

# ATTACHMENT VOLUME 2

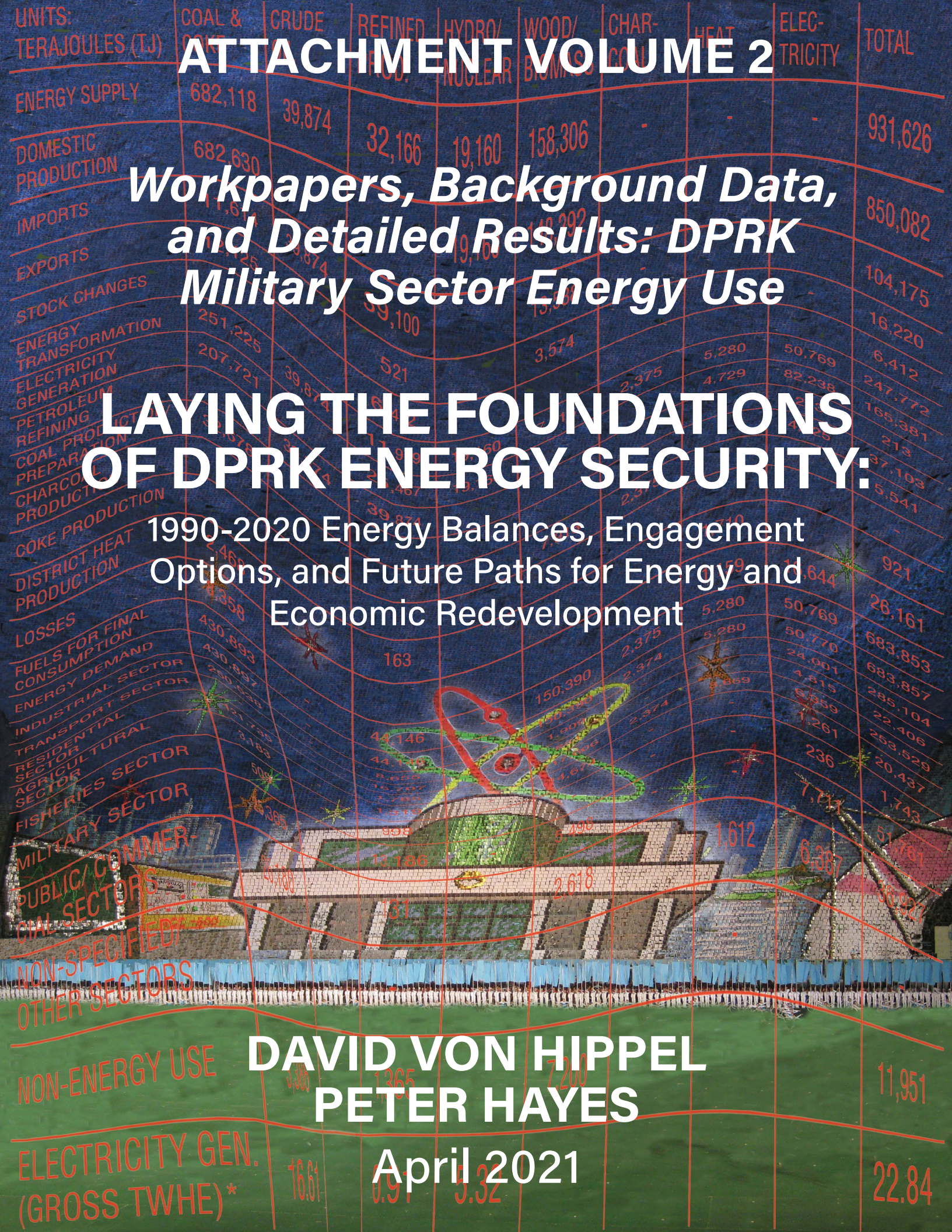
## Workpapers, Background Data, and Detailed Results: DPRK Military Sector Energy Use

# LAYING THE FOUNDATIONS OF DPRK ENERGY SECURITY:

1990-2020 Energy Balances, Engagement  
Options, and Future Paths for Energy and  
Economic Redevelopment

DAVID VON HIPPEL  
PETER HAYES

April 2021







The Nautilus Institute  
*for Security and Sustainability*

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**FOUNDATIONS OF ENERGY SECURITY**  
**FOR THE DPRK:**  
**1990-2020 ENERGY BALANCES,**  
**ENGAGEMENT OPTIONS, AND FUTURE**  
**PATHS FOR ENERGY AND ECONOMIC**  
**REDEVELOPMENT**

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**ATTACHMENT VOLUME 2**

**WORKPAPERS, BACKGROUND DATA,  
AND DETAILED RESULTS: DPRK  
MILITARY SECTOR ENERGY USE**

*Prepared by David F. von Hippel and Peter Hayes*

*The Nautilus Institute for Security and Sustainability*

**April 26, 2021**

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## **ATTACHMENT 2**

### **WORKPAPERS, BACKGROUND DATA, AND DETAILED RESULTS:**

#### **ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK: WORKPAPERS AND SUMMARY TABLES AND GRAPHICS FOR 1990, 1996, 2000, 2005, 2008 THROUGH 2010, AND 2014 THROUGH 2020**

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## Summary Results

**ESTIMATES AND PROJECTIONS OF ANNUAL FUEL USE  
BY THE MILITARY SECTOR IN THE DPRK UPDATE 2020  
SUMMARY: FUEL USE IN EQUIPMENT AND  
MILITARY MANUFACTURING, 1990, 1996, 2000, 2005, 2008 THROUGH 2010, AND 2014 THROUGH 2020**

MILITARY BRANCH Equipment	Est. Number in Service	1990			1996	2000	2005	2008	2009	2010
		Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ
<b>GROUND FORCES</b>										
Tanks	5,832	2.05E+05	3.0%	1.2%	1.64E+05	1.15E+05	1.01E+05	7.87E+04	7.87E+04	8.02E+04
Amphibious Vehicles	900	1.04E+04	0.2%	0.1%	8.35E+03	5.85E+03	5.11E+03	4.00E+03	4.00E+03	4.08E+03
Armored Fighting Vehicles	4,015	4.50E+04	0.7%	0.3%	3.60E+04	2.52E+04	2.21E+04	1.73E+04	1.73E+04	1.76E+04
Truck/Tank-Mounted Guns, Missiles	516	2.64E+03	0.0%	0.0%	2.12E+03	1.49E+03	1.30E+03	1.02E+03	1.02E+03	1.04E+03
Jeeps and Motorcycles	9,045	2.15E+05	3.1%	1.2%	1.87E+05	1.33E+05	1.15E+05	1.04E+05	9.74E+04	1.04E+05
2 1/2 Ton Trucks	72,403	6.23E+06	90.9%	35.8%	5.42E+06	3.84E+06	3.33E+06	3.01E+06	2.82E+06	3.01E+06
Other Trucks and Utility Equipment	1,632	1.44E+05	2.1%	0.8%	1.30E+05	9.19E+04	7.97E+04	7.21E+04	6.75E+04	7.21E+04
<b>TOTAL: Ground Forces</b>	<b>94,343</b>	<b>6.85E+06</b>	<b>100.0%</b>	<b>39.4%</b>	<b>5.94E+06</b>	<b>4.21E+06</b>	<b>3.65E+06</b>	<b>3.29E+06</b>	<b>3.08E+06</b>	<b>3.29E+06</b>
<b>AIR FORCE</b>										
Fighters	748	1.76E+06	66.4%	10.1%	1.17E+06	8.06E+05	1.36E+06	1.54E+06	1.10E+06	1.36E+06
Bombers	82	3.96E+04	1.5%	0.2%	2.64E+04	1.81E+04	3.05E+04	3.46E+04	2.47E+04	3.05E+04
Transport	308	2.76E+05	10.4%	1.6%	2.32E+05	1.76E+05	2.10E+05	2.15E+05	2.10E+05	2.21E+05
Helicopters	275	8.03E+04	3.0%	0.5%	6.02E+04	4.52E+04	6.02E+04	7.53E+04	8.78E+04	1.13E+05
<b>TOTAL: Aircraft</b>	<b>1,413</b>	<b>2.15E+06</b>	<b>81.3%</b>	<b>12.4%</b>	<b>1.49E+06</b>	<b>1.05E+06</b>	<b>1.66E+06</b>	<b>1.86E+06</b>	<b>1.42E+06</b>	<b>1.72E+06</b>
Service (Ground) Vehicles	6,235	4.94E+05	18.7%	2.8%	3.95E+05	3.21E+05	3.46E+05	3.71E+05	3.71E+05	3.81E+05
<b>TOTAL: Air Force</b>		<b>2.65E+06</b>	<b>100.0%</b>	<b>15.2%</b>	<b>1.89E+06</b>	<b>1.37E+06</b>	<b>2.00E+06</b>	<b>2.23E+06</b>	<b>1.79E+06</b>	<b>2.10E+06</b>
<b>NAVY</b>										
Frigates	3	1.34E+05	1.9%	0.8%	9.57E+04	9.49E+04	9.65E+04	7.22E+04	6.72E+04	7.72E+04
Corvettes	2	1.79E+04	0.3%	0.1%	1.28E+04	1.26E+04	1.29E+04	9.63E+03	8.95E+03	1.03E+04
Missile Attack Boats	39	1.07E+06	15.5%	6.2%	7.66E+05	7.59E+05	7.72E+05	5.78E+05	5.37E+05	6.18E+05
Patrol and Mine Craft	351	5.05E+06	72.8%	29.1%	3.60E+06	3.57E+06	3.63E+06	2.71E+06	2.52E+06	2.90E+06
Amphibious Craft	324	2.31E+05	3.3%	1.3%	4.53E+05	6.57E+05	6.57E+05	5.84E+05	5.11E+05	6.57E+05
Submarines	84	5.56E+04	0.8%	0.3%	5.56E+04	5.00E+04	5.00E+04	4.45E+04	4.45E+04	4.45E+04
<b>TOTAL: Naval Vessels</b>	<b>803</b>	<b>6.57E+06</b>	<b>94.7%</b>	<b>37.8%</b>	<b>4.98E+06</b>	<b>5.14E+06</b>	<b>5.22E+06</b>	<b>4.00E+06</b>	<b>3.69E+06</b>	<b>4.31E+06</b>
Service (Land) Vehicles	4,077	3.71E+05	5.3%	2.1%	2.81E+05	2.90E+05	2.95E+05	2.26E+05	2.08E+05	2.43E+05
<b>TOTAL: Naval Forces</b>		<b>6.94E+06</b>	<b>100.0%</b>	<b>39.9%</b>	<b>5.26E+06</b>	<b>5.43E+06</b>	<b>5.51E+06</b>	<b>4.23E+06</b>	<b>3.90E+06</b>	<b>4.55E+06</b>
<b>MILITARY MANUFACTURING: Coal Use</b>		8.90E+05	GJ/yr	5.1%	6.23E+05	4.01E+05	4.01E+05	4.01E+05	4.01E+05	4.01E+05
<b>MILITARY MANUFACTURING: Electricity Use</b>		4.77E+04	GJ/yr	0.3%	3.34E+04	2.15E+04	2.15E+04	2.15E+04	2.15E+04	2.15E+04
<b>TOTAL, ALL MILITARY ENERGY USES ABOVE</b>		<b>1.74E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>1.37E+07</b>	<b>1.14E+07</b>	<b>1.16E+07</b>	<b>1.02E+07</b>	<b>9.20E+06</b>	<b>1.04E+07</b>

*Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21*

MILITARY BRANCH Equipment	Est. Number in Service	1990			2014	2015	2016	2017	2018	2019	2020
		Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ	Fuel Cons GJ
<b>GROUND FORCES</b>											
Tanks	5,832	2.05E+05	3.0%	1.2%	7.78E+04	8.30E+04	9.00E+04	6.94E+04	6.94E+04	6.94E+04	3.86E+04
Amphibious Vehicles	900	1.04E+04	0.2%	0.1%	3.96E+03	4.23E+03	4.58E+03	3.53E+03	3.53E+03	3.53E+03	1.96E+03
Armored Fighting Vehicles	4,015	4.50E+04	0.7%	0.3%	1.28E+04	1.38E+04	1.50E+04	1.16E+04	1.16E+04	1.16E+04	6.45E+03
Truck/Tank-Mounted Guns, Missiles	516	2.64E+03	0.0%	0.0%	1.01E+03	1.07E+03	1.16E+03	8.98E+02	8.98E+02	8.98E+02	4.99E+02
Jeeps and Motorcycles	9,045	2.15E+05	3.1%	1.2%	1.16E+05	1.27E+05	1.31E+05	1.32E+05	1.32E+05	1.32E+05	7.89E+04
2 1/2 Ton Trucks	72,403	6.23E+06	90.9%	35.8%	3.35E+06	3.68E+06	3.79E+06	3.83E+06	3.83E+06	3.83E+06	2.28E+06
Other Trucks and Utility Equipment	1,632	1.44E+05	2.1%	0.8%	6.48E+04	7.15E+04	7.42E+04	7.52E+04	7.52E+04	7.52E+04	4.49E+04
<b>TOTAL: Ground Forces</b>	<b>94,343</b>	<b>6.85E+06</b>	<b>100.0%</b>	<b>39.4%</b>	<b>3.62E+06</b>	<b>3.98E+06</b>	<b>4.11E+06</b>	<b>4.12E+06</b>	<b>4.12E+06</b>	<b>4.12E+06</b>	<b>2.46E+06</b>
<b>AIR FORCE</b>											
Fighters	748	1.76E+06	66.4%	10.1%	1.04E+06	1.37E+06	1.61E+06	1.14E+06	1.07E+06	1.22E+06	7.86E+05
Bombers	82	3.96E+04	1.5%	0.2%	2.35E+04	3.09E+04	3.63E+04	2.57E+04	2.41E+04	2.74E+04	1.77E+04
Transport	308	2.76E+05	10.4%	1.6%	2.14E+05	2.47E+05	2.42E+05	2.48E+05	2.36E+05	2.60E+05	1.89E+05
Helicopters	275	8.03E+04	3.0%	0.5%	1.29E+05	1.51E+05	1.51E+05	1.23E+05	1.18E+05	1.29E+05	9.58E+04
<b>TOTAL: Aircraft</b>	<b>1,413</b>	<b>2.15E+06</b>	<b>81.3%</b>	<b>12.4%</b>	<b>1.41E+06</b>	<b>1.80E+06</b>	<b>2.04E+06</b>	<b>1.54E+06</b>	<b>1.45E+06</b>	<b>1.63E+06</b>	<b>1.09E+06</b>
Service (Ground) Vehicles	6,235	4.94E+05	18.7%	2.8%	4.90E+05	5.08E+05	5.26E+05	5.78E+05	5.64E+05	5.78E+05	4.28E+05
<b>TOTAL: Air Force</b>		<b>2.65E+06</b>	<b>100.0%</b>	<b>15.2%</b>	<b>1.90E+06</b>	<b>2.31E+06</b>	<b>2.57E+06</b>	<b>2.12E+06</b>	<b>2.01E+06</b>	<b>2.21E+06</b>	<b>1.52E+06</b>
<b>NAVY</b>											
Frigates	3	1.34E+05	1.9%	0.8%	6.88E+04	6.88E+04	7.05E+04	5.04E+04	4.70E+04	4.70E+04	2.52E+04
Corvettes	2	1.79E+04	0.3%	0.1%	4.24E+03	3.92E+03	3.68E+03	2.39E+03	2.23E+03	2.23E+03	1.19E+03
Missile Attack Boats	39	1.07E+06	15.5%	6.2%	5.97E+05	6.05E+05	6.29E+05	4.55E+05	4.25E+05	4.25E+05	2.28E+05
Patrol and Mine Craft	351	5.05E+06	72.8%	29.1%	2.48E+06	2.49E+06	2.57E+06	1.84E+06	1.72E+06	1.72E+06	9.20E+05
Amphibious Craft	324	2.31E+05	3.3%	1.3%	5.27E+05	5.27E+05	5.27E+05	5.27E+05	4.92E+05	4.92E+05	2.81E+05
Submarines	84	5.56E+04	0.8%	0.3%	3.71E+04	3.71E+04	3.71E+04	3.24E+04	3.01E+04	3.01E+04	1.76E+04
<b>TOTAL: Naval Vessels</b>	<b>803</b>	<b>6.57E+06</b>	<b>94.7%</b>	<b>37.8%</b>	<b>3.71E+06</b>	<b>3.73E+06</b>	<b>3.83E+06</b>	<b>2.91E+06</b>	<b>2.71E+06</b>	<b>2.71E+06</b>	<b>1.47E+06</b>
Service (Land) Vehicles	4,077	3.71E+05	5.3%	2.1%	2.10E+05	2.11E+05	2.16E+05	1.64E+05	1.53E+05	1.53E+05	8.31E+04
<b>TOTAL: Naval Forces</b>		<b>6.94E+06</b>	<b>100.0%</b>	<b>39.9%</b>	<b>3.92E+06</b>	<b>3.94E+06</b>	<b>4.05E+06</b>	<b>3.07E+06</b>	<b>2.87E+06</b>	<b>2.87E+06</b>	<b>1.56E+06</b>
<b>MILITARY MANUFACTURING: Coal Use</b>		8.90E+05	GJ/yr	5.1%	4.27E+05	4.36E+05	4.45E+05	4.45E+05	4.45E+05	4.45E+05	2.23E+05
<b>MILITARY MANUFACTURING: Electricity Use</b>		4.77E+04	GJ/yr	0.3%	2.29E+04	2.34E+04	2.38E+04	2.38E+04	2.38E+04	2.38E+04	1.19E+04
<b>TOTAL, ALL MILITARY ENERGY USES ABOVE</b>		<b>1.74E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>9.89E+06</b>	<b>1.07E+07</b>	<b>1.12E+07</b>	<b>9.78E+06</b>	<b>9.47E+06</b>	<b>9.67E+06</b>	<b>5.76E+06</b>

