conservation in China's Residential and Commercial Sectors: Patterns, Problems, and Prospects". by Feng Liu, LBL, March, 1993, p.41.)
- 3 Derived based on data in 1, pages 26 and 63.
- 4 Assumed to be twice the level in public and commercial buildings.
- 5 As estimated in other Military Energy Consumption sections.

**ESTIMATES AND PROJECTIONS OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK:
MILITARY GROUND VEHICLES AND ARMAMENTS**

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Date Last Modified:	10/14/97

Summary Input Data and Results

Hours of Ground Maneuvers Per Year, 1990:	1000
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Vehicle Types	Est. Number	Fuel Economy Range (km per Gallon)		Fract. of Time in Use	Ave. Speed when in Use	1990			
						Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Fraction of Total
<i>Notes</i>				1	2				
Tanks	5,832	1.97	2.08	50%	25	500	5.46E+07	2.05E+06	22.2%
Amphibious Vehicles	900	1.04	26.50	50%	20	500	2.78E+06	1.04E+05	1.1%
Armored Fighting Vehicles	4,015	6.53	7.50	50%	30	500	1.38E+07	4.50E+05	4.9%
Truck/Tank-Mounted Guns, Missiles	516	1.97	6.44	25%	20	250	7.06E+05	2.64E+04	0.3%
Jeeps and Motorcycles	9,045	26.50	50	50%	30	500	6.61E+06	2.15E+05	2.3%
2 1/2 Ton Trucks	72,403	8.63		50%	30	500	1.91E+08	6.23E+06	67.6%
Other Trucks and Utility Equipment	1,632	3.85	8.63	50%	25	500	3.97E+06	1.44E+05	1.6%
TOTALS	94,343						2.74E+08	9.22E+06	100.0%
Diesel Consumption							6.09E+07	2.29E+06	24.8%
Gasoline Consumption							2.13E+08	6.93E+06	75.2%

Notes:

- 1 This fraction is assumed to be 25% for vehicles used primarily in engineering operations, 50% for most others.
- 2 Average speed applies to most, but not necessarily all, vehicles in class.

**ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK
MILITARY GROUND VEHICLES AND ARMAMENTS**

Detailed Data and Results

COMMON ASSUMPTIONS & PARAMETERS	
GROUND FORCES	
Hours of Maneuvers Per Year, 1990:	1000
Fraction of Stock Unuseable:	20% <i>Note 21</i>
Conversion Factor:	3.8 liters/gal
Diesel Energy Content:	0.037584 GJ/liter
Gasoline Energy Content:	0.03253 GJ/liter

Estimate of Number of Vehicles In Military Fleet

Branch or Unit of Ground Forces	Personnel Number	TOTAL per Unit Personnel	Notes	MOTORIZED EQUIPMENT, BY TYPE, PER UNIT																				
				TANKS			AMPHIBIOUS VEH. AND TANK RTVR					ARMORED FTG. VEHICLES		GUNS, MISSILES										
				Medium T-54/55	Med: T62/ 63/PT-76	ASLT	PT-76 Lt Amph	PTS Trk Amph	K-61 Trk Amph	AMPHI GAZ-46	Tank FERRY	Retriever	BTR-60	BRDM	AAG ZSU-57	BM-21 (URAL-375)								
Reserve Infantry Divisions	26	10,359	269,334	1	31	2																		
Reserve-Infantry Brigades	18	8,296	149,328	2																				
Infantry Divisions	30	10,359	310,770	1	31	2																		
Truck Mobile Divisions	1	8,194	8,194	5	93			16									330						18	
Infantry Brigades	4	8,296	33,184	2																				
Truck Mobile Brigades	20	4,781	95,620	4		31		5								99	15							
Armored Brigades	15	2,481	37,215	3	6	133									7	58	3			6			6	
Special Operations Brigades	22			6																				
Elite Training Regiments	5	1,490	7,450				95	10						6										
Engineering River Regiments	5	1,660	8,300								60	7	12											
SAM Regiments	5	1,112	5,560																			30		
AAA Regiments	5	529	2,645																					
FROG Battalions	10	173	1,730																					
Command and Support	1	338	338																					
Artillery Regiments	3	735	2,205																					
MRL Regiment	1	751	751																					30
AAA Regiments	2	529	1,058																					
Engineering Regiment	1	1,206	1,206						10	20														
Signal Battalion	1	299	299																					
Decon Battalion	1	315	315																					
ATGM Company	1	81	81																					
Field Hospital	1	435	435																					
TOTAL INDICATED LAND FORCES			936,018		1,919	2,727	475	166	10	320	35	60	199	3,180	345	240	138							
Reported Ground Personnel			1.07E+06	7			5,121						790		3,525									
TRUED-UP LAND FORCES	True-Up Factor:		1.14		2,185	3,106	541	189	11	364	40	68	227	3,622	393	273	157							
Equipment Totals by Category							5,832						900		4,015									