**Summary of Military Activity Assumptions**

**ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN DPRK  
SUMMARY OF KEY ACTIVITY LEVEL ASSUMPTIONS FOR 1990, 1996, 2000,  
2005, 2008 THROUGH 2010, AND 2014 THROUGH 2020**

<b>Detailed Data and Results</b>	
Prepared By:	David Von Hippel
Date Last Modified:	5/20/2020

**UPDATE 2020**

GROUND FORCES	Trucks and General Use Vehicles	Tanks, Amph. Veh., Armored Veh., Other Arms
Hours of Maneuvers Per Year, 1990:	1000	100
Hours of Maneuvers Per Year, 1996:	870	80
Hours of Maneuvers Per Year, 2000:	660	60
Hours of Maneuvers Per Year, 2005	600	55
Hours of Maneuvers Per Year, 2008	630	50
Hours of Maneuvers Per Year, 2009	590	50
Hours of Maneuvers Per Year, 2010	630	51
Hours of Maneuvers Per Year, 2014	630	55
Hours of Maneuvers Per Year, 2015	675	57
Hours of Maneuvers Per Year, 2016	680	60
Hours of Maneuvers Per Year, 2017	670	45
Hours of Maneuvers Per Year, 2018	670	45
Hours of Maneuvers Per Year, 2019	670	45
Hours of Maneuvers Per Year, 2020	400	25

AIRCRAFT							
Mission Hours Per Year:	1990	1996	2000	2005	2008	2009	2010
Fighters/Bombers	24	16	11	19	21	15	19
Transport Aircraft	50	42	32	38	39	38	40
Helicopters	32	24	18	24	30	35	45
Ave. airspeed--Fract. of Maximum	80%	80%	80%	80%	80%	80%	80%
Mission Hours Per Year:	2014	2015	2016	2017	2018	2019	2020
Fighters/Bombers	16	20	23	16	15	17	11
Transport Aircraft	39	44	42	42	40	44	32
Helicopters	47	55	55	45	43	47	35
Ave. airspeed--Fract. of Maximum	80%	80%	80%	80%	80%	80%	80%

<b>MILITARY SHIPS AND BOATS</b>							
<b>Active Hours Per Year in:</b>	<b>1990</b>	<b>1996</b>	<b>2000</b>	<b>2005</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Amphibious	50	50	45	45	40	35	45
Submarines	100	100	90	90	80	80	80
Other Vessels	800	570	565	575	430	400	460
Ave. power use--Fract. of Maximum	50%	50%	50%	50%	50%	50%	50%
<b>Active Hours Per Year in:</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
Amphibious	45	45	45	45	42	42	24
Submarines	80	80	80	70	65	65	38
Other Vessels	410	410	420	300	280	280	150
Ave. power use--Fract. of Maximum	50%	50%	50%	50%	50%	50%	50%

<b>PROJECTION OF ENERGY REQUIRMENTS FOR MILITARY PRODUCT MANUFACTURING</b>	
Ratio of Military Equipment Output in 1996 versus 1990:	0.7
Ratio of Military Equipment Output in 2000 versus 1990:	0.45
Ratio of Military Equipment Output in 2005 versus 1990:	0.45
Ratio of Military Equipment Output in 2008 versus 1990:	0.45
Ratio of Military Equipment Output in 2009) versus 1990:	0.45
Ratio of Military Equipment Output in 2010 versus 1990:	0.45
Ratio of Military Equipment Output in 2014 versus 1990:	0.48
Ratio of Military Equipment Output in 2015 versus 1990:	0.49
Ratio of Military Equipment Output in 2016 versus 1990:	0.5
Ratio of Military Equipment Output in 2017 versus 1990:	0.5
Ratio of Military Equipment Output in 2018 versus 1990:	0.5
Ratio of Military Equipment Output in 2019 versus 1990:	0.5
Ratio of Military Equipment Output in 2020 versus 1990:	0.25

## Summary Tables and Graphics

### ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN DPRK SUMMARY TABLES AND GRAPHICS FOR 1990, 1996, 2000, 2005, 2008 THROUGH 2010, AND 2014 THROUGH 2020

#### Summary Graphics

Prepared By: David Von Hippel  
Date Last Modified: 5/20/2020

#### UPDATE 2020

MILITARY BRANCH Equipment	1990			1996			2000			2005		
	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total
<b>GROUND FORCES</b>												
Tanks/Heavy Arms	2.63E+05	3.8%	1.6%	2.11E+05	3.5%	1.6%	1.48E+05	3.5%	1.3%	1.29E+05	3.5%	1.2%
2 1/2 Ton Trucks	6.23E+06	90.9%	37.9%	5.42E+06	91.1%	41.4%	3.84E+06	91.2%	34.9%	3.33E+06	91.1%	29.8%
Oth Trucks/Utility	3.59E+05	5.2%	2.2%	3.17E+05	5.3%	2.4%	2.25E+05	5.3%	2.0%	1.95E+05	5.3%	1.7%
<b>TOTAL: Ground Forces</b>	<b>6.85E+06</b>	<b>100.0%</b>	<b>41.7%</b>	<b>5.94E+06</b>	<b>100.0%</b>	<b>45.4%</b>	<b>4.21E+06</b>	<b>100.0%</b>	<b>38.3%</b>	<b>3.65E+06</b>	<b>100.0%</b>	<b>32.7%</b>
<b>AIR FORCE</b>												
Fighters/Bombers	1.80E+06	67.9%	10.9%	1.20E+06	63.6%	9.2%	8.24E+05	60.3%	7.5%	1.39E+06	69.2%	12.4%
Transport/Helic.	3.56E+05	13.4%	2.2%	2.92E+05	15.5%	2.2%	2.22E+05	16.2%	2.0%	2.70E+05	13.5%	2.4%
Service (Grnd) Veh.	4.94E+05	18.7%	3.0%	3.95E+05	21.0%	3.0%	3.21E+05	23.5%	2.9%	3.46E+05	17.3%	3.1%
<b>TOTAL: Air Force</b>	<b>2.65E+06</b>	<b>100.0%</b>	<b>16.1%</b>	<b>1.89E+06</b>	<b>100.0%</b>	<b>14.4%</b>	<b>1.37E+06</b>	<b>100.0%</b>	<b>12.4%</b>	<b>2.00E+06</b>	<b>100.0%</b>	<b>17.9%</b>
<b>NAVY</b>												
Patrol Craft	5.05E+06	72.8%	30.7%	3.60E+06	68.4%	27.5%	3.57E+06	65.7%	32.4%	3.63E+06	65.8%	32.5%
Other Vessels	1.51E+06	21.8%	9.2%	1.38E+06	26.3%	10.6%	1.57E+06	29.0%	14.3%	1.59E+06	28.8%	14.2%
Service (Land) Veh.	3.71E+05	5.3%	2.3%	2.81E+05	5.3%	2.1%	2.90E+05	5.3%	2.6%	2.95E+05	5.3%	2.6%
<b>TOTAL: Naval Forces</b>	<b>6.94E+06</b>	<b>100.0%</b>	<b>42.2%</b>	<b>5.26E+06</b>	<b>100.0%</b>	<b>40.2%</b>	<b>5.43E+06</b>	<b>100.0%</b>	<b>49.3%</b>	<b>5.51E+06</b>	<b>100.0%</b>	<b>49.4%</b>
<b>TOTAL MILITARY EQUIP ENERGY USE</b>												
	<b>1.64E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>1.31E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>1.10E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>1.12E+07</b>	<b>GJ/yr</b>	<b>100%</b>



*Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21*

MILITARY BRANCH Equipment	2008			2009			2010			2014		
	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total
<b>GROUND FORCES</b>												
Tanks/Heavy Arms	1.01E+05	3.1%	1.0%	1.01E+05	3.3%	1.2%	1.03E+05	3.1%	1.0%	9.56E+04	2.6%	1.0%
2 1/2 Ton Trucks	3.01E+06	91.6%	30.9%	2.82E+06	91.4%	32.1%	3.01E+06	91.5%	30.3%	3.35E+06	92.4%	35.4%
Oth Trucks/Utility	1.76E+05	5.4%	1.8%	1.65E+05	5.3%	1.9%	1.76E+05	5.4%	1.8%	1.80E+05	5.0%	1.9%
<b>TOTAL: Ground Forces</b>	<b>3.29E+06</b>	<b>100.0%</b>	<b>33.7%</b>	<b>3.08E+06</b>	<b>100.0%</b>	<b>35.1%</b>	<b>3.29E+06</b>	<b>100.0%</b>	<b>33.1%</b>	<b>3.62E+06</b>	<b>100.0%</b>	<b>38.4%</b>
<b>AIR FORCE</b>												
Fighters/Bombers	1.57E+06	70.4%	16.1%	1.12E+06	62.7%	12.8%	1.39E+06	66.0%	13.9%	1.07E+06	56.1%	11.3%
Transport/Helic.	2.90E+05	13.0%	3.0%	2.97E+05	16.6%	3.4%	3.34E+05	15.9%	3.4%	3.42E+05	18.0%	3.6%
Service (Grnd) Veh.	3.71E+05	16.6%	3.8%	3.71E+05	20.7%	4.2%	3.81E+05	18.1%	3.8%	4.90E+05	25.8%	5.2%
<b>TOTAL: Air Force</b>	<b>2.23E+06</b>	<b>100.0%</b>	<b>22.9%</b>	<b>1.79E+06</b>	<b>100.0%</b>	<b>20.4%</b>	<b>2.10E+06</b>	<b>100.0%</b>	<b>21.1%</b>	<b>1.90E+06</b>	<b>100.0%</b>	<b>20.1%</b>
<b>NAVY</b>												
Patrol Craft	2.71E+06	64.2%	27.8%	2.52E+06	64.7%	28.8%	2.90E+06	63.8%	29.2%	2.48E+06	63.2%	26.3%
Other Vessels	1.29E+06	30.5%	13.2%	1.17E+06	30.0%	13.3%	1.41E+06	30.9%	14.1%	1.23E+06	31.5%	13.1%
Service (Land) Veh.	2.26E+05	5.3%	2.3%	2.08E+05	5.3%	2.4%	2.43E+05	5.3%	2.4%	2.10E+05	5.3%	2.2%
<b>TOTAL: Naval Forces</b>	<b>4.23E+06</b>	<b>100.0%</b>	<b>43.4%</b>	<b>3.90E+06</b>	<b>100.0%</b>	<b>44.4%</b>	<b>4.55E+06</b>	<b>100.0%</b>	<b>45.8%</b>	<b>3.92E+06</b>	<b>100.0%</b>	<b>41.5%</b>
<b>TOTAL MILITARY EQUIP ENERGY USE</b>												
	<b>9.75E+06</b>	<b>GJ/yr</b>	<b>100%</b>	<b>8.78E+06</b>	<b>GJ/yr</b>	<b>100%</b>	<b>9.94E+06</b>	<b>GJ/yr</b>	<b>100%</b>	<b>9.44E+06</b>	<b>GJ/yr</b>	<b>100%</b>

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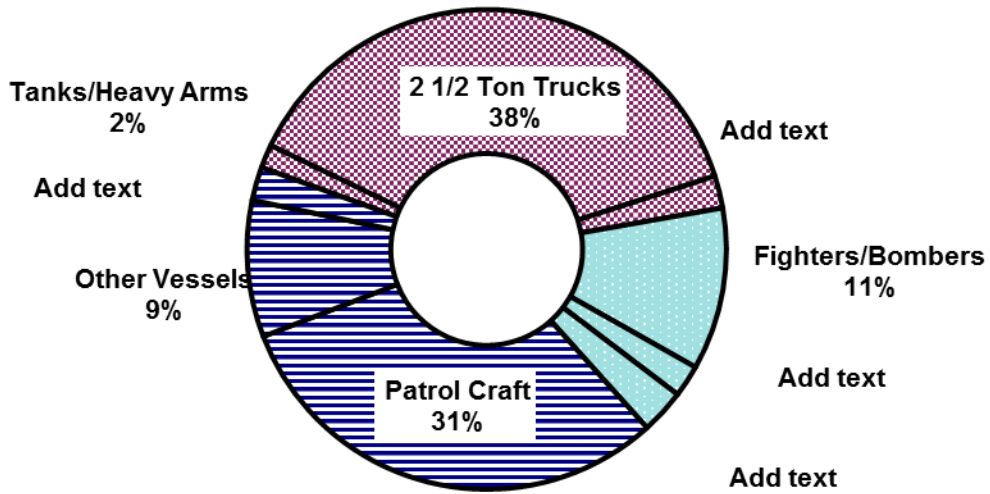
	2015			2016			2017			2018		
<b>MILITARY BRANCH Equipment</b>	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total
<b>GROUND FORCES</b>												
Tanks/Heavy Arms	1.02E+05	2.6%	1.0%	1.11E+05	2.7%	1.0%	8.55E+04	2.1%	0.9%	8.55E+04	2.1%	0.9%
2 1/2 Ton Trucks	3.68E+06	92.4%	35.9%	3.79E+06	92.3%	35.4%	3.83E+06	92.9%	41.1%	3.83E+06	92.9%	41.1%
Oth Trucks/Utility	1.98E+05	5.0%	1.9%	2.05E+05	5.0%	1.9%	2.07E+05	5.0%	2.2%	2.07E+05	5.0%	2.2%
<b>TOTAL: Ground Forces</b>	<b>3.98E+06</b>	<b>100.0%</b>	<b>38.9%</b>	<b>4.11E+06</b>	<b>100.0%</b>	<b>38.3%</b>	<b>4.12E+06</b>	<b>100.0%</b>	<b>44.2%</b>	<b>4.12E+06</b>	<b>100.0%</b>	<b>44.2%</b>
<b>AIR FORCE</b>												
Fighters/Bombers	1.40E+06	60.8%	13.7%	1.65E+06	64.2%	15.4%	1.17E+06	55.2%	12.6%	1.10E+06	51.8%	11.8%
Transport/Helic.	3.98E+05	17.2%	3.9%	3.93E+05	15.3%	3.7%	3.71E+05	17.5%	4.0%	3.54E+05	16.7%	3.8%
Service (Grnd) Veh.	5.08E+05	22.0%	5.0%	5.26E+05	20.5%	4.9%	5.78E+05	27.3%	6.2%	5.64E+05	26.6%	6.1%
<b>TOTAL: Air Force</b>	<b>2.31E+06</b>	<b>100.0%</b>	<b>22.6%</b>	<b>2.57E+06</b>	<b>100.0%</b>	<b>23.9%</b>	<b>2.12E+06</b>	<b>100.0%</b>	<b>22.8%</b>	<b>2.01E+06</b>	<b>95.1%</b>	<b>21.6%</b>
<b>NAVY</b>												
Patrol Craft	2.49E+06	63.2%	24.4%	2.57E+06	63.4%	23.9%	1.84E+06	59.9%	19.8%	1.72E+06	55.9%	18.5%
Other Vessels	1.24E+06	31.5%	12.1%	1.27E+06	31.3%	11.8%	1.07E+06	34.7%	11.5%	9.96E+05	32.4%	10.7%
Service (Land) Veh.	2.11E+05	5.3%	2.1%	2.16E+05	5.3%	2.0%	1.64E+05	5.3%	1.8%	1.53E+05	5.0%	1.6%
<b>TOTAL: Naval Forces</b>	<b>3.94E+06</b>	<b>100.0%</b>	<b>38.6%</b>	<b>4.05E+06</b>	<b>100.0%</b>	<b>37.7%</b>	<b>3.07E+06</b>	<b>100.0%</b>	<b>33.0%</b>	<b>2.87E+06</b>	<b>93.3%</b>	<b>30.8%</b>
<b>TOTAL MILITARY EQUIP ENERGY USE</b>	<b>1.02E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>1.07E+07</b>	<b>GJ/yr</b>	<b>100%</b>	<b>9.31E+06</b>	<b>GJ/yr</b>	<b>100%</b>	<b>9.00E+06</b>	<b>GJ/yr</b>	<b>97%</b>

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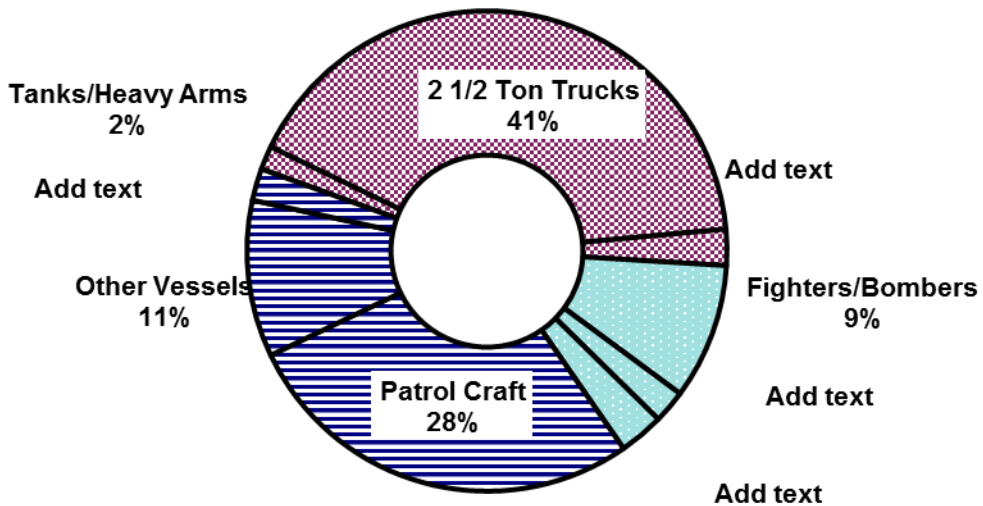
<b>MILITARY BRANCH Equipment</b>	<b>2019</b>			<b>2020</b>		
	Fuel Cons GJ	Fraction of Branch	Fraction of Total	Fuel Cons GJ	Fraction of Branch	Fraction of Total
<b>GROUND FORCES</b>						
Tanks/Heavy Arms	8.55E+04	2.1%	0.9%	4.75E+04	1.9%	0.9%
2 1/2 Ton Trucks	3.83E+06	92.9%	41.6%	2.28E+06	93.0%	41.3%
Oth Trucks/Utility	2.07E+05	5.0%	2.3%	1.24E+05	5.0%	2.2%
<b>TOTAL: Ground Forces</b>	<b>4.12E+06</b>	<b>100.0%</b>	<b>44.8%</b>	<b>2.46E+06</b>	<b>100.0%</b>	<b>44.4%</b>
<b>AIR FORCE</b>						
Fighters/Bombers	1.24E+06	56.3%	13.5%	8.04E+05	53.0%	14.5%
Transport/Helic.	3.89E+05	17.6%	4.2%	2.85E+05	18.8%	5.2%
Service (Grnd) Veh.	5.78E+05	26.1%	6.3%	4.28E+05	28.2%	7.7%
<b>TOTAL: Air Force</b>	<b>2.21E+06</b>	<b>100.0%</b>	<b>24.0%</b>	<b>1.52E+06</b>	<b>100.0%</b>	<b>27.4%</b>
<b>NAVY</b>						
Patrol Craft	1.72E+06	59.9%	18.7%	9.20E+05	59.1%	16.6%
Other Vessels	9.96E+05	34.7%	10.8%	5.53E+05	35.5%	10.0%
Service (Land) Veh.	1.53E+05	5.3%	1.7%	8.31E+04	5.3%	1.5%
<b>TOTAL: Naval Forces</b>	<b>2.87E+06</b>	<b>100.0%</b>	<b>31.2%</b>	<b>1.56E+06</b>	<b>100.0%</b>	<b>28.1%</b>
<b>TOTAL MILITARY EQUIP ENERGY USE</b>	<b>9.20E+06</b>	<b>GJ/yr</b>	<b>100%</b>	<b>5.53E+06</b>	<b>GJ/yr</b>	<b>100%</b>



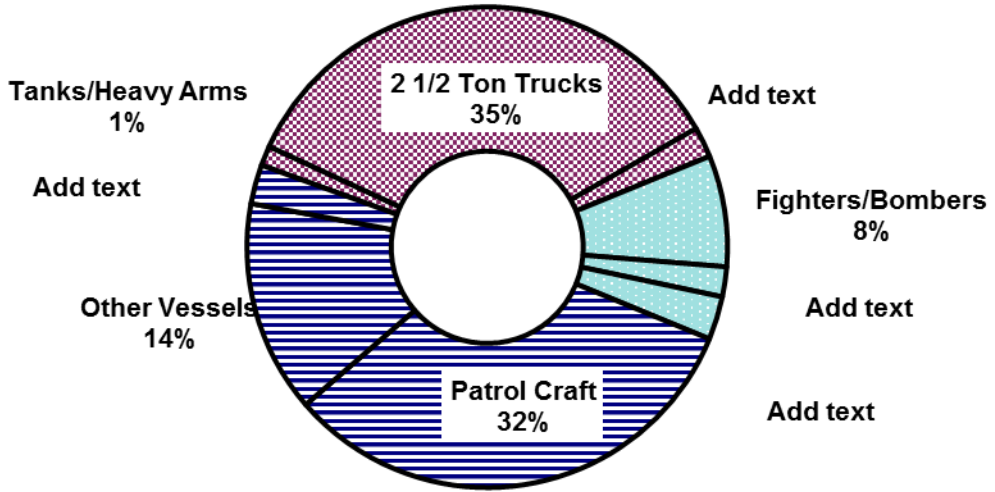
### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 1990



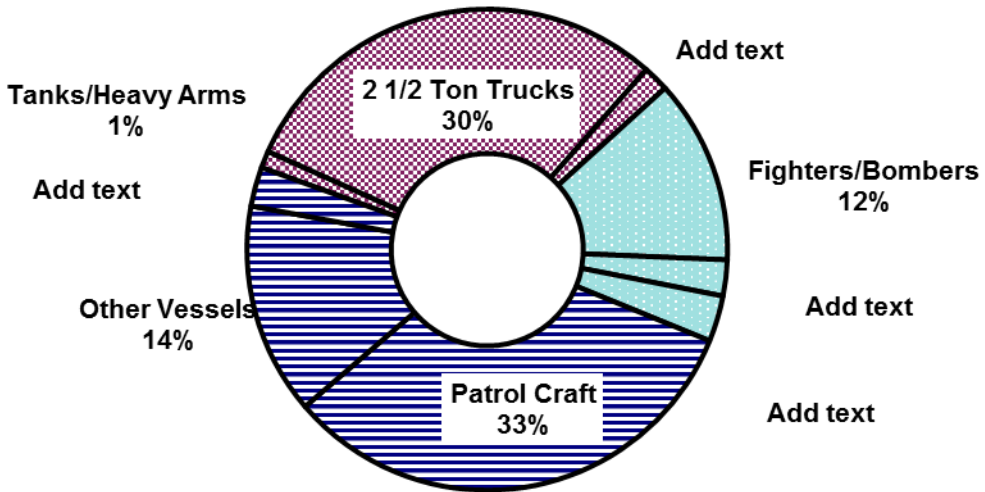
### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 1996



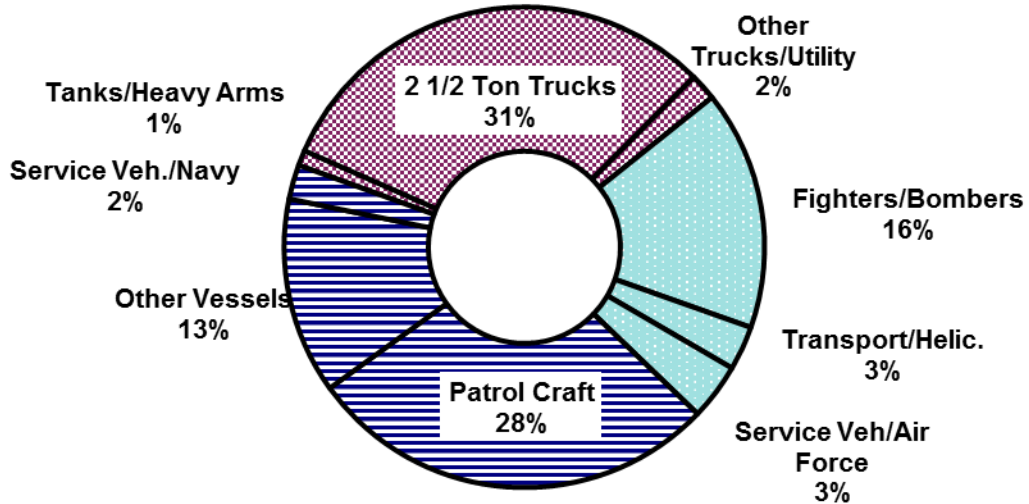
### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2000



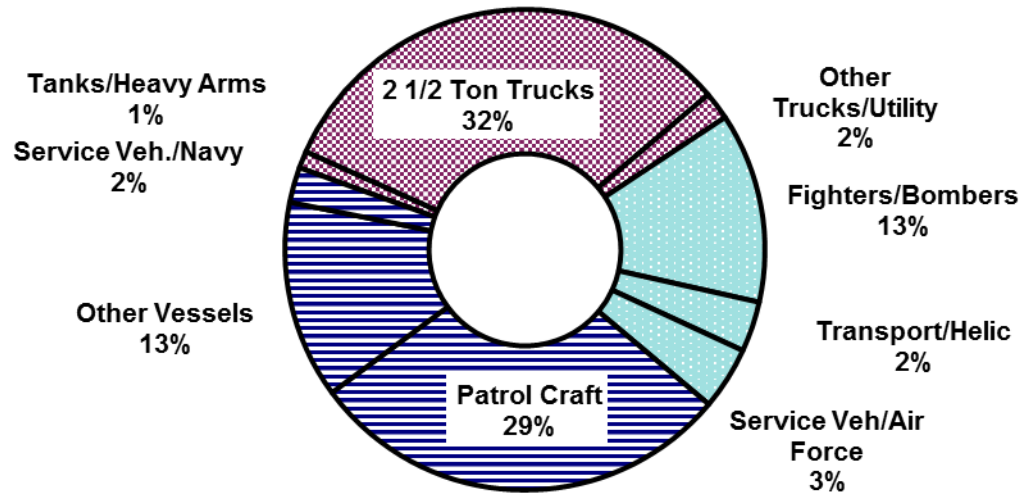
### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2005



### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2008

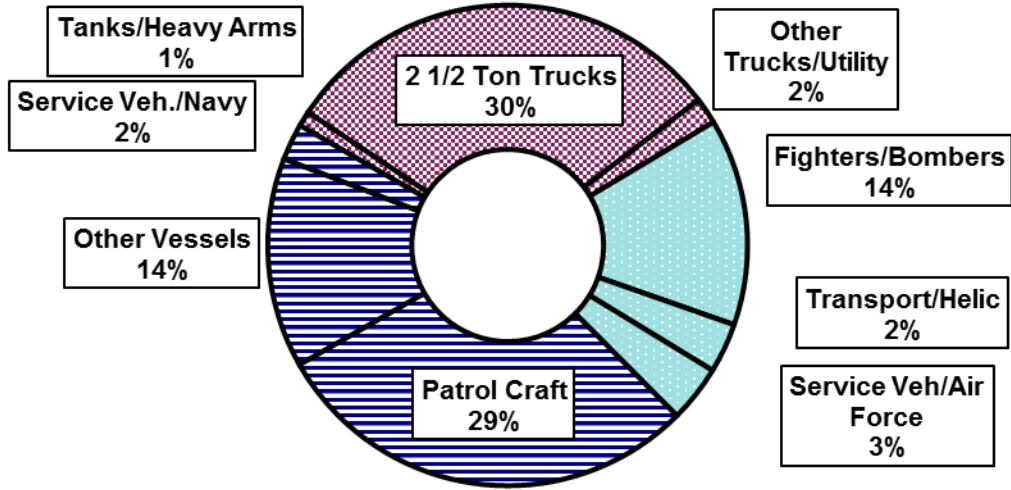


### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2009

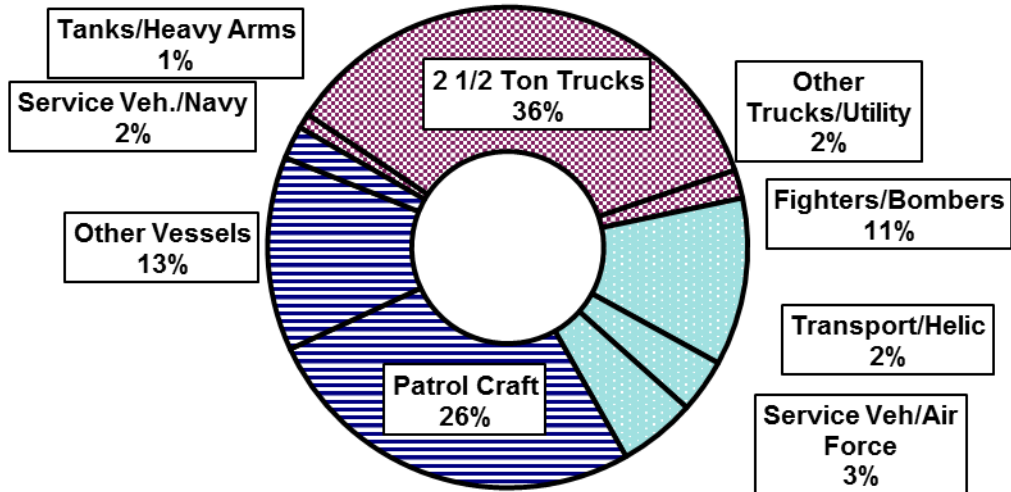




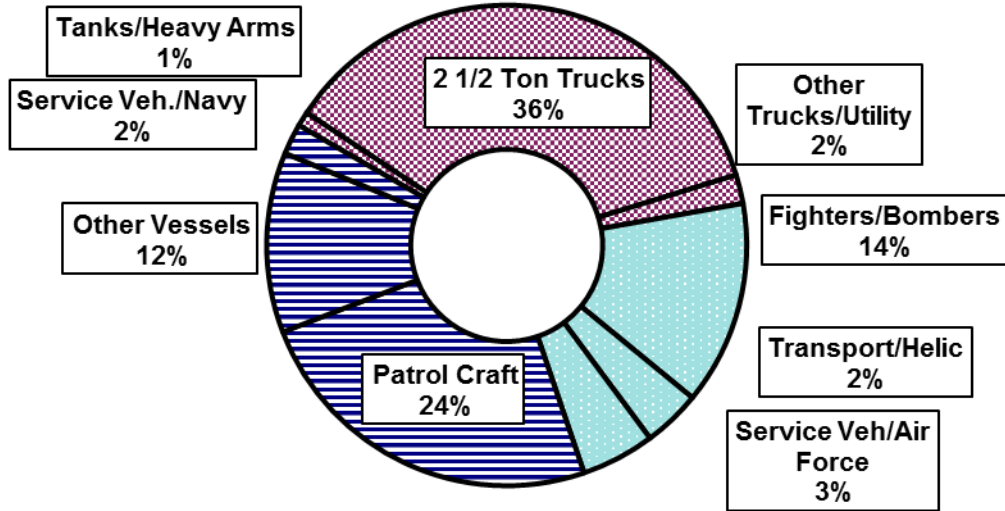
### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2010