Estimate of Number of Vehicles In Military Fleet

					MOTORIZED EQUIPMENT, BY TYPE, PER UNIT														
					GUNS, MISSILES (Cont.)			LIGHT VEH.		TRUCKS AND UTILITY VEHICLES									
Branch or Unit of Ground Forces	Personnel Number	TOTAL per Unit	Personnel	Notes	BM-20,24 (ZIL-151,7)	FROG 3/5 (PT-76)	FROG 7 (ZIL-135)	JEEPS	Motor-Cycles	2.5 T Truck	Dump	Zil-135	Zil-151	KRAZ-214	GAZ-63	Zil-157V	Power Boats	Oth Hvy Equip.	
Reserve Infantry Divisions	26	10,359	269,334	1				57	29	692									
Reserve-Infantry Brigades	18	8,296	149,328	2				39	29	503									
Infantry Divisions	30	10,359	310,770	1				57	29	692									
Truck Mobile Divisions	1	8,194	8,194	5				56		255									
Infantry Brigades	4	8,296	33,184	2				39	29	503									
Truck Mobile Brigades	20	4,781	95,620	4				28	8	376									
Armored Brigades	15	2,481	37,215	3				26		162									
Special Operations Brigades	22			6															
Elite Training Regiments	5	1,490	7,450					14	14	133									
Engineering River Regiments	5	1,660	8,300					10		148			96	18	72		24	15	
SAM Regiments	5	1,112	5,560					8		60							36		
AAA Regiments	5	529	2,645					14		104									
FROG Battalions	10	173	1,730			3	3			54		3					3		
Command and Support	1	338	338					44	30	68									
Artillery Regiments	3	735	2,205					4		75									
MRL Regiment	1	751	751			15		10		48									
AAA Regiments	2	529	1,058					14		104									
Engineering Regiment	1	1,206	1,206					9		103	23							12	
Signal Battalion	1	299	299					5	20	37									
Decon Battalion	1	315	315					1		30									
ATGM Company	1	81	81					1		5									
Field Hospital	1	435	435					4		63									
TOTAL INDICATED LAND FORCES			936,018			15	30	30	5,400	2,542	63,575	23	30	480	90	360	210	132	108
Reported Ground Personnel			1.07E+06	7			453		7,942	63,575									1,433
TRUED-UP LAND FORCES	True-Up Factor:		1.14			17	34	34	6,150	2,895	72,403	26	34	547	102	410	239	150	123
Equipment Totals by Category							516		9,045	72,403									1,632

MOTORIZED EQUIPMENT, BY TYPE, PER UNIT															
			TANKS			AMPHIBIOUS VEH. AND TANK RTVR					ARMORED FTG. VEHICLES		GUNS, MISSILES		
			Medium	Med: T62/		PT-76	PTS	K-61	AMPHI Tank				AAG	BM-21	
			T-54/55	63/PT-76	ASLT	Lt Amph	Trk Amph	Trk Amph	GAZ-46	FERRY	Retriever	BTR-60	BRDM	ZSU-57	(URAL-375)
Fuel Use Effic. Calculations	Units	Notes													
Reported Range	km		500	500	300	260	500	260	530	500	300	500	750	500	650
Reported Fuel Capacity (Est)	gal		254	240	150	67	240	67	20	480	148	76.6	100	254	110
Reported Horsepower	hp								55						180
Payload	ton						5.5	3.3	0.4	11					4.9
Fuel Used			Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Gas	Diesel	Diesel	Gas??	Gas	Diesel	Diesel??
Fuel Use Efficiency	km/gal		1.97	2.08	2.00	3.88	2.08	3.88	26.50	1.04	2.03	6.53	7.50	1.97	5.91
Notes			8	8, 9	8	8	12	13	14	15	8	8	16		11
Operating Assumptions															
Fract. Time In-Use During Maneuvers			50%	50%	50%	50%	50%	50%	50%	25%	25%	50%	50%	25%	25%
Average Speed During Maneuvers	km/hr		25	25	25	20	20	20	20	15	15	30	30	20	20
Hours of Operation, 1990	hrs		500	500	500	500	500	500	500	250	250	500	500	250	250
Hours of Operation, 1996	hrs		425	425	425	425	425	425	425	212.5	212.5	425	425	212.5	212.5
Hours of Operation, 2000--Recovery Scenario	hrs		550	550	550	550	550	550	550	275	275	550	550	275	275
Hours of Operation, 2000--Decline Scenario	hrs		375	375	375	375	375	375	375	187.5	187.5	375	375	187.5	187.5
Hours of Operation, 2005--Recovery Scenario	hrs		580	580	580	580	580	580	580	290	290	580	580	290	290
Hours of Operation, 2005--Decline Scenario	hrs		425	425	425	425	425	425	425	212.5	212.5	425	425	212.5	212.5
Fuel Consumption Results, 1990															
TOTAL FUEL USED	gal	22	5.55E+06	7.45E+06	1.35E+06	1.95E+05	2.19E+04	3.76E+05	6.02E+03	4.92E+04	8.39E+04	3.3E+06	3.1E+05	1.39E+05	2.66E+04
By Vehicle Category	gal	All Veh.	7.21E+07		1.44E+07						7.31E+05		3.6E+06		
TOTAL FUEL USED	liters		2.11E+07	2.83E+07	5.14E+06	7.41E+05	8.31E+04	1.43E+06	2.29E+04	1.87E+05	3.19E+05	1.3E+07	1.2E+06	5.28E+05	1.01E+05
By Vehicle Category	liters	All Veh.	2.74E+08		5.46E+07						2.78E+06		1.4E+07		
TOTAL FUEL USED	GJ		7.93E+05	1.06E+06	1.93E+05	2.78E+04	3.12E+03	5.37E+04	7.44E+02	7.03E+03	1.20E+04	4.1E+05	3.9E+04	1.98E+04	3.80E+03
By Vehicle Category	GJ	All Veh.	9.22E+06		2.05E+06						1.04E+05		4.5E+05		