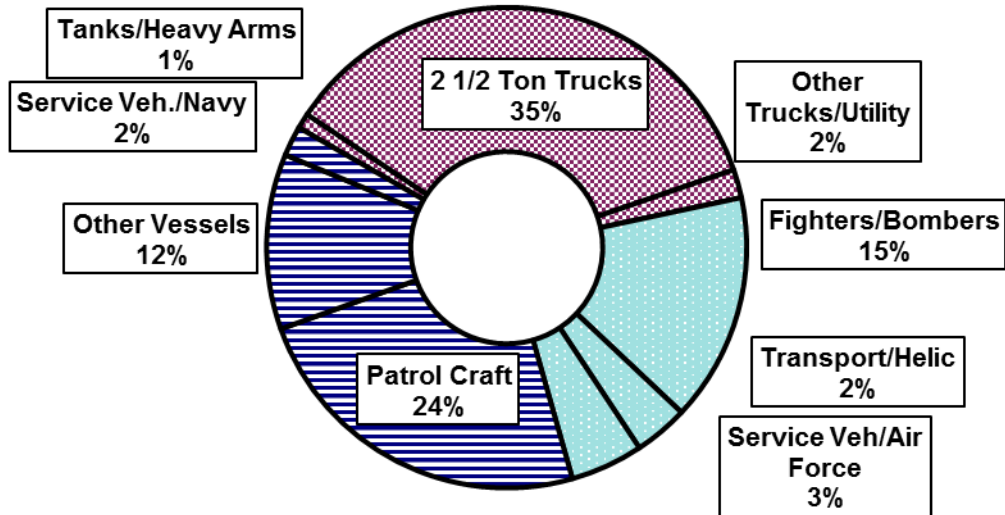
### DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2014



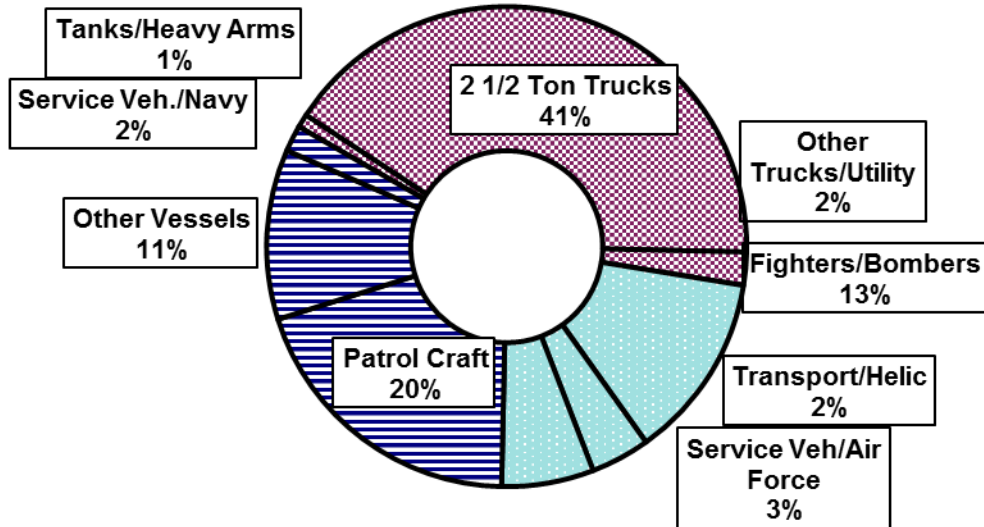
**DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2015**



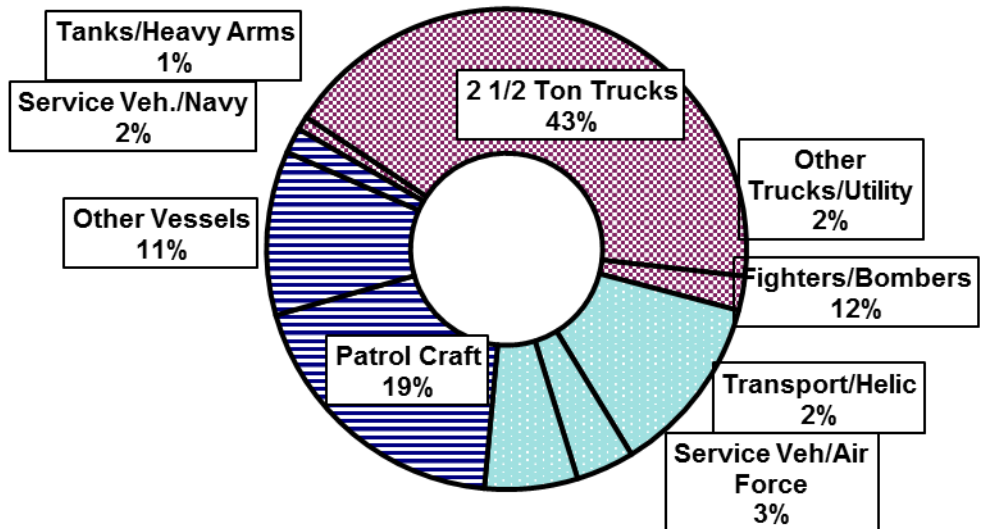
**DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2016**



**DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2017**

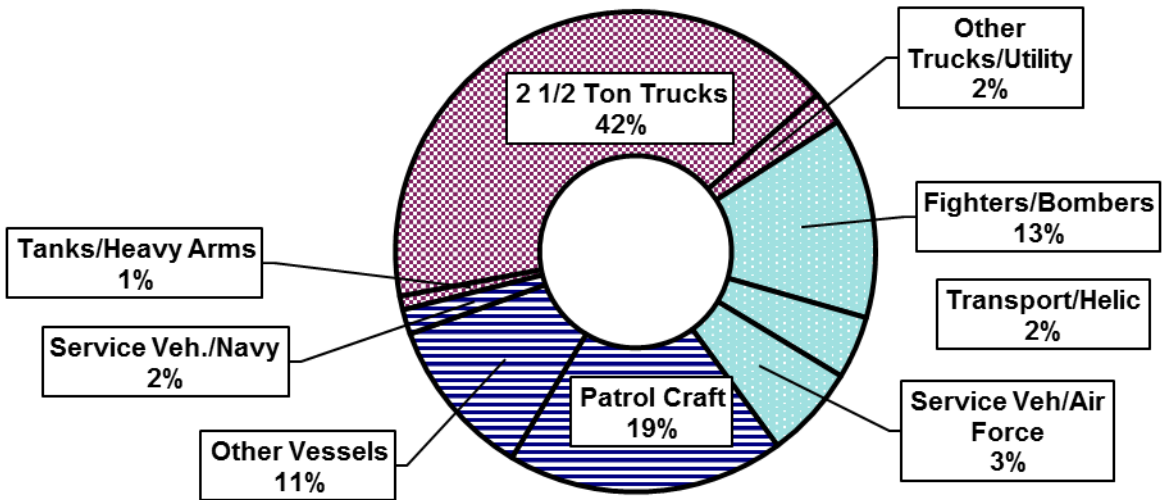


**DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2018**

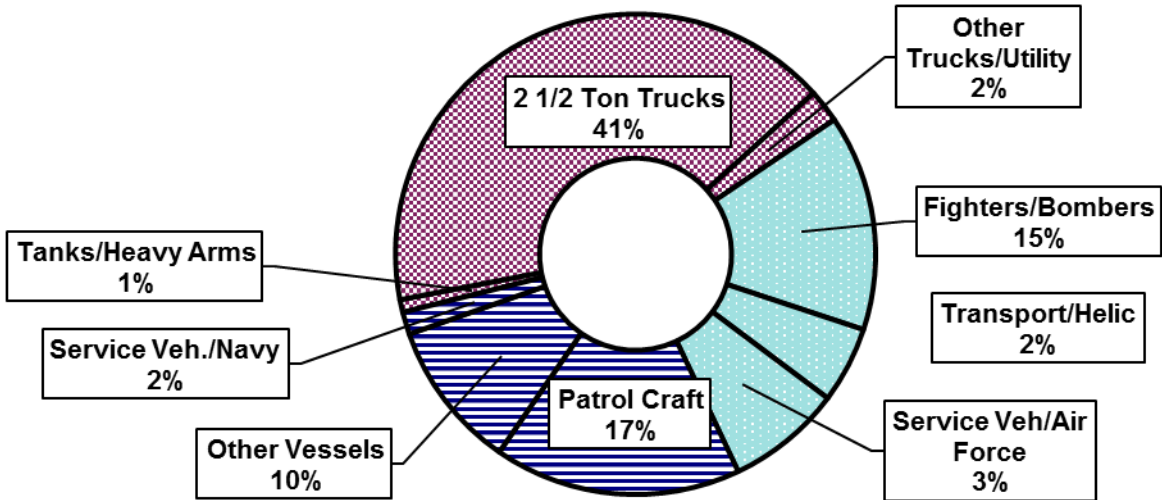




**DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2019**



**DPRK Military Sector Petroleum Product Demand by Vehicle/Equipment Type: 2020**



**Summary Inputs and Results: Ground Forces Energy Use**

**ESTIMATES AND PROJECTIONS OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK:  
MILITARY GROUND VEHICLES AND ARMAMENTS UPDATE 2020**

Prepared By: David Von Hippel																																														
Date Last Modified: 5/20/2020																																														
<b>Summary Input Data and Results</b>																																														
	<table border="1"> <thead> <tr> <th></th> <th>Trucks and General Use Vehicles</th> <th>Tanks, Amph. Veh., Armored Veh., Other Arms</th> </tr> </thead> <tbody> <tr> <td>Hours of Ground Maneuvers Per Year, 1990:</td> <td>1000</td> <td>100</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 1996:</td> <td>870</td> <td>80</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2000:</td> <td>660</td> <td>60</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2005:</td> <td>600</td> <td>55</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2008:</td> <td>630</td> <td>50</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2009:</td> <td>590</td> <td>50</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2010:</td> <td>630</td> <td>51</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2014:</td> <td>630</td> <td>55</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2015:</td> <td>675</td> <td>57</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2016:</td> <td>680</td> <td>60</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2017:</td> <td>670</td> <td>45</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2018:</td> <td>670</td> <td>45</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2019:</td> <td>670</td> <td>45</td> </tr> <tr> <td>Hours of Ground Maneuvers Per Year, 2020:</td> <td>400</td> <td>25</td> </tr> </tbody> </table>		Trucks and General Use Vehicles	Tanks, Amph. Veh., Armored Veh., Other Arms	Hours of Ground Maneuvers Per Year, 1990:	1000	100	Hours of Ground Maneuvers Per Year, 1996:	870	80	Hours of Ground Maneuvers Per Year, 2000:	660	60	Hours of Ground Maneuvers Per Year, 2005:	600	55	Hours of Ground Maneuvers Per Year, 2008:	630	50	Hours of Ground Maneuvers Per Year, 2009:	590	50	Hours of Ground Maneuvers Per Year, 2010:	630	51	Hours of Ground Maneuvers Per Year, 2014:	630	55	Hours of Ground Maneuvers Per Year, 2015:	675	57	Hours of Ground Maneuvers Per Year, 2016:	680	60	Hours of Ground Maneuvers Per Year, 2017:	670	45	Hours of Ground Maneuvers Per Year, 2018:	670	45	Hours of Ground Maneuvers Per Year, 2019:	670	45	Hours of Ground Maneuvers Per Year, 2020:	400	25
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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				1996			2000		
						Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Fraction of Total	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ
<i>Notes</i>				1	2										
Tanks	5,832	1.97	2.08	50%	25	50	5.46E+06	2.05E+05	3.0%	40	4.36E+06	1.64E+05	30	3.06E+06	1.15E+05
Amphibious Vehicles	900	1.04	26.50	50%	20	50	2.78E+05	1.04E+04	0.2%	40	2.22E+05	8.35E+03	30	1.56E+05	5.85E+03
Armored Fighting Vehicles	4,015	6.53	7.50	50%	30	50	1.38E+06	4.50E+04	0.7%	40	1.11E+06	3.60E+04	30	7.76E+05	2.52E+04
Truck/Tank-Mounted Guns, Missiles	516	1.97	6.44	25%	20	25	7.06E+04	2.64E+03	0.0%	20	5.65E+04	2.12E+03	15	3.96E+04	1.49E+03
Jeeps and Motorcycles	9,045	26.50	50	50%	30	500	6.61E+06	2.15E+05	3.1%	435	5.75E+06	1.87E+05	330	4.08E+06	1.33E+05
2 1/2 Ton Trucks	72,403	8.63		50%	30	500	1.91E+08	6.23E+06	90.9%	435	1.67E+08	5.42E+06	330	1.18E+08	3.84E+06
Other Trucks and Utility Equipment	1,632	3.85	8.63	50%	25	500	3.97E+06	1.44E+05	2.1%	435	3.45E+06	1.30E+05	330	2.45E+06	9.19E+04
<b>TOTALS</b>	<b>94,343</b>						<b>2.09E+08</b>	<b>6.85E+06</b>	<b>100.0%</b>		<b>1.81E+08</b>	<b>5.94E+06</b>		<b>1.29E+08</b>	<b>4.21E+06</b>
<b>Diesel Consumption</b>							8.69E+06	3.27E+05	4.8%		7.16E+06	2.69E+05		5.04E+06	1.89E+05
<b>Gasoline Consumption</b>							2.00E+08	6.52E+06	95.2%		1.74E+08	5.68E+06		1.24E+08	4.02E+06

Vehicle Types	2005			2008			2009			2010			2014		
	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ
<i>Notes</i>															
Tanks	27.5	2.67E+06	1.01E+05	25	2.09E+06	7.87E+04	25	2.09E+06	7.87E+04	25.5	2.14E+06	8.02E+04	27.5	2.07E+06	7.78E+04
Amphibious Vehicles	27.5	1.36E+05	5.11E+03	25	1.07E+05	4.00E+03	25	1.07E+05	4.00E+03	25.5	1.09E+05	4.08E+03	27.5	1.05E+05	3.96E+03
Armored Fighting Vehicles	27.5	6.79E+05	2.21E+04	25	5.31E+05	1.73E+04	25	5.31E+05	1.73E+04	25.5	5.42E+05	1.76E+04	27.5	3.94E+05	1.28E+04
Truck/Tank-Mounted Guns, Missiles	13.75	3.46E+04	1.30E+03	12.5	2.71E+04	1.02E+03	12.5	2.71E+04	1.02E+03	12.75	2.76E+04	1.04E+03	13.75	2.68E+04	1.01E+03
Jeeps and Motorcycles	300	3.54E+06	1.15E+05	315	3.20E+06	1.04E+05	295	2.99E+06	9.74E+04	315	3.20E+06	1.04E+05	315	3.55E+06	1.16E+05
2 1/2 Ton Trucks	300	1.02E+08	3.33E+06	315	9.25E+07	3.01E+06	295	8.67E+07	2.82E+06	315	9.25E+07	3.01E+06	315	1.03E+08	3.35E+06
Other Trucks and Utility Equipment	300	2.12E+06	7.97E+04	315	1.92E+06	7.21E+04	295	1.80E+06	6.75E+04	315	1.92E+06	7.21E+04	315	1.72E+06	6.48E+04
<b>TOTALS</b>		<b>1.12E+08</b>	<b>3.65E+06</b>		<b>1.00E+08</b>	<b>3.29E+06</b>		<b>9.42E+07</b>	<b>3.08E+06</b>		<b>1.00E+08</b>	<b>3.29E+06</b>		<b>1.11E+08</b>	<b>3.62E+06</b>
<b>Diesel Consumption</b>		4.39E+06	1.65E+05		3.62E+06	1.36E+05		3.54E+06	1.33E+05		3.67E+06	1.38E+05		3.46E+06	1.30E+05
<b>Gasoline Consumption</b>		1.07E+08	3.49E+06		9.68E+07	3.15E+06		9.07E+07	2.95E+06		9.68E+07	3.15E+06		1.07E+08	3.49E+06

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Vehicle Types	2015			2016			2017		
	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ
<i>Notes</i>									
Tanks	28.5	2.21E+06	8.30E+04	30	2.39E+06	9.00E+04	22.5	1.85E+06	6.94E+04
Amphibious Vehicles	28.5	1.13E+05	4.23E+03	30	1.22E+05	4.58E+03	22.5	9.41E+04	3.53E+03
Armored Fighting Vehicles	28.5	4.23E+05	1.38E+04	30	4.60E+05	1.50E+04	22.5	3.57E+05	1.16E+04
Truck/Tank-Mounted Guns, Missiles	14.25	2.86E+04	1.07E+03	15	3.10E+04	1.16E+03	11.25	2.39E+04	8.98E+02
Jeeps and Motorcycles	337.5	3.90E+06	1.27E+05	340	4.03E+06	1.31E+05	335	4.06E+06	1.32E+05
2 1/2 Ton Trucks	337.5	1.13E+08	3.68E+06	340	1.17E+08	3.79E+06	335	1.18E+08	3.83E+06
Other Trucks and Utility Equipment	337.5	1.90E+06	7.15E+04	340	1.97E+06	7.42E+04	335	2.00E+06	7.52E+04
<b>TOTALS</b>		1.22E+08	3.98E+06		1.26E+08	4.11E+06		1.26E+08	4.12E+06
<b>Diesel Consumption</b>		3.74E+06	1.40E+05		3.98E+06	1.50E+05		3.42E+06	1.29E+05
<b>Gasoline Consumption</b>		1.18E+08	3.84E+06		1.22E+08	3.96E+06		1.23E+08	3.99E+06

Vehicle Types	2018			2019			2020		
	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ	Annual Hrs Use	Fuel Cons (liters)	Fuel Cons GJ
<i>Notes</i>									
Tanks	22.5	1.85E+06	6.94E+04	22.5	1.85E+06	6.94E+04	12.5	1.03E+06	3.86E+04
Amphibious Vehicles	22.5	9.41E+04	3.53E+03	22.5	9.41E+04	3.53E+03	12.5	5.23E+04	1.96E+03
Armored Fighting Vehicles	22.5	3.57E+05	1.16E+04	22.5	3.57E+05	1.16E+04	12.5	1.98E+05	6.45E+03
Truck/Tank-Mounted Guns, Missiles	11.25	2.39E+04	8.98E+02	11.25	2.39E+04	8.98E+02	6.25	1.33E+04	4.99E+02
Jeeps and Motorcycles	335	4.06E+06	1.32E+05	335	4.06E+06	1.32E+05	200	2.43E+06	7.89E+04
2 1/2 Ton Trucks	335	1.18E+08	3.83E+06	335	1.18E+08	3.83E+06	200	7.02E+07	2.28E+06
Other Trucks and Utility Equipment	335	2.00E+06	7.52E+04	335	2.00E+06	7.52E+04	200	1.19E+06	4.49E+04
<b>TOTALS</b>		1.26E+08	4.12E+06		1.26E+08	4.12E+06		7.51E+07	2.46E+06
<b>Diesel Consumption</b>		3.42E+06	1.29E+05		3.42E+06	1.29E+05		1.96E+06	7.37E+04
<b>Gasoline Consumption</b>		1.23E+08	3.99E+06		1.23E+08	3.99E+06		7.32E+07	2.38E+06

**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.

Detailed Inputs and Results: Ground Forces Energy Use

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

**UPDATE 2020**

**Detailed Data and Results**

Prepared By: David Von Hippel  
Date Last Modified: 5/20/2020

COMMON ASSUMPTIONS & PARAMETERS		
	Trucks and General Use Vehicles	Tanks, Amph. Veh., Armored Veh., Other Arms
<b>GROUND FORCES</b>		
Hours of Maneuvers Per Year, 1990:	1000	100
Hours of Maneuvers Per Year, 1996:	870	80
Hours of Maneuvers Per Year, 2000:	660	60
Hours of Maneuvers Per Year, 2005:	600	55
Hours of Maneuvers Per Year, 2008:	630	50
Hours of Maneuvers Per Year, 2009:	590	50
Hours of Maneuvers Per Year, 2010:	630	51
Hours of Maneuvers Per Year, 2014:	630	55
Hours of Maneuvers Per Year, 2015:	675	57
Hours of Maneuvers Per Year, 2016:	680	60
Hours of Maneuvers Per Year, 2017:	670	45
Hours of Maneuvers Per Year, 2018:	670	45
Hours of Maneuvers Per Year, 2019:	670	45
Hours of Maneuvers Per Year, 2020:	400	25
Fraction of Stock Unuseable:	20%	
Conversion Factor:	3.8	liters/gal
Diesel Energy Content:	0.037584	GJ/liter
Gasoline Energy Content:	0.0325304	GJ/liter

Note 25  
Note 24  
Note 27  
Note 30  
Note 30  
Note 30  
Note 30  
Note 30  
Note 30  
Note 31  
Note 21



*Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21*

Estimate of Number of Vehicles In Military Fleet					MOTORIZED EQUIPMENT, BY TYPE, PER UNIT												
Branch or Unit of Ground Forces	Number	Personnel		Notes	TANKS			AMPHIBIOUS VEH. AND TANK RTVR					ARMORED FTG. VEHICLES		GUNS, MISSILES		
		per Unit	TOTAL Personnel		Medium T-54/55	Med: T62/63/PT-76	ASLT	PT-76 Lt Amph	PTS Trk Amph	K-61 Trk Amph	GAZ-46	AMPHI FERRY	Tank Retriever	BTR-60	BRDM	AAG ZSU-57	BM-21 (URAL-375)
		Reserve Infantry Divisions	26		10,359	269,334	1	31	2						1		
Reserve-Infantry Brigades	18	8,296	149,328	2													
Infantry Divisions	30	10,359	310,770	1	31	2						1					
Truck Mobile Divisions	1	8,194	8,194	5	93			16				8	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														
<b>TOTAL INDICATED LAND FORCES</b>			<b>936,018</b>		<b>1,919</b>	<b>2,727</b>	<b>475</b>	<b>166</b>	<b>10</b>	<b>320</b>	<b>35</b>	<b>60</b>	<b>199</b>	<b>3,180</b>	<b>345</b>	<b>240</b>	<b>138</b>
Reported Ground Personnel (as of 1990)			1.07E+06	7, 23, 26			5,121					790		3,525			
<b>TRUED-UP LAND FORCES</b>	True-Up Factor, '90/'96:		<b>1.14</b>		<b>2,185</b>	<b>3,106</b>	<b>541</b>	<b>189</b>	<b>11</b>	<b>364</b>	<b>40</b>	<b>68</b>	<b>227</b>	<b>3,622</b>	<b>393</b>	<b>273</b>	<b>157</b>
<b>Equipment Totals by Category</b>							<b>5,832</b>					<b>900</b>		<b>4,015</b>			

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<b>Estimate of Number of Vehicles In Military Fleet</b>				<b>MOTORIZED EQUIPMENT, BY TYPE, PER UNIT</b>															
Branch or Unit of Ground Forces	Personnel		TOTAL Personnel	Notes	<b>GUNS, MISSILES (Cont.)</b>			<b>LIGHT VEH.</b>		<b>2.5 T Truck</b>	<b>TRUCKS AND UTILITY VEHICLES</b>								
	Number	per Unit			BM-20,24 (ZIL-151,7)	FROG 3/5 (PT-76)	FROG 7 (ZIL-135)	JEEPS	Motor- Cycles		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	33
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									
<b>TOTAL INDICATED LAND FORCES</b>			<b>936,018</b>			15	30	30	5,400	2,542	63,575	23	30	480	90	360	210	132	108
Reported Ground Personnel (as of 1990)			1.07E+06	7,23,26				453		7,942	63,575								1,433
<b>TRUED-UP LAND FORCES</b>	True-Up Factor, '90/96:		1.14			17	34	34	6,150	2,895	72,403	26	34	547	102	410	239	150	123
<b>Equipment Totals by Category</b>								516		9,045	72,403								1,632

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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)
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
<b>Operating Assumptions</b>															
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		50	50	50	50	50	50	50	25	25	50	50	25	25
Hours of Operation, 1996	hrs		40	40	40	40	40	40	40	20	20	40	40	20	20
Hours of Operation, 2000	hrs		30	30	30	30	30	30	30	15	15	30	30	15	15
Hours of Operation, 2005	hrs		27.5	27.5	27.5	27.5	27.5	27.5	27.5	13.75	13.75	27.5	27.5	13.75	13.75
Hours of Operation, 2008	hrs		25	25	25	25	25	25	25	12.5	12.5	25	25	12.5	12.5
Hours of Operation, 2009	hrs		25	25	25	25	25	25	25	12.5	12.5	25	25	12.5	12.5
Hours of Operation, 2010	hrs		25.5	25.5	25.5	25.5	25.5	25.5	25.5	12.75	12.75	25.5	25.5	12.75	12.75
Hours of Operation, 2014	hrs		27.5	27.5	27.5	27.5	27.5	27.5	27.5	13.75	13.75	27.5	27.5	13.75	13.75
Hours of Operation, 2015	hrs		28.5	28.5	28.5	28.5	28.5	28.5	28.5	14.25	14.25	28.5	28.5	14.25	14.25
Hours of Operation, 2016	hrs		30	30	30	30	30	30	30	15	15	30	30	15	15
Hours of Operation, 2017	hrs		22.5	22.5	22.5	22.5	22.5	22.5	22.5	11.25	11.25	22.5	22.5	11.25	11.25
Hours of Operation, 2018	hrs		22.5	22.5	22.5	22.5	22.5	22.5	22.5	11.25	11.25	22.5	22.5	11.25	11.25
Hours of Operation, 2019	hrs		22.5	22.5	22.5	22.5	22.5	22.5	22.5	11.25	11.25	22.5	22.5	11.25	11.25
Hours of Operation, 2020	hrs		12.5	12.5	12.5	12.5	12.5	12.5	12.5	6.25	6.25	12.5	12.5	6.25	6.25

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		MOTORIZED EQUIPMENT, BY TYPE, PER UNIT														
		GUNS, MISSILES (Cont.)			LIGHT VEH.		2.5 T	TRUCKS AND UTILITY VEHICLES								
		BM-20,24 (ZIL-151,7)	FROG 3/5 (PT-76)	FROG 7 (ZIL-135)	JEEPS	Motor- Cycles	Truck	Dump	Zil-135	Zil-151	Kraz-214	GAZ-63	Zil-157V	Power Boats	Oth Hvy Equip.	
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	
<b>Operating Assumptions</b>																
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		15	
Hours of Operation, 1990	hrs	25	25	25	500	500	500	500	500	500	500	500	500	250	250	
Hours of Operation, 1996	hrs	20	20	20	435	435	435	435	435	435	435	435	435	217.5	217.5	
Hours of Operation, 2000	hrs	15	15	15	330	330	330	330	330	330	330	330	330	165	165	
Hours of Operation, 2005	hrs	13.75	13.75	13.75	300	300	300	300	300	300	300	300	300	150	150	
Hours of Operation, 2008	hrs	12.5	12.5	12.5	315	315	315	315	315	315	315	315	315	157.5	157.5	
Hours of Operation, 2009	hrs	12.5	12.5	12.5	295	295	295	295	295	295	295	295	295	147.5	147.5	
Hours of Operation, 2010	hrs	12.75	12.75	12.75	315	315	315	315	315	315	315	315	315	157.5	157.5	
Hours of Operation, 2014	hrs	13.75	13.75	13.75	315	315	315	315	315	315	315	315	315	157.5	157.5	
Hours of Operation, 2015	hrs	14.25	14.25	14.25	337.5	337.5	337.5	337.5	337.5	337.5	337.5	337.5	337.5	168.75	168.75	
Hours of Operation, 2016	hrs	15	15	15	340	340	340	340	340	340	340	340	340	170	170	
Hours of Operation, 2017	hrs	11.25	11.25	11.25	335	335	335	335	335	335	335	335	335	167.5	167.5	
Hours of Operation, 2018	hrs	11.25	11.25	11.25	335	335	335	335	335	335	335	335	335	167.5	167.5	
Hours of Operation, 2019	hrs	11.25	11.25	11.25	335	335	335	335	335	335	335	335	335	167.5	167.5	
Hours of Operation, 2020	hrs	6.25	6.25	6.25	200	200	200	200	200	200	200	200	200	100	100	

Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21

MOTORIZED EQUIPMENT, BY TYPE, PER UNIT															
		TANKS			AMPHIBIOUS VEH. AND TANK RTVR						ARMORED FTG. VEHICLES		GUNS, MISSILES		
		Medium	Med: T62/ T-54/55	ASLT	PT-76 Lt Amph	PTS Trk Amph	K-61 Trk Amph	GAZ-46	AMPHI FERRY	Tank Retriever	BTR-60	BRDM	AAG ZSU-57	BM-21 (URAL-375)	
<b>Fuel Consumption Results, 1990</b>															
TOTAL FUEL USED	gal	22	5.55E+05	7.45E+05	1.35E+05	1.95E+04	2.19E+03	3.76E+04	6.02E+02	4.92E+03	8.39E+03	3.3E+05	3.1E+04	1.39E+04	2.66E+03
By Vehicle Category	gal	22	All Veh.	5.50E+07	1.44E+06	7.31E+04	3.6E+05								
TOTAL FUEL USED	liters		2.11E+06	2.83E+06	5.14E+05	7.41E+04	8.31E+03	1.43E+05	2.29E+03	1.87E+04	3.19E+04	1.3E+06	1.2E+05	5.28E+04	1.01E+04
By Vehicle Category	liters		All Veh.	2.09E+08	5.46E+06	2.78E+05	1.4E+06								
TOTAL FUEL USED	GJ		7.93E+04	1.06E+05	1.93E+04	2.78E+03	3.12E+02	5.37E+03	7.44E+01	7.03E+02	1.20E+03	4.1E+04	3.9E+03	1.98E+03	3.80E+02
By Vehicle Category	GJ		All Veh.	6.85E+06	2.05E+05	1.04E+04	4.5E+04								
<b>Fuel Consumption Results, 1996</b>															
TOTAL FUEL USED	gal	22	4.44E+05	5.96E+05	1.08E+05	1.56E+04	1.75E+03	3.01E+04	4.81E+02	3.94E+03	6.71E+03	2.7E+05	2.5E+04	1.11E+04	2.13E+03
By Vehicle Category	gal	22	All Veh.	4.78E+07	1.15E+06	5.85E+04	2.9E+05								
TOTAL FUEL USED	liters		1.69E+06	2.27E+06	4.11E+05	5.92E+04	6.65E+03	1.14E+05	1.83E+03	1.50E+04	2.55E+04	1.0E+06	9.6E+04	4.22E+04	8.09E+03
By Vehicle Category	liters		All Veh.	1.81E+08	4.36E+06	2.22E+05	1.1E+06								
TOTAL FUEL USED	GJ		6.34E+04	8.52E+04	1.55E+04	2.23E+03	2.50E+02	4.29E+03	5.95E+01	5.62E+02	9.58E+02	3.3E+04	3.1E+03	1.59E+03	3.04E+02
By Vehicle Category	GJ		All Veh.	5.94E+06	1.64E+05	8.35E+03	3.6E+04								
<b>Fuel Consumption Results, 2000</b>															
TOTAL FUEL USED	gal	22	3.11E+05	4.18E+05	7.58E+04	1.09E+04	1.23E+03	2.11E+04	3.37E+02	2.76E+03	4.70E+03	1.9E+05	1.8E+04	7.78E+03	1.49E+03
By Vehicle Category	gal	22	All Veh.	3.38E+07	8.05E+05	4.10E+04	2.0E+05								
TOTAL FUEL USED	liters		1.18E+06	1.59E+06	2.88E+05	4.15E+04	4.66E+03	8.00E+04	1.28E+03	1.05E+04	1.79E+04	7.1E+05	6.7E+04	2.96E+04	5.67E+03
By Vehicle Category	liters		All Veh.	1.29E+08	3.06E+06	1.56E+05	7.8E+05								
TOTAL FUEL USED	GJ		4.44E+04	5.97E+04	1.08E+04	1.56E+03	1.75E+02	3.01E+03	4.17E+01	3.94E+02	6.71E+02	2.3E+04	2.2E+03	1.11E+03	2.13E+02
By Vehicle Category	GJ		All Veh.	4.21E+06	1.15E+05	5.85E+03	2.5E+04								
<b>Fuel Consumption Results, 2005</b>															
TOTAL FUEL USED	gal	22	2.72E+05	3.65E+05	6.63E+04	9.55E+03	1.07E+03	1.84E+04	2.95E+02	2.41E+03	4.11E+03	1.6E+05	1.5E+04	6.81E+03	1.30E+03
By Vehicle Category	gal	22	All Veh.	2.93E+07	7.04E+05	3.59E+04	1.8E+05								
TOTAL FUEL USED	liters		1.03E+06	1.39E+06	2.52E+05	3.63E+04	4.07E+03	7.00E+04	1.12E+03	9.16E+03	1.56E+04	6.2E+05	5.9E+04	2.59E+04	4.95E+03
By Vehicle Category	liters		All Veh.	1.12E+08	2.67E+06	1.36E+05	6.8E+05								
TOTAL FUEL USED	GJ		3.89E+04	5.22E+04	9.47E+03	1.36E+03	1.53E+02	2.63E+03	3.65E+01	3.44E+02	5.87E+02	2.0E+04	1.9E+03	9.72E+02	1.86E+02
By Vehicle Category	GJ		All Veh.	3.65E+06	1.01E+05	5.11E+03	2.2E+04								