MOTORIZED EQUIPMENT, BY TYPE, PER UNIT																
			GUNS, MISSILES (Cont.)			LIGHT VEH.		TRUCKS AND UTILITY VEHICLES								
			BM-20,24 (ZIL-151.7)	FROG 3/5 (PT-76)	FROG 7 (ZIL-135)	JEEPS	Motor- Cycles	2.5 T Truck	Dump	Zil-135	Zil-151	Kraz-214	GAZ-63	Zil-157V	Power Boats	Oth Hvy Equip.
Fuel Use Effic. Calculations	Units	Notes														
Reported Range	km		600, 430	260	500	530		345	530	500	600	530	345	430		
Reported Fuel Capacity (Est)	gal			67	130	20		40	130	130	80	130	40	80		
Reported Horsepower	hp		92, 109		180	54		70	205	180	92	205	55	109	28	
Payload	ton				11			2.2	7.7	11	2.7	7.7	2.2			
Fuel Used			Diesel??	Diesel	Gas	Gas	Gas	Gas	Diesel	Gas	Diesel??	Diesel	Gas	Diesel??	Diesel??	Diesel??
Fuel Use Efficiency	km/gal		6.4375	3.88	3.85	26.50	50	8.63	4.08	3.85	7.50	4.08	8.63	5.38	0.195	5.38
Notes			11		17		19	10	17	17	11	11	10	11	20	18
Operating Assumptions																
Fract. Time In-Use During Maneuvers			25%	25%	25%	50%	50%	50%	50%	50%	50%	50%	50%	50%	25%	25%
Average Speed During Maneuvers	km/hr		20	20	20	30	30	30	25	25	25	25	25	25	25	15
Hours of Operation, 1990	hrs		250	250	250	500	500	500	500	500	500	500	500	500	250	250
Hours of Operation, 1996	hrs		212.5	212.5	212.5	425	425	425	425	425	425	425	425	425	212.5	212.5
Hours of Operation, 2000--Recovery Scenario	hrs		275	275	275	550	550	550	550	550	550	550	550	550	275	275
Hours of Operation, 2000--Decline Scenario	hrs		187.5	187.5	187.5	375	375	375	375	375	375	375	375	375	187.5	187.5
Hours of Operation, 2005--Recovery Scenario	hrs		290	290	290	580	580	580	580	580	580	580	580	580	290	290
Hours of Operation, 2005--Decline Scenario	hrs		212.5	212.5	212.5	425	425	425	425	425	425	425	425	425	212.5	212.5
Fuel Consumption Results, 1990																
TOTAL FUEL USED	gal	22	2.65E+03	8.80E+03	8.88E+03	1.39E+06	3.47E+05	5.04E+07	3.2E+04	4.4E+04	3.6E+05	1.3E+05	2.4E+05	2.2E+05	0.0E+00	1.7E+04
By Vehicle Category	gal	All Veh. 22			1.86E+05		1.74E+06	5.04E+07								1.0E+06
TOTAL FUEL USED	liters		1.01E+04	3.35E+04	3.38E+04	5.29E+06	1.32E+06	1.91E+08	1.2E+05	1.7E+05	1.4E+06	4.8E+05	9.0E+05	8.5E+05	0.0E+00	6.5E+04
By Vehicle Category	liters	All Veh. 22			7.06E+05		6.61E+06	1.91E+08								4.0E+06
TOTAL FUEL USED	GJ		3.79E+02	1.26E+03	1.10E+03	1.72E+05	4.29E+04	6.23E+06	4.6E+03	5.5E+03	5.2E+04	1.8E+04	2.9E+04	3.2E+04	0.0E+00	2.5E+03
By Vehicle Category	GJ	All Veh. 22			2.64E+04		2.15E+05	6.23E+06								1.4E+05

NOTES:

- 1 "Infantry Division" from North Korea Handbook, page 5-5
- 2 "Basic Corps Independent Infantry Brigade" from Opposing Force Training Module, p. 11-13
- 3 "Tank Brigade" from North Korea Handbook, page 5-31
- 4 "Mechanized Infantry Brigade" from North Korea Handbook, page 5-37
- 5 "Mechanized Infantry Division--Strategic Forces Command" from Opposing Force Training Module, p. 11-3
- 6 "Special Operations Brigades" are assumed to be those units listed in the Opposing Force Training Module as being under either the Strategic Forces Command or the Basic Army Corps, but which are not obviously included in the force units accounted for separately here.
- 7 From "Military Balance: North vs. South" Unclassified DOD document, September 27, 1993.
- 8 From Opposing Force Training Module, pp. 13-16 - 13-22.
- 9 For T-62. Pt-76 is a lighter, amphibious tank with a range of 260 km and a fuel load of 67 gal, but the ratio of the two types is not known.
- 10 Engine size and range are as listed for the older but similar Sungni-58, which is reported to be very fuel-inefficient. Fuel tank capacity is a guess. Data from reference 8, page 13-29.
- 11 Estimates based on measurements of drawings in reference 8.
- 12 Carriage, size seem similar to T-62 tank.
- 13 Carriage, size seem similar to PT-76 tank.
- 14 Built on Jeep chassis--assumed to have similar performance
- 15 Ferry consists of two tracked vehicles, each of which is assumed to have performance like T-62 tank.
- 16 Carriage seems similar to GAZ-66 2.2 ton truck. Fuel capacity for latter estimated based on measurement of drawings in reference 8.
- 17 Assumed similar to KRAZ-214.
- 18 Assumed similar to Zil-157V on average. Reference 8 lists the lighter Zil-151 as one of the prime movers used for cranes.
- 19 Rough Estimate
- 20 Assumes boats will have similar engines to tractors, with similar fuel consumption.
- 21 Unusable equipment includes equipment rendered unusable by age, rust, or lack of spare parts.
- 22 Energy use as calculated here excludes fuel that would be used by equipment considered unusable.

**ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK
MILITARY AIRCRAFT**

Detailed Data and Results

COMMON ASSUMPTIONS & PARAMETERS--AIRCRAFT USE	
Mission Hours Per Year:	1990
Fighters/Bombers (Note 13)	24
Transport Aircraft	50
Helicopters	32
Ave. airspeed--Fract. of Maximum	80%
Kerosene/Jet Fuel Energy Cont. (GJ/ltr)	0.0350 <i>Note 15</i>
Aviation Gasoline Energy Cont. (GJ/ltr)	0.0321 <i>Note 15</i>

Type of Aircraft	Class	Notes:	Number in Air Force				Number in Air Force Assumed	Fuel Range km	Fuel Capacity liters	Max. Speed km/hr	Cruise Speed km/hr	Ave. Fuel Consumpt l/hr	1990	
			Estimates from Sources										Total Fuel Consumpt liters	Total Fuel Consumpt GJ
			1	2	3	4								
Fixed Wing														
F-5 (MIG-17) Fresco	Fighter		130			140	130	1270	2365	1145		1706	5.32E+06	1.86E+05
F-6 (MIG-19) Farmer	Fighter/Bomber		160	160		110	160	1390	2170	1590		1986	7.63E+06	2.67E+05
MIG-21 Fishbed D/F/J	Fighter		160	120		130	160	971	2340	2230		4299	1.65E+07	5.78E+05
F-7 (Fishbed C)	Fighter		40				40	1203	2340	2230		3470	3.33E+06	1.17E+05
MIG-23 Flogger B/C/E/G/K	Fighter		46				46	1800	5750	2440		6236	6.88E+06	2.41E+05
MIG-29 Fulcrum A/B	Fighter		10	"2 reg"	13		13	2100	4365	2440		4057	1.27E+06	4.43E+04
MIG-15 Fagot	Fighter	5				180	144	1368	2365	1017		1407	4.86E+06	1.70E+05
SU-7B Fitter A	Fighter		20	20		20	20	1450	5275	1696	850	4936	2.37E+06	8.29E+04
SU-25 Frogfoot A	Fighter	9	35	>20	36		35	1250	4568	848		2479	2.08E+06	7.29E+04
IL-28 Beagle	Bomber		80	82		85	82	2180	1740	900		575	1.13E+06	3.96E+04
Y-5 (AN-2 Colt)	Transport		270	>250		205	270	900	1200	220		235	3.17E+06	1.02E+05
AN-24 (Coke)	Transport		6	10			6	600	5550	484		3582	1.07E+06	3.45E+04
IL-18 Coot	Transport		2				2	6500	30000	675	625	2885	2.88E+05	9.26E+03
IL-12 Coach (Civil)	Transport	6,10,11					10	1500	6500	675	625	2708	1.35E+06	4.35E+04
LI-2 Cab (Civil)	Transport	6,10,11					10	1500	6500	675	625	2708	1.35E+06	4.35E+04
IL-14 Crate (Civil)	Transport	6, 10					10	1500	6500	675	625	2708	1.35E+06	4.35E+04
Fighters (All)			601	748	748	580	748						5.03E+07	1.76E+06
Bombers (All)			80	82	82	85	82						1.13E+06	3.96E+04
Transport (All)			278	310	310	205	308						8.59E+06	2.76E+05
Helicopters														
MI-2 Hoplite		7		"Most"			113	715	846	210		199	7.19E+05	2.31E+04
MI-4 Hound		8, 12				75	45	325	846	210	160	416	6.00E+05	1.92E+04
MI-8 Hip		8					30	475	1870	250	225	886	8.50E+05	2.73E+04
MI-17 Hip								475	1870	250	240	945		
Hughes 500 D/E				87	>75		87	480	240	250	240	120	3.34E+05	1.07E+04
All			275	275			275						2.50E+06	8.03E+04
												Kerosene/Jet Fuel	5.14E+07	1.80E+06
												Aviation Gasoline	1.11E+07	3.56E+05
ALL AIRCRAFT														
												TOTAL ALL FUELS	6.25E+07	2.15E+06
Air Force Personnel			80,000			3								
Service Vehicles			6,235			16							1.52E+07	4.94E+05
TOTAL: AIRCRAFT PLUS GROUND SUPPORT VEHICLES												TOTAL ALL FUELS	7.76E+07	2.65E+06