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		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.	
<b>Fuel Consumption Results, 1990</b>																
TOTAL FUEL USED	gal	22	2.65E+02	8.80E+02	8.88E+02	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	22			1.86E+04		1.74E+06	5.04E+07								1.0E+06
TOTAL FUEL USED	liters		1.01E+03	3.35E+03	3.38E+03	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				7.06E+04		6.61E+06	1.91E+08								4.0E+06
TOTAL FUEL USED	GJ		3.79E+01	1.26E+02	1.10E+02	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				2.64E+03		2.15E+05	6.23E+06								1.4E+05
<b>Fuel Consumption Results, 1996</b>																
TOTAL FUEL USED	gal	22	2.12E+02	7.04E+02	7.11E+02	1.21E+06	3.02E+05	4.38E+07	2.8E+04	3.9E+04	3.2E+05	1.1E+05	2.1E+05	1.9E+05	0.0E+00	1.5E+04
By Vehicle Category	gal	22			1.49E+04		1.51E+06	4.38E+07								9.1E+05
TOTAL FUEL USED	liters		8.07E+02	2.68E+03	2.70E+03	4.60E+06	1.15E+06	1.67E+08	1.1E+05	1.5E+05	1.2E+06	4.2E+05	7.9E+05	7.4E+05	0.0E+00	5.7E+04
By Vehicle Category	liters				5.65E+04		5.75E+06	1.67E+08								3.5E+06
TOTAL FUEL USED	GJ		3.03E+01	1.01E+02	1.01E+02	1.50E+05	3.74E+04	5.42E+06	4.0E+03	5.5E+03	4.5E+04	1.6E+04	3.0E+04	2.8E+04	0.0E+00	2.1E+03
By Vehicle Category	GJ				2.12E+03		1.87E+05	5.42E+06								1.3E+05
<b>Fuel Consumption Results, 2000</b>																
TOTAL FUEL USED	gal	22	1.49E+02	4.94E+02	4.98E+02	8.59E+05	2.14E+05	3.11E+07	2.0E+04	2.7E+04	2.2E+05	7.8E+04	1.5E+05	1.4E+05	0.0E+00	1.1E+04
By Vehicle Category	gal	22			1.04E+04		1.07E+06	3.11E+07								6.4E+05
TOTAL FUEL USED	liters		5.65E+02	1.88E+03	1.89E+03	3.26E+06	8.14E+05	1.18E+08	7.5E+04	1.0E+05	8.5E+05	2.9E+05	5.6E+05	5.2E+05	0.0E+00	4.0E+04
By Vehicle Category	liters				3.96E+04		4.08E+06	1.18E+08								2.4E+06
TOTAL FUEL USED	GJ		2.12E+01	7.05E+01	7.11E+01	1.06E+05	2.65E+04	3.84E+06	2.8E+03	3.9E+03	3.2E+04	1.1E+04	2.1E+04	2.0E+04	0.0E+00	1.5E+03
By Vehicle Category	GJ				1.49E+03		1.33E+05	3.84E+06								9.2E+04
<b>Fuel Consumption Results, 2005</b>																
TOTAL FUEL USED	gal	22	1.30E+02	4.32E+02	4.35E+02	7.45E+05	1.86E+05	2.69E+07	1.7E+04	2.4E+04	1.9E+05	6.7E+04	1.3E+05	1.2E+05	0.0E+00	9.2E+03
By Vehicle Category	gal	22			9.11E+03		9.30E+05	2.69E+07								5.6E+05
TOTAL FUEL USED	liters		4.94E+02	1.64E+03	1.65E+03	2.83E+06	7.06E+05	1.02E+08	6.5E+04	9.0E+04	7.4E+05	2.6E+05	4.8E+05	4.5E+05	0.0E+00	3.5E+04
By Vehicle Category	liters				3.46E+04		3.54E+06	1.02E+08								2.1E+06
TOTAL FUEL USED	GJ		1.86E+01	6.16E+01	6.22E+01	9.20E+04	2.30E+04	3.33E+06	2.5E+03	3.4E+03	2.8E+04	9.6E+03	1.8E+04	1.7E+04	0.0E+00	1.3E+03
By Vehicle Category	GJ				1.30E+03		1.15E+05	3.33E+06								8.0E+04

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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)			
<b>Fuel Consumption Results, 2008</b>																	
TOTAL FUEL USED	gal			22	2.13E+05	2.86E+05	5.19E+04	7.48E+03	8.39E+02	1.44E+04	2.31E+02	1.89E+03	3.22E+03	1.3E+05	1.2E+04	5.33E+03	1.02E+03
By Vehicle Category	gal	All Veh.	2.64E+07	22			5.51E+05					2.81E+04		1.4E+05			
TOTAL FUEL USED	liters				8.09E+05	1.09E+06	1.97E+05	2.84E+04	3.19E+03	5.48E+04	8.77E+02	7.17E+03	1.22E+04	4.9E+05	4.6E+04	2.02E+04	3.88E+03
By Vehicle Category	liters	All Veh.	1.00E+08				2.09E+06					1.07E+05		5.3E+05			
TOTAL FUEL USED	GJ				3.04E+04	4.08E+04	7.41E+03	1.07E+03	1.20E+02	2.06E+03	2.85E+01	2.70E+02	4.59E+02	1.6E+04	1.5E+03	7.61E+02	1.46E+02
By Vehicle Category	GJ	All Veh.	3.29E+06				7.87E+04					4.00E+03		1.7E+04			
<b>Fuel Consumption Results, 2009</b>																	
TOTAL FUEL USED	gal			22	2.13E+05	2.86E+05	5.19E+04	7.48E+03	8.39E+02	1.44E+04	2.31E+02	1.89E+03	3.22E+03	1.3E+05	1.2E+04	5.33E+03	1.02E+03
By Vehicle Category	gal	All Veh.	2.48E+07	22			5.51E+05					2.81E+04		1.4E+05			
TOTAL FUEL USED	liters				8.09E+05	1.09E+06	1.97E+05	2.84E+04	3.19E+03	5.48E+04	8.77E+02	7.17E+03	1.22E+04	4.9E+05	4.6E+04	2.02E+04	3.88E+03
By Vehicle Category	liters	All Veh.	9.42E+07				2.09E+06					1.07E+05		5.3E+05			
TOTAL FUEL USED	GJ				3.04E+04	4.08E+04	7.41E+03	1.07E+03	1.20E+02	2.06E+03	2.85E+01	2.70E+02	4.59E+02	1.6E+04	1.5E+03	7.61E+02	1.46E+02
By Vehicle Category	GJ	All Veh.	3.08E+06				7.87E+04					4.00E+03		1.7E+04			
<b>Fuel Consumption Results, 2010</b>																	
TOTAL FUEL USED	gal			22	2.17E+05	2.92E+05	5.29E+04	7.63E+03	8.56E+02	1.47E+04	2.35E+02	1.93E+03	3.28E+03	1.3E+05	1.2E+04	5.43E+03	1.04E+03
By Vehicle Category	gal	All Veh.	2.64E+07	22			5.62E+05					2.86E+04		1.4E+05			
TOTAL FUEL USED	liters				8.26E+05	1.11E+06	2.01E+05	2.90E+04	3.25E+03	5.59E+04	8.95E+02	7.32E+03	1.25E+04	5.0E+05	4.7E+04	2.06E+04	3.96E+03
By Vehicle Category	liters	All Veh.	1.00E+08				2.14E+06					1.09E+05		5.4E+05			
TOTAL FUEL USED	GJ				3.10E+04	4.17E+04	7.56E+03	1.09E+03	1.22E+02	2.10E+03	2.91E+01	2.75E+02	4.69E+02	1.6E+04	1.5E+03	7.76E+02	1.49E+02
By Vehicle Category	GJ	All Veh.	3.29E+06				8.02E+04					4.08E+03		1.8E+04			

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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.				
<b>Fuel Consumption Results, 2008</b>																	
TOTAL FUEL USED	gal		22	1.02E+02	3.38E+02	3.41E+02	6.73E+05	1.68E+05	2.43E+07	1.6E+04	2.1E+04	1.8E+05	6.1E+04	1.1E+05	1.1E+05	0.0E+00	8.3E+03
By Vehicle Category	gal	All Veh.	2.64E+07			7.13E+03		8.41E+05	2.43E+07								5.0E+05
TOTAL FUEL USED	liters			3.87E+02	1.28E+03	1.30E+03	2.56E+06	6.38E+05	9.25E+07	5.9E+04	8.2E+04	6.7E+05	2.3E+05	4.4E+05	4.1E+05	0.0E+00	3.2E+04
By Vehicle Category	liters	All Veh.	1.00E+08			2.71E+04		3.20E+06	9.25E+07								1.9E+06
TOTAL FUEL USED	GJ			1.45E+01	4.82E+01	4.87E+01	8.32E+04	2.08E+04	3.01E+06	2.2E+03	3.1E+03	2.5E+04	8.7E+03	1.6E+04	1.5E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	3.29E+06			1.02E+03		1.04E+05	3.01E+06								7.2E+04
<b>Fuel Consumption Results, 2009</b>																	
TOTAL FUEL USED	gal		22	1.02E+02	3.38E+02	3.41E+02	6.30E+05	1.57E+05	2.28E+07	1.5E+04	2.0E+04	1.6E+05	5.7E+04	1.1E+05	1.0E+05	0.0E+00	7.8E+03
By Vehicle Category	gal	All Veh.	2.48E+07			7.13E+03		7.88E+05	2.28E+07								4.7E+05
TOTAL FUEL USED	liters			3.87E+02	1.28E+03	1.30E+03	2.40E+06	5.98E+05	8.67E+07	5.5E+04	7.6E+04	6.3E+05	2.2E+05	4.1E+05	3.8E+05	0.0E+00	3.0E+04
By Vehicle Category	liters	All Veh.	9.42E+07			2.71E+04		2.99E+06	8.67E+07								1.8E+06
TOTAL FUEL USED	GJ			1.45E+01	4.82E+01	4.87E+01	7.79E+04	1.94E+04	2.82E+06	2.1E+03	2.9E+03	2.4E+04	8.1E+03	1.5E+04	1.4E+04	0.0E+00	1.1E+03
By Vehicle Category	GJ	All Veh.	3.08E+06			1.02E+03		9.74E+04	2.82E+06								6.8E+04
<b>Fuel Consumption Results, 2010</b>																	
TOTAL FUEL USED	gal		22	1.04E+02	3.45E+02	3.48E+02	6.73E+05	1.68E+05	2.43E+07	1.6E+04	2.1E+04	1.8E+05	6.1E+04	1.1E+05	1.1E+05	0.0E+00	8.3E+03
By Vehicle Category	gal	All Veh.	2.64E+07			7.27E+03		8.41E+05	2.43E+07								5.0E+05
TOTAL FUEL USED	liters			3.95E+02	1.31E+03	1.32E+03	2.56E+06	6.38E+05	9.25E+07	5.9E+04	8.2E+04	6.7E+05	2.3E+05	4.4E+05	4.1E+05	0.0E+00	3.2E+04
By Vehicle Category	liters	All Veh.	1.00E+08			2.76E+04		3.20E+06	9.25E+07								1.9E+06
TOTAL FUEL USED	GJ			1.48E+01	4.92E+01	4.97E+01	8.32E+04	2.08E+04	3.01E+06	2.2E+03	3.1E+03	2.5E+04	8.7E+03	1.6E+04	1.5E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	3.29E+06			1.04E+03		1.04E+05	3.01E+06								7.2E+04

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MOTORIZED EQUIPMENT, BY TYPE, PER UNIT														
TANKS			AMPHIBIOUS VEH. AND TANK RTVR							ARMORED FTG. VEHICLES		GUNS, MISSILES		
Medium	Med: T62/ T-54/55	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)		

**Fuel Consumption Results, 2014**

TOTAL FUEL USED	gal		22, 29	2.11E+05	2.83E+05	5.13E+04	7.39E+03	8.29E+02	1.42E+04	2.28E+02	1.87E+03	3.18E+03	9.5E+04	9.0E+03	5.27E+03	1.01E+03
By Vehicle Category	gal	All Veh.	2.91E+07	22, 29	5.45E+05							2.77E+04		1.0E+05		
TOTAL FUEL USED	liters			8.00E+05	1.07E+06	1.95E+05	2.81E+04	3.15E+03	5.41E+04	8.67E+02	7.09E+03	1.21E+04	3.6E+05	3.4E+04	2.00E+04	3.83E+03
By Vehicle Category	liters	All Veh.	1.11E+08		2.07E+06							1.05E+05		3.9E+05		
TOTAL FUEL USED	GJ			3.01E+04	4.04E+04	7.33E+03	1.06E+03	1.18E+02	2.04E+03	2.82E+01	2.67E+02	4.54E+02	1.2E+04	1.1E+03	7.52E+02	1.44E+02
By Vehicle Category	GJ	All Veh.	3.62E+06		7.78E+04							3.96E+03		1.3E+04		

**Fuel Consumption Results, 2015**

TOTAL FUEL USED	gal		22, 29	2.25E+05	3.02E+05	5.48E+04	7.89E+03	8.85E+02	1.52E+04	2.44E+02	1.99E+03	3.40E+03	1.0E+05	9.6E+03	5.62E+03	1.08E+03
By Vehicle Category	gal	All Veh.	3.20E+07	22, 29	5.81E+05							2.96E+04		1.1E+05		
TOTAL FUEL USED	liters			8.54E+05	1.15E+06	2.08E+05	3.00E+04	3.36E+03	5.78E+04	9.26E+02	7.57E+03	1.29E+04	3.9E+05	3.6E+04	2.14E+04	4.09E+03
By Vehicle Category	liters	All Veh.	1.22E+08		2.21E+06							1.13E+05		4.2E+05		
TOTAL FUEL USED	GJ			3.21E+04	4.31E+04	7.82E+03	1.13E+03	1.26E+02	2.17E+03	3.01E+01	2.85E+02	4.85E+02	1.3E+04	1.2E+03	8.03E+02	1.54E+02
By Vehicle Category	GJ	All Veh.	3.98E+06		8.30E+04							4.23E+03		1.4E+04		