Notes:

- 1 North Korea Handbook, US Department of Defense, 1994. (PC-2600-6421-94). Pages 6-165 - 6-178.
- 2 North Korea. The Foundations for Military Strength. US Defense Intelligence Agency (1990?). Pp. 47-48.
- 3 Point Paper. Republic of Korea/North Korea: Military Capabilities (with Military Balance). JICPAC (ONK), Sept. 1993.
- 4 From Opposing Force Training Module. North Korean Military Forces. Field Manual No. 34-21. Headquarters Department of the Army (US). February, 1982. Chapter 14.
- 5 Not given in source 1. Number assumed brings total of fighters up to that listed in sources 2 and 3.
- 6 Not given in source 1. Numbers assumed are guesses to bring total of transports to figures listed in sources 2 and 3.
- 7 Not given in source 1. Number assumed brings total of helicopters up to that listed in sources 2 and 3.
- 8 No breakdown between MI-4 and MI-8 available. Breakdown assumed is a guess. MI-8 and MI-17 are similar aircraft.
- 9 Fuel capacity estimated based on (max weight - empty weight - weapons weight).
- 10 No information available (1940's vintage aircraft). Range and fuel capacity assumed similar to IL-14.
- 11 Speed assumed similar to IL-18.
- 12 Fuel capacity assumed similar to the MI-2.
- 13 Translates to approximately two 1-hr missions per month per aircraft.
- 14 Fuel Capacity data are from the following sources: A) Jane's All the World's Aircraft, 1990/91, 1981/82, 1972/73, and 1968/69 editions. Jane's Publishing Co., N.Y., NY; B) Air Forces of the World, C.Chant, Brian Trodd Publishing House, Ltd (1990); C) Military Aircraft of the World, J.W.R. Taylor and G/ Swanborough, Ian Allen Ltd., UK (1979). Range and airspeed data are from a mixture of these sources and sources 1 and 4, above.
- 15 All jet aircraft are assumed to use Kerosene/Jet Fuel, while all propeller-driven craft and helicopters are assumed to use Aviation Gasoline.
- 16 Ground support vehicles for Air Force assumed to include light vehicles, 2 1/2 ton trucks, and larger trucks and utility vehicles in the same proportions as are used in the ground forces. The number of these vehicles per person in the Air Force is assumed to be the same as in the DPRK Army.

**ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK
MILITARY SHIPS AND BOATS**

Detailed Data and Results		COMMON ASSUMPTIONS & PARAMETERS--NAVAL ENERGY USE											FUEL CONSUMPTION RESULTS		
True-Up Factors (see Note 14) Missile Attack Boats: 1.50 Amphibious: 1.46 Other Sm. Surface Vessels: 1.04		Active Hours Per Year in:		1990											
		Amphibious		50											
		Submarines		100											
		Other Vessels		800											
		Ave. power use--Fract. of Maximum		50%											
		Marine Diesel Fuel Cons. (15)		0.38 lb/hp-hr											
		Sub Diesel Fuel Cons. (16)		0.5 lb/hp-hr											
		Diesel Energy Content:		0.0376 GJ/liter											
		Conversion Factor		2.2 lb/kg											
		Diesel Fuel Density		0.87 kg/liter											
		1990													
Type of Vessel	Class	Notes	Number in DPRK Navy Estimates from Sources					Number in Navy Assumed	Displcmt Tons	Range n.miles	Speed knots	Engine Power (b/s/hp)	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
			1	2	3	4	5								
Nanjing Class	Frigate	21			4	2	1	1800	4000	14	15000	1,191,223	1.19E+06	4.48E+04	
T (Tral) Class	Lg Patrol				2		2	475		18	3000	238,245	4.76E+05	1.79E+04	
Sariwon Class	Lg Patrol				3	4	4	450		21	3000	238,245	9.53E+05	3.58E+04	
SO 1 Class	Lg Patrol				15	15	16	250	1100	13	7500	595,611	9.53E+06	3.58E+05	
Artillerist Class	Lg Patrol	17			2		2	240		25	7500	595,611	1.19E+06	4.48E+04	
Hainan Class	Lg Patrol				4	6	6	400	1000	10	8800	698,851	4.19E+06	1.58E+05	
Taechong Class	Lg Patrol				2	7	7	400			7500	595,611	4.17E+06	1.57E+05	
OSA 1 Class	Missile Att.				8	16	24	200	800	25	12000	952,978	2.29E+07	8.60E+05	
Komar Class	Missile Att.				10	8	15	80	400	30	4800	381,191	5.72E+06	2.15E+05	
Shanghi Class--Gun	Fast Att.				8	12	13	155	800	17	4800	381,191	4.96E+06	1.86E+05	
Swatow Class--Gun	Fast Att.				8	8	8	80	500	28	3000	238,245	1.91E+06	7.16E+04	
Chodo Class--Gun	Fast Att.				4	4	4	130	2000	10	6000	476,489	1.91E+06	7.16E+04	
K-48 Class--Gun	Fast Att.				4	4	4	100		24	5000	397,074	1.59E+06	5.97E+04	
MO IV Class--Gun	Fast Att.	13			20		21	56		25	3000	238,245	5.00E+06	1.88E+05	
Chongjin Class--Gun	Fast Att.	7			30	45	47	80		40	4800	381,191	1.79E+07	6.73E+05	
P 6--Torpedo	Fast Att.				62		60	65	75	450	30	4800	381,191	2.48E+07	9.31E+05
P 4--Torpedo	Fast Att.				12			13	25	50	4800	381,191	4.96E+06	1.86E+05	
Iwon--Torpedo	Fast Att.	10			15	15	16	40			3600	285,893	4.57E+06	1.72E+05	
An Ju--Torpedo	Fast Att.				6	6	6	35	1300	20	4800	381,191	2.29E+06	8.60E+04	
Chaho Class--Torpedo	Fast Att.				60	66	69	80		40	4800	381,191	2.63E+07	9.89E+05	
Sin Hung/Kosong--Torp.	Fast Att.	8	>60		60	72	75	35			2400	190,596	1.43E+07	5.37E+05	
Shersen Class--Torpedo	Fast Att.				4	3	4	160		41	12000	952,978	3.81E+06	1.43E+05	
KM 4--Torpedo	Fast Att.				10	10	10	10			146	11,595	1.16E+05	4.36E+03	
Torpedo Boats	Patrol				150		229								
Light Patrol	Patrol	19					21	2			146	11,595	2.43E+05	9.15E+03	
Hantaeh	Landing	12, 18			8		8	12	150		5000	24,817	2.98E+05	1.12E+04	
Nampo	Landing				>100		70	100	82	375	40	4800	23,824	3.48E+06	1.31E+05
Hanchon	Landing	9, 18			5	25	36	150		10	5000	24,817	8.93E+05	3.36E+04	
Whiskey	Submarine				4		4	15	1030	13,000	8	4000	52,247	2.09E+05	7.85E+03
Romeo, Chinese	Submarine				4		4	4	1100	16,000	10	4000	52,247	2.09E+05	7.85E+03
Romeo, NK	Submarine				16		11	16	1100	16,000	10	4000	52,247	8.36E+05	3.14E+04
Frigates					1	1		1					1.19E+06	4.48E+04	
Corvettes					2	2		2					4.76E+05	1.79E+04	
Missile Attack Boats					39	39	18	39					2.86E+07	1.07E+06	
Coastal Patrol Craft					388	388									
Mine Warfare Craft		11			23	23	42	56							
Amphibious Craft					194	194	75	194					4.67E+06	1.76E+05	
Submarines					24	24	15	24					1.25E+06	4.71E+04	
Trawlers							105								
TOTAL, ALL VESSELS					671	671	568	671	89,216				1.71E+08	6.42E+06	
Those Using Heavy Fuel Oil							1	1,800					1.19E+06	4.48E+04	
Naval Personnel	60,000	3													
Service Vehicles	4,077	20											1.14E+07	3.71E+05	
TOTAL: VESSELS PLUS SERVICE VEHICLES													1.82E+08	6.79E+06	