**Fuel Consumption Results, 2016**

TOTAL FUEL USED	gal		22, 29	2.44E+05	3.27E+05	5.93E+04	8.55E+03	9.60E+02	1.65E+04	2.64E+02	2.16E+03	3.68E+03	1.1E+05	1.0E+04	6.09E+03	1.17E+03
By Vehicle Category	gal	All Veh.	3.31E+07	22, 29	6.30E+05							3.21E+04		1.2E+05		
TOTAL FUEL USED	liters			9.26E+05	1.24E+06	2.26E+05	3.25E+04	3.65E+03	6.26E+04	1.00E+03	8.20E+03	1.40E+04	4.2E+05	4.0E+04	2.32E+04	4.44E+03
By Vehicle Category	liters	All Veh.	1.26E+08		2.39E+06							1.22E+05		4.6E+05		
TOTAL FUEL USED	GJ			3.48E+04	4.67E+04	8.48E+03	1.22E+03	1.37E+02	2.35E+03	3.26E+01	3.08E+02	5.26E+02	1.4E+04	1.3E+03	8.70E+02	1.67E+02
By Vehicle Category	GJ	All Veh.	4.11E+06		9.00E+04							4.58E+03		1.5E+04		

**Fuel Consumption Results, 2017**

TOTAL FUEL USED	gal		22, 29	1.88E+05	2.52E+05	4.58E+04	6.60E+03	7.40E+02	1.27E+04	2.04E+02	1.67E+03	2.84E+03	8.6E+04	8.1E+03	4.70E+03	9.01E+02
By Vehicle Category	gal	All Veh.	3.32E+07	22, 29	4.86E+05							2.48E+04		9.4E+04		
TOTAL FUEL USED	liters			7.14E+05	9.59E+05	1.74E+05	2.51E+04	2.81E+03	4.83E+04	7.74E+02	6.33E+03	1.08E+04	3.3E+05	3.1E+04	1.79E+04	3.42E+03
By Vehicle Category	liters	All Veh.	1.26E+08		1.85E+06							9.41E+04		3.6E+05		
TOTAL FUEL USED	GJ			2.68E+04	3.60E+04	6.54E+03	9.42E+02	1.06E+02	1.82E+03	2.52E+01	2.38E+02	4.06E+02	1.1E+04	1.0E+03	6.71E+02	1.29E+02
By Vehicle Category	GJ	All Veh.	4.12E+06		6.94E+04							3.53E+03		1.2E+04		

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		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 Consumption Results, 2014**

TOTAL FUEL USED	gal		22, 29	1.01E+02	3.34E+02	3.37E+02	7.48E+05	1.87E+05	2.71E+07	1.4E+04	1.9E+04	1.8E+05	5.5E+04	1.0E+05	9.7E+04	0.0E+00	7.5E+03
By Vehicle Category	gal	All Veh.	2.91E+07	22, 29		7.05E+03		9.35E+05	2.71E+07								4.5E+05
TOTAL FUEL USED	liters			3.83E+02	1.27E+03	1.28E+03	2.84E+06	7.10E+05	1.03E+08	5.3E+04	7.3E+04	6.0E+05	2.1E+05	3.9E+05	3.7E+05	0.0E+00	2.8E+04
By Vehicle Category	liters	All Veh.	1.11E+08			2.68E+04		3.55E+06	1.03E+08								1.7E+08
TOTAL FUEL USED	GJ			1.44E+01	4.77E+01	4.81E+01	9.25E+04	2.31E+04	3.35E+06	2.0E+03	2.8E+03	2.3E+04	7.8E+03	1.5E+04	1.4E+04	0.0E+00	1.1E+03
By Vehicle Category	GJ	All Veh.	3.62E+06			1.01E+03		1.18E+05	3.35E+06								6.5E+04

**Fuel Consumption Results, 2015**

TOTAL FUEL USED	gal		22, 29	1.07E+02	3.57E+02	3.60E+02	8.22E+05	2.05E+05	2.97E+07	1.5E+04	2.1E+04	1.7E+05	6.0E+04	1.1E+05	1.1E+05	0.0E+00	8.2E+03
By Vehicle Category	gal	All Veh.	3.20E+07	22, 29		7.52E+03		1.03E+06	2.97E+07								5.0E+05
TOTAL FUEL USED	liters			4.08E+02	1.35E+03	1.37E+03	3.12E+06	7.79E+05	1.13E+08	5.9E+04	8.1E+04	6.8E+05	2.3E+05	4.3E+05	4.1E+05	0.0E+00	3.1E+04
By Vehicle Category	liters	All Veh.	1.22E+08			2.86E+04		3.90E+06	1.13E+08								1.9E+08
TOTAL FUEL USED	GJ			1.53E+01	5.09E+01	5.14E+01	1.02E+05	2.54E+04	3.68E+06	2.2E+03	3.0E+03	2.5E+04	8.6E+03	1.8E+04	1.5E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	3.98E+06			1.07E+03		1.27E+05	3.68E+06								7.2E+04

**Fuel Consumption Results, 2016**

TOTAL FUEL USED	gal		22, 29	1.16E+02	3.88E+02	3.90E+02	8.48E+05	2.12E+05	3.07E+07	1.6E+04	2.2E+04	1.8E+05	6.3E+04	1.2E+05	1.1E+05	0.0E+00	8.5E+03
By Vehicle Category	gal	All Veh.	3.31E+07	22, 29		8.15E+03		1.08E+06	3.07E+07								5.2E+05
TOTAL FUEL USED	liters			4.43E+02	1.47E+03	1.48E+03	3.22E+06	8.04E+05	1.17E+08	6.1E+04	8.4E+04	6.9E+05	2.4E+05	4.5E+05	4.2E+05	0.0E+00	3.2E+04
By Vehicle Category	liters	All Veh.	1.26E+08			3.10E+04		4.03E+06	1.17E+08								2.0E+08
TOTAL FUEL USED	GJ			1.68E+01	5.52E+01	5.57E+01	1.05E+05	2.62E+04	3.79E+06	2.3E+03	3.2E+03	2.8E+04	8.9E+03	1.7E+04	1.6E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	4.11E+06			1.18E+03		1.31E+05	3.79E+06								7.4E+04

**Fuel Consumption Results, 2017**

TOTAL FUEL USED	gal		22, 29	8.99E+01	2.98E+02	3.01E+02	8.56E+05	2.14E+05	3.10E+07	1.6E+04	2.2E+04	1.8E+05	6.3E+04	1.2E+05	1.1E+05	0.0E+00	8.7E+03
By Vehicle Category	gal	All Veh.	3.32E+07	22, 29		8.29E+03		1.07E+06	3.10E+07								5.3E+05
TOTAL FUEL USED	liters			3.41E+02	1.13E+03	1.14E+03	3.25E+06	8.11E+05	1.18E+08	6.2E+04	8.5E+04	7.0E+05	2.4E+05	4.8E+05	4.3E+05	0.0E+00	3.3E+04
By Vehicle Category	liters	All Veh.	1.26E+08			2.39E+04		4.08E+06	1.18E+08								2.0E+08
TOTAL FUEL USED	GJ			1.28E+01	4.26E+01	4.30E+01	1.08E+05	2.64E+04	3.83E+06	2.3E+03	3.2E+03	2.8E+04	9.1E+03	1.7E+04	1.6E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	4.12E+06			8.98E+02		1.32E+05	3.83E+06								7.5E+04



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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 Consumption Results, 2018**

TOTAL FUEL USED	gal		22, 29	1.88E+05	2.52E+05	4.58E+04	6.60E+03	7.40E+02	1.27E+04	2.04E+02	1.67E+03	2.84E+03	8.58E+04	8.1E+03	4,701.55	900.58
By Vehicle Category	gal	All Veh.	3.32E+07	22, 29	4.86E+05							2.48E+04	9.4E+04			
TOTAL FUEL USED	liters			7.14E+05	9.59E+05	1.74E+05	2.51E+04	2.81E+03	4.83E+04	7.74E+02	6.33E+03	1.08E+04	3.26E+05	3.1E+04	1.79E+04	3.42E+03
By Vehicle Category	liters	All Veh.	1.26E+08		1.85E+06							9.41E+04	3.6E+05			
TOTAL FUEL USED	GJ			2.68E+04	3.60E+04	6.54E+03	9.42E+02	1.06E+02	1.82E+03	2.52E+01	2.38E+02	4.06E+02	1.06E+04	1.0E+03	6.71E+02	1.29E+02
By Vehicle Category	GJ	All Veh.	4.12E+06		6.94E+04							3.53E+03	1.2E+04			

**Fuel Consumption Results, 2019**

TOTAL FUEL USED	gal		22, 29	1.88E+05	2.52E+05	4.58E+04	6.60E+03	7.40E+02	1.27E+04	2.04E+02	1.67E+03	2.84E+03	8.58E+04	8.1E+03	4,701.55	900.58
By Vehicle Category	gal	All Veh.	3.32E+07	22, 29	4.86E+05							2.48E+04	9.4E+04			
TOTAL FUEL USED	liters			7.14E+05	9.59E+05	1.74E+05	2.51E+04	2.81E+03	4.83E+04	7.74E+02	6.33E+03	1.08E+04	3.26E+05	3.1E+04	1.79E+04	3.42E+03
By Vehicle Category	liters	All Veh.	1.26E+08		1.85E+06							9.41E+04	3.6E+05			
TOTAL FUEL USED	GJ			2.68E+04	3.60E+04	6.54E+03	9.42E+02	1.06E+02	1.82E+03	2.52E+01	2.38E+02	4.06E+02	1.06E+04	1.0E+03	6.71E+02	1.29E+02
By Vehicle Category	GJ	All Veh.	4.12E+06		6.94E+04							3.53E+03	1.2E+04			

**Fuel Consumption Results, 2020**

TOTAL FUEL USED	gal		22, 29	1.04E+05	1.40E+05	2.54E+04	3.67E+03	4.11E+02	7.07E+03	1.13E+02	9.26E+02	1.58E+03	4.77E+04	4.5E+03	2,611.55	500E+02
By Vehicle Category	gal	All Veh.	1.98E+07	22, 29	2.70E+05							1.38E+04	5.2E+04			
TOTAL FUEL USED	liters			3.97E+05	5.33E+05	9.67E+04	1.39E+04	1.56E+03	2.69E+04	4.30E+02	3.52E+03	5.99E+03	1.81E+05	1.7E+04	9.93E+03	1.90E+03
By Vehicle Category	liters	All Veh.	7.51E+07		1.03E+06							5.23E+04	2.0E+05			
TOTAL FUEL USED	GJ			1.49E+04	2.00E+04	3.63E+03	5.24E+02	5.87E+01	1.01E+03	1.40E+01	1.32E+02	2.25E+02	5.89E+03	5.6E+02	3.73E+02	7.15E+01
By Vehicle Category	GJ	All Veh.	2.46E+06		3.86E+04							1.96E+03	6.4E+03			

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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	Boats	Power	Oth Hvy Equip.	

**Fuel Consumption Results, 2018**

TOTAL FUEL USED	gal		22, 29	8.99E+01	2.98E+02	3.01E+02	8.56E+05	2.14E+05	3.10E+07	1.6E+04	2.2E+04	1.8E+05	6.3E+04	1.2E+05	1.1E+05	0.0E+00	8.7E+03
By Vehicle Category	gal	All Veh.	3.32E+07	22, 29	6.29E+03			1.07E+06	3.10E+07								5.3E+05
TOTAL FUEL USED	liters			3.41E+02	1.13E+03	1.14E+03	3.25E+06	8.11E+05	1.18E+08	6.2E+04	8.5E+04	7.0E+05	2.4E+05	4.6E+05	4.3E+05	0.0E+00	3.3E+04
By Vehicle Category	liters	All Veh.	1.26E+08		2.39E+04			4.06E+06	1.18E+08								2.0E+06
TOTAL FUEL USED	GJ			1.28E+01	4.26E+01	4.30E+01	1.06E+05	2.64E+04	3.83E+06	2.3E+03	3.2E+03	2.6E+04	9.1E+03	1.7E+04	1.6E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	4.12E+06		8.98E+02			1.32E+05	3.83E+06								7.5E+04

**Fuel Consumption Results, 2019**

TOTAL FUEL USED	gal		22, 29	8.99E+01	2.98E+02	3.01E+02	8.56E+05	2.14E+05	3.10E+07	1.6E+04	2.2E+04	1.8E+05	6.3E+04	1.2E+05	1.1E+05	0.0E+00	8.7E+03
By Vehicle Category	gal	All Veh.	3.32E+07	22, 29	6.29E+03			1.07E+06	3.10E+07								5.3E+05
TOTAL FUEL USED	liters			3.41E+02	1.13E+03	1.14E+03	3.25E+06	8.11E+05	1.18E+08	6.2E+04	8.5E+04	7.0E+05	2.4E+05	4.6E+05	4.3E+05	0.0E+00	3.3E+04
By Vehicle Category	liters	All Veh.	1.26E+08		2.39E+04			4.06E+06	1.18E+08								2.0E+06
TOTAL FUEL USED	GJ			1.28E+01	4.26E+01	4.30E+01	1.06E+05	2.64E+04	3.83E+06	2.3E+03	3.2E+03	2.6E+04	9.1E+03	1.7E+04	1.6E+04	0.0E+00	1.2E+03
By Vehicle Category	GJ	All Veh.	4.12E+06		8.98E+02			1.32E+05	3.83E+06								7.5E+04

**Fuel Consumption Results, 2020**

TOTAL FUEL USED	gal		22, 29	4.99E+01	1.66E+02	1.67E+02	5.11E+05	1.27E+05	1.85E+07	9.7E+03	1.3E+04	1.1E+05	3.8E+04	7.2E+04	6.7E+04	0.0E+00	5.2E+03
By Vehicle Category	gal	All Veh.	1.98E+07	22, 29	3.49E+03			6.38E+05	1.85E+07								3.1E+05
TOTAL FUEL USED	liters			1.90E+02	6.29E+02	6.35E+02	1.94E+06	4.84E+05	7.02E+07	3.7E+04	5.1E+04	4.2E+05	1.4E+05	2.7E+05	2.5E+05	0.0E+00	2.0E+04
By Vehicle Category	liters	All Veh.	7.51E+07		1.33E+04			2.43E+06	7.02E+07								1.2E+06
TOTAL FUEL USED	GJ			7.13E+00	2.37E+01	2.39E+01	6.32E+04	1.58E+04	2.28E+06	1.4E+03	1.9E+03	1.6E+04	5.4E+03	1.0E+04	9.6E+03	0.0E+00	7.4E+02
By Vehicle Category	GJ	All Veh.	2.46E+06		4.99E+02			7.89E+04	2.28E+06								4.5E+04

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### **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.*

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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 have been used by equipment considered unusable.

23 Republic of Korea National Intelligence Service, "North Korea Military. The KPA: Troops & Equipment", from <http://www.fas.org/irp/world/rok/nis-docs/defense08.htm>, visited 5/21/02, lists the total ground forces for the DPRK at a total of 996,000 troops in 20 corps units. Assuming that this estimate holds for the year 2000, a "true-up factor" for the equipment estimates above of 1.06408 is implied.

24 It has not been possible to obtain unclassified information that provides any specific information on recent fuel use by the DPRK military. Analysts contacted regarding the "tempo" of recent DPRK military exercises, and reports in the media (for example, "NK Ground Exercises Up as Navy and Air Force Decline", Yoo Yong-won, [www.chosun.com](http://www.chosun.com), 2001- 9-10) suggest that the DPRK military exercise tempo for ground forces has increased somewhat in recent years, but not substantially, and that some of the apparent increase in exercises may be an increase in the number of soldiers involved, but not necessarily the number of fuel-using vehicles and armaments. Accordingly, we assume that the average hours of annual use by ground vehicles in 2000 was slightly lower than in 1996 by 2000, and somewhat lower still, in part due to fuel supply restrictions, in 2005.

25 Observers of DPRK and other countries' military activity suggest that the active (mobile) hours for tanks, mobile armaments, armoured vehicles, amphibious vehicles, and similar equipment are typically, under routine (non-wartime) use, likely to be quite limited. Trucks and other utility vehicles that are used both for training/exercise use and also (especially in the DPRK) for other goods and human transport uses, are assumed likely to be used significantly more than tanks and other armaments. See also Note 27.