Notes:

- 1 North Korea Handbook, US Department of Defense, 1994. (PC-2600-6421-94). Pages 6-165 - 6-178.
- 2 North Korea, The Foundations for Military Strength. US Defense Intelligence Agency (1990?). Pp. 44-46.
- 3 Point Paper, Republic of Korea/North Korea: Military Capabilities (with Military Balance). JICPAC (ONK), Sept. 1993.
- 4 From Opposing Force Training Module, North Korean Military Forces. Field Manual No. 34-21. Headquarters Department of the Army (US). February, 1982. Chapter 15.
- 5 Jane's Fighting Ships, 1987-88. Edited by J. Moore, Jane's Publishing Co., NY, NY. P. 329-222.
- 6 Speed shown is that given with the range of the vessel, if specified.
- 7 Assumed similar to Chaho Class based on information in source 4.
- 8 Similar to Soviet "D3" class.
- 9 Source 4 shows this vessel as approximately twice as long and 10% wider than the Nampo.
- 10 Similar to Soviet "P 2" class.
- 11 Total shown for source 4 are vessels listed in source 1 as mine-capable.
- 12 Source 1 shows this vessel to be about 30% longer, 10% narrower than the Hanchon
- 13 Assumed similar to Swatow class (engine size)
- 14 "True-up" factors are used to inflate numbers of vessels by individual class (from 4 and 5) to the aggregate values presented in sources 2 and 3.
- 15 Generic value for fuel consumption by marine diesel engines from The Marine Power Plant, L.B.Chapman McGraw-Hill, 1942. This figure may (or may not) be slightly high for the DPRK Navy. Figure judged to be reasonable by a representative of a US distributor of marine diesel engines, who gave a range of 0.32 lb/hp-hr for best modern diesels, to 0.40+ for older diesels, with 20 hp-hr/gallon (0.364 lb/hp-hr) as a modern rule of thumb. Same representative also indicated that a range of 0.4 to 0.6 of maximum power use was a reasonable range for a ship cruising at sea.
- 16 Generic value for fuel consumption by submarine diesel engines from Submarine Design and Development, N.Freedman, Naval Institute Press, Annapolis, MD, 1984. P. 131.
- 17 Assumed similar to SO 1 class (engine size)
- 18 Assumed similar to K-48 class (engine size)
- 19 Assumed similar to KM-4 torpedo class (engine size)
- 20 Service vehicles for Navy assumed to include light vehicles, 2 1/2 ton trucks, and larger trucks and utility vehicles in the same proportions as are used in the ground forces. The number of these vehicles per person in the Navy is assumed to be the same as in the DPRK Army.
- 21 Frigate is assumed to be fueled with heavy oil. All other vessels are assumed to be diesel-fueled.

ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK ENERGY USE IN MANUFACTURING MILITARY EQUIPMENT

COMMON ASSUMPTIONS & PARAMETERS	
Lifetime of Ground Forces Equipment (yrs):	20
Lifetime of Small Armaments (yrs):	10
Lifetime of Naval Vessels (yrs):	30
Fract. of Weight of Equip. as Iron & Steel	90%

		Estimated Number in Service	Average Weight Each (t)	Made in DPRK?	Equip. Lifetime (years)	Total Weight (t)	Estimated Iron&Steel Needed (t)
GROUND FORCES: VEHICLES							
	Notes:		1				
Tanks							
	T-54/55	2,185	36	Yes?	20	7.87E+04	3.54E+03
	T62/63/PT-76	3,106	36.4	Yes?	20	1.13E+05	5.09E+03
	Assault	541	30	Yes?	20	1.62E+04	7.30E+02
Amphibious Vehicles +							
	PT-76	189	14	Yes?	20	2.65E+03	1.19E+02
	PTS	11	20	Yes?	20	2.28E+02	1.02E+01
	K-61	364	15	Yes?	20	5.47E+03	2.46E+02
	GAZ-46	40	2	Yes	20	7.97E+01	3.59E+00
	Amphibious Ferry	68	50	Yes?	20	3.42E+03	1.54E+02
	Tank Retriever	227	29	Yes?	20	6.57E+03	2.96E+02
Armored Fighting Vehicles							
	BTR-60	3,622	10	Yes?	20	3.62E+04	1.63E+03
	BRDM	393	5	Yes?	20	1.96E+03	8.84E+01
Truck/Tank Mtd Guns & Missiles							
	AAG	273	31	Yes?	20	8.47E+03	3.81E+02
	BM-21	2	157	Yes?	20	2.04E+03	9.19E+01
	BM-20,24	17	9	Yes?	20	1.54E+02	6.92E+00
	FROG 3/5	34	16	Yes?	20	5.47E+02	2.46E+01
	FROG 7	34	20	Yes?	20	6.83E+02	3.07E+01
Light Vehicles							
	Jeeps	6,150	1.5	Yes	20	9.22E+03	4.15E+02
	Motorcycles	2,895	0.2	Yes	20	5.79E+02	2.61E+01
2 1/2 T Trucks							
	Trucks and Utility Vehicles	72,403	2.9	Yes	20	2.10E+05	9.45E+03
	Dump	26	13.5	Yes	20	3.54E+02	1.59E+01
	Zil-135	34	12.4	No	20	4.24E+02	0.00E+00
	Zil-151	547	6.1	No	20	3.33E+03	0.00E+00
	KRAZ-214	102	13.5	Yes	20	1.38E+03	6.23E+01
	GAZ-63	410	2.9	Yes	20	1.19E+03	5.35E+01
	Zil-157V	239	6.6	No	20	1.58E+03	0.00E+00
	Power Boats	150	1	Yes	20	1.50E+02	6.76E+00
	Other Heavy Equipment	123	6.6	Yes	20	8.12E+02	3.65E+01
TOTAL--GROUND FORCES VEHICLES		94,343				5.05E+05	2.25E+04

	Estimated Number in Service	Average Weight Each (t)	Made in DPRK?	Equip. Lifetime (years)	Total Weight (t)	Estimated Iron&Steel Needed (t)
Notes:						
		1				
GROUND FORCES: OTHER ARMAMENTS						
Towed Guns and Missile Launchers	3	10,000	6	Yes?	20	6.00E+04
Light Arms, Various	4			Yes?	10	42,640
TOTAL--GROUND FORCES OTHER						1.03E+05
NAVAL FORCES						
Total Tonnage of Naval Vessels	5			Yes	30	8.92E+04
Service Vehicles	7	4,077		(varies)	20	1.29E+04
TOTAL--NAVAL FORCES						1.02E+05
AIR FORCES						
AIRCRAFT	6			No		0
Service Vehicles	7	6,235		(varies)	20	1.72E+04
TOTAL--AIR FORCES						1.72E+04
TOTAL IRON&STEEL REQUIRED/YR FOR MILITARY EQUIPMENT						3.30E+04

CALCULATION OF ENERGY REQUIREMENTS FOR MILITARY PRODUCT MANUFACTURING, 1990						
Energy Required to melt iron for steel	250	kgce/te crude steel		Note 8		
Average number of melts to produce military products		2		Note 9		
DPRK Steelmaking processes assumed to be	10%	more energy intensive than in China				
Conversion Factor:		29.3	GJ/tce			
ESTIMATED COAL TO MANUFACTURE IRON AND STEEL MILITARY EQUIPMENT					5.32E+05	GJ
Fract. Energy Use in Production of Military Equipment Represented by Iron and Steel					60%	Note 9
ESTIMATED TOTAL COAL USED IN MILITARY EQUIPMENT MANUFACTURE					8.87E+05	GJ
Ratio of Electricity Use to Coal Use in DPRK (Non-Military) Iron and Steel Industry					0.054	Note 10
ESTIMATED TOTAL ELECTRICITY USED IN MILITARY EQUIPMENT MANUFACTURE					4.75E+04	GJ

Notes:

- 1 From *Opposing Force Training Module, North Korean Military Forces*. Field Manual No. 34-21. Figures in **italics** are guesses--no data available.
- 2 Weight of launcher only--prime mover assumed to be imported.
- 3 *Point Paper, Republic of Korea/North Korea: Military Capabilities* (with Military Balance). JICPAC (ONK), Sept. 1993. This source reports roughly 10,800 artillery pieces and rocket launchers. Figure shown nets out roughly guns and missiles included in the accounting of ground forces vehicles. Weight per unit is a rough estimate, and is probably more likely to be high than low.
- 4 Assumes an average of 40 kg of light arms per person in the Army.
- 5 Sum of displacement of Naval vessels. Actual weight of vessels may be different.
- 6 All aircraft assumed to be imported.
- 7 Based on service/ground support vehicle totals calculated in the Aircraft and Navy sheets, and the vehicle tonnages shown in the Ground Forces section of this sheet.
- 8 "The Energy Efficiency of the Steel Industry of China", M.Ross and L.Feng. *Energy*, Volume 16, no. 5 (1991), pp. 833-848.
- 9 Peter Zimmerman, personal communication.
- 10 Assumes that the ratio of electricity to coal use in military manufacturing will be similar to that in the iron and steel subsector of the DPRK's (assumed) non-military industries. Ratio calculated from figures in estimated energy balance for DPRK.