26 There are a range of different estimates for the number of ground troops in the DPRK military in the years since 2000, though the range of estimates is not great. The document [The Asian Military Balance: An Analytic Overview—A Comparative Summary of Military Expenditures; Manpower; Land, Air, and Naval Forces; and Arms Sales](http://www.csis.org/media/isis/pubs/asia_ro_asian_mb_comp%5B1%5D.pdf), by Anthony H. Cordesman and G. Ryan Faith of the Center for Strategic and International Studies, Washington, D.C., (available as [http://www.csis.org/media/isis/pubs/asia\\_ro\\_asian\\_mb\\_comp%5B1%5D.pdf](http://www.csis.org/media/isis/pubs/asia_ro_asian_mb_comp%5B1%5D.pdf)), published May, 2003, lists the manpower of DPRK ground forces in 2003 at 950,000 troops. Assuming that this estimate holds for 2005, a "true-up factor" for the equipment estimates above of 1.014938 is implied.

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- 27 The publication *Seoul Wolgan Choson* published an article by Kim Yon-kwang and Yi Sang-hun, dated 1 October, 2003 (pages 168-181), entitled "Kim Chong-il's Military is Hoarding All Rice Aid as Military Provision", and is based on an interview with a DPRK soldier named Chin Yon-kyu, who had defected to the ROK, but who was (or claimed to be) a driver for a high-ranking officer. This article includes a quote from Chin that suggests typical training for heavy equipment was minimal: "Due to the fuel shortage, the North Korean Army's training exercises for heavily armed vehicles such as tanks is said to involve 'an annual travel distance of 30 kilometers'". This quote would appear to pertain to the time period around 2000, and the interviewee claims to have been based near Wonsan, in the "rear area". If this information can be taken at face value, it would imply that a true estimate for training use for tanks (and other heavy armaments) might be just a few tens of km, as opposed to the 200 - 700 km/yr we estimate. Although it seems likely that training with heavy armaments is limited, and has been decreasing over the years, we will, until additional information becomes available, stay with our higher estimates of average usage. In so doing, we discount somewhat Chin Yon-kyu's account, in part because A) Chin appears to have been stationed well North of the DMZ, where training (and concentration of operable equipment, as well as fuel supplies) would be expected to be far less than in areas closer to the DMZ, and B) because it is only one, anecdotal account. Additional information on this topic would, however, be very welcome.
- In the same interview, the interviewee reported that starting in "...1992, the North Korean Army has begun to gradually use fuel oil (including benzene, gasoline, and diesel) stored for combat emergencies. Fuel oil tanks for use in combat are all empty."
- 28 Several recent estimates based on the 2008 DPRK Census, including "[North Korea Census 2008] Korean People's Army estimated to number 700 thousand troops" (*The Hankyoreh*, dated 3/19/2010, and available as [http://english.hani.co.kr/arti/english\\_edition/e\\_northkorea/411106.html](http://english.hani.co.kr/arti/english_edition/e_northkorea/411106.html)) have estimated that the current number of people in the DPRK military is approximately 700,000 As this reduction of troops from previous estimates may not necessarily mean a proportionate reduction in movements by energy-using vehicles, we adopt a true-up factor for 2008 and 2009 that assumes a reduction in energy use equal to about half of the proportional reduction in troop levels from previous years, or 0.874



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29 Anthony H. Cordesman and Nick Harrington (2018), The Korean Civil-Military Balance (3rd Major Revision: May 24, 2018),

Center for Strategic and International Studies, available as [https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180524\\_](https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180524_)

Revised\_Korea\_Civil\_Military\_Balance.pdf?SmnEiJ6\_TyH.ZuekRzXzBLYJBr1157K. provides and quotes several estimates of the number of personnel in DPRK Ground Forces, ranging from 950,000 (US DOD, 2017) to 1,100,000 (ROK, Cordesman), with Japan's 2017 estimate of 1,020,000 in the middle.

This would be a substantial increase from the 2008 estimate above, which may be in error, or the more recent estimates may be overstated, or the increase may be the result of renewed emphasis on the military under Kim Jong II. We assume that the ground troupe strength as of 2017 is indeed 1,020,000, and estimate increases in troop strength starting from 2010 through 2017, and assume, consistent with the above, that changes in energy use are about half of the changes in troop levels.

For other armaments, 2012 and 2017 estimates from the US DOD as provided by Cordesman are used, interpreted as described below.

See also, Office of the US Secretary of Defense, Military and Security Developments Involving the Democratic People's Republic of Korea, Report to Congress, dated 2/13/2018, and available as <https://media.defense.gov/2018/May/22/2001920587/-1/-1/1/REPORT-TO-CONGRESS-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-DEMOCRATIC-PEOPLES-REPUBLIC-OF-KOREA-2017.PDF>.

Lacking additional information, we assume that the tendency in recent years to grow the armed forces was balanced in 2018 by reductions in access to funds and fuels caused by UNSC sanctions, and thus the number of personnel and vehicles in 2018 were approximately the same as in 2017.

Category	Estimated number of personnel and heavy vehicles/armaments							True-up relative to estimates through 2010					
	2010	2012	2014	2015	2016	2017	2018	2012	2014	2015	2016	2017	2018
Personnel	700,000		882,857	928,571	974,286	1,020,000	1,020,000		0.972	0.996	1.020	1.045	1.045
Tanks		4100	4140	4160	4180	4200	4200	0.801	0.8084	0.812	0.816	0.820	0.820
Armored Vehicles		2100	2140	2160	2180	2200	2200	0.596	0.607	0.613	0.618	0.624	0.624
All Other Heavy Vehicles								0.801	0.808	0.812	0.816	0.820	0.820

Although the USDOD (as cited in Cordesman) provides overall numbers for field artillery and multiple rocket launchers for 2012 and 2017 (13,600 and 14,100 total in 2012 and 2017), these figures include (are mostly) towed gun and missile launchers, and are thus not comparable with the numbers of vehicles we track above, which are all self-propelled vehicles.

As such, we assume that self-propelled guns and missile launchers, as well as amphibious vehicles and tank retrieving equipment, follow the same estimated trends as tanks, and use the same true-up factors as derived above. For 2.5 tonne trucks and light vehicles, we use the true-up factors for overall personnel to drive changes in energy use.

## Detailed Inputs and Results: Military Aircraft

### ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK

#### MILITARY AIRCRAFT

UPDATE 2020

Detailed Data and Results	
Prepared By:	David Von Hippel
Date Last Modified:	5/20/2020

COMMON ASSUMPTIONS & PARAMETERS--AIRCRAFT USE						
(See Notes 22, 23, 25, 26, and 27)						
Mission Hours Per Year:	1990	1996	2000	2005	2008	2009
Fighters/Bombers (Note 13)	24	16	11	18.5	21	15
Transport Aircraft	50	42	32	38	39	38
Helicopters	32	24	18	24	30	35
Ave. airspeed--Fract. of Maximum	80%	80%	80%	80%	80%	80%
Use of Service Vehicles Per Person Relative to 1990	100%	80%	65%	70%	75%	75%
Kerosene/Jet Fuel Energy Cont. (GJ/ltr)	0.035	Note 15				
Aviation Gasoline Energy Cont. (GJ/ltr)	0.0321	Note 15				

<b>COMMON ASSUMPTIONS &amp; PARAMETERS--AIRCRAFT USE</b>								
<b>Mission Hours Per Year:</b>	<b>2010</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
<b>Fighters/Bombers (Note 13)</b>	18.5	15.5	20	23	16	15	17	11
<b>Transport Aircraft</b>	40	39	44	42	42	40	44	32
<b>Helicopters</b>	45	47	55	55	45	43	47	35
<b>Ave. airspeed--Fract. of Maximum</b>	80%	80%	80%	80%	80%	80%	80%	80%
<b>Use of Service Vehicles Per Person Relative to 1990</b>	77%	80%	80%	80%	85%	83%	85%	63%

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											1990						
Type of Aircraft	Class	Notes:	Number in Air Force Estimates from Sources					Number in Air Force Assumed	Range km	Fuel Capacity liters	Max. Speed km/hr	Cruise Speed km/hr	Ave. Fuel Consumpt l/hr	Total Fuel Consumpt liters	Total Fuel Consumpt GJ		
			1	2	3	4	17									18	
<b>Fixed Wing</b>											19	14	14	14	14		
F-5 (MIG-17) Fresco	Fighter		130			140		120	130	1270	2365	1145		1706	5.32E+06	1.86E+05	
F-6 (MIG-19) Farmer	Fighter/Bomber		160	160		110	>100	160	160	1390	2170	1590		1986	7.63E+06	2.67E+05	
MIG-21 Fishbed D/F/J	Fighter		160	120		130	120	160	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	45	46	1800	5750	2440		6236	6.88E+06	2.41E+05	
MIG-29 Fulcrum A/B	Fighter		10	"2 reg"	13			15	13	2100	4365	2440		4057	1.27E+06	4.43E+04	
MIG-15 Fagot	Fighter	5				180		190	144	1368	2365	1017		1407	4.86E+06	1.70E+05	
SU-7B Fitter A	Fighter		20	20		20	20	20	20	1450	5275	1696	850	4936	2.37E+06	8.29E+04	
SU-25 Frogfoot A	Fighter	9	35	>20	36		36	35	35	1250	4568	848		2479	2.08E+06	7.29E+04	
IL-28 Beagle	Bomber		80	82		85	82	80	82	2180	1740	900		575	1.13E+06	3.96E+04	
Y-5 (AN-2 Colt)	Transport	20	270	>250		205	270	>300	270	900	1200	220		235	3.17E+06	1.02E+05	
AN-24 (Coke)	Transport		6	10				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	
<b>helicopters</b>																	
MI-2 Hoplite		7	"Most"						188	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	87	480	240	250	240	120	3.34E+05	1.07E+04	
All			275	275					275						2.50E+06	8.03E+04	
											<b>Kerosene/Jet Fuel</b>		5.14E+07	1.80E+06			
											<b>Aviation Gasoline</b>		1.11E+07	3.56E+05			
<b>ALL AIRCRAFT</b>											1413	<b>TOTAL ALL FUELS</b>		6.25E+07	2.15E+06		
Air Force Personnel		80,000	3, 21														
Service Vehicles		6,235	16												1.52E+07	4.94E+05	
<b>TOTAL: AIRCRAFT PLUS GROUND SUPPORT VEHICLES</b>											<b>TOTAL ALL FUELS</b>		7.76E+07	2.65E+06			

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		1996	2000	2005	2008	2009	2010	2014	2015	2016	2017	2018	2019	2020
Type of Aircraft	Class	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ	Total Fuel Consumpt GJ
		<i>Notes:</i>												
<b>Fixed Wing</b>														
F-5 (MIG-17) Fresco	Fighter	1.24E+05	8.54E+04	1.44E+05	1.63E+05	1.16E+05	1.44E+05	1.10E+05	1.45E+05	1.71E+05	1.21E+05	1.14E+05	1.29E+05	8.33E+04
F-6 (MIG-19) Farmer	Fighter/Bomber	1.78E+05	1.22E+05	2.06E+05	2.33E+05	1.67E+05	2.06E+05	1.58E+05	2.08E+05	2.45E+05	1.74E+05	1.63E+05	1.84E+05	1.19E+05
MIG-21 Fishbed D/F/J	Fighter	3.85E+05	2.65E+05	4.45E+05	5.05E+05	3.61E+05	4.45E+05	3.43E+05	4.51E+05	5.30E+05	3.76E+05	3.52E+05	3.99E+05	2.58E+05
F-7 (Fishbed C)	Fighter	7.77E+04	5.34E+04	8.99E+04	1.02E+05	7.29E+04	8.99E+04	6.91E+04	9.11E+04	1.07E+05	7.58E+04	7.11E+04	8.06E+04	5.21E+04
MIG-23 Flogger B/C/E/G/K	Fighter	1.61E+05	1.10E+05	1.86E+05	2.11E+05	1.51E+05	1.86E+05	1.43E+05	1.88E+05	2.21E+05	1.57E+05	1.47E+05	1.67E+05	1.08E+05
MIG-29 Fulcrum A/B	Fighter	2.95E+04	2.03E+04	3.41E+04	3.88E+04	2.77E+04	3.41E+04	2.63E+04	3.46E+04	4.06E+04	2.88E+04	2.70E+04	3.06E+04	1.98E+04
MIG-15 Fagot	Fighter	1.13E+05	7.80E+04	1.31E+05	1.49E+05	1.06E+05	1.31E+05	1.01E+05	1.33E+05	1.56E+05	1.11E+05	1.04E+05	1.18E+05	7.61E+04
SU-7B Fitter A	Fighter	5.53E+04	3.80E+04	6.39E+04	7.25E+04	5.18E+04	6.39E+04	4.92E+04	6.48E+04	7.60E+04	5.39E+04	5.06E+04	5.73E+04	3.71E+04
SU-25 Frogfoot A	Fighter	4.86E+04	3.34E+04	5.62E+04	6.38E+04	4.55E+04	5.62E+04	4.32E+04	5.69E+04	6.68E+04	4.74E+04	4.44E+04	5.04E+04	3.26E+04
IL-28 Beagle	Bomber	2.64E+04	1.81E+04	3.05E+04	3.46E+04	2.47E+04	3.05E+04	2.35E+04	3.09E+04	3.63E+04	2.57E+04	2.41E+04	2.74E+04	1.77E+04
Y-5 (AN-2 Colt)	Transport	8.54E+04	6.51E+04	7.73E+04	7.93E+04	7.73E+04	8.13E+04	7.88E+04	9.12E+04	8.93E+04	9.15E+04	8.71E+04	9.59E+04	6.97E+04
AN-24 (Coke)	Transport	2.90E+04	2.21E+04	2.62E+04	2.69E+04	2.62E+04	2.76E+04	2.67E+04	3.09E+04	3.03E+04	3.10E+04	2.96E+04	3.25E+04	2.36E+04
IL-18 Coot	Transport	7.78E+03	5.92E+03	7.04E+03	7.22E+03	7.04E+03	7.41E+03	7.17E+03	8.30E+03	8.13E+03	8.33E+03	7.93E+03	8.73E+03	6.35E+03
IL-12 Coach (Civil)	Transport	3.65E+04	2.78E+04	3.30E+04	3.39E+04	3.30E+04	3.48E+04	3.37E+04	3.90E+04	3.82E+04	3.91E+04	3.72E+04	4.10E+04	2.98E+04
LI-2 Cab (Civil)	Transport	3.65E+04	2.78E+04	3.30E+04	3.39E+04	3.30E+04	3.48E+04	3.37E+04	3.90E+04	3.82E+04	3.91E+04	3.72E+04	4.10E+04	2.98E+04
IL-14 Crate (Civil)	Transport	3.65E+04	2.78E+04	3.30E+04	3.39E+04	3.30E+04	3.48E+04	3.37E+04	3.90E+04	3.82E+04	3.91E+04	3.72E+04	4.10E+04	2.98E+04
Fighters (All)		1.17E+06	8.06E+05	1.36E+06	1.54E+06	1.10E+06	1.36E+06	1.04E+06	1.37E+06	1.61E+06	1.14E+06	1.07E+06	1.22E+06	7.86E+05
Bombers (All)		2.64E+04	1.81E+04	3.05E+04	3.46E+04	2.47E+04	3.05E+04	2.35E+04	3.09E+04	3.63E+04	2.57E+04	2.41E+04	2.74E+04	1.77E+04
Transport (All)		2.32E+05	1.76E+05	2.10E+05	2.15E+05	2.10E+05	2.21E+05	2.14E+05	2.47E+05	2.42E+05	2.48E+05	2.36E+05	2.60E+05	1.89E+05
<b>helicopters</b>														
MI-2 Hoplite		1.73E+04	1.30E+04	1.73E+04	2.16E+04	2.52E+04	3.24E+04	3.69E+04	4.32E+04	4.32E+04	3.54E+04	3.38E+04	3.69E+04	2.75E+04
MI-4 Hound		1.44E+04	1.08E+04	1.44E+04	1.80E+04	2.10E+04	2.71E+04	3.08E+04	3.61E+04	3.61E+04	2.95E+04	2.82E+04	3.08E+04	2.30E+04
MI-8 Hip		2.05E+04	1.53E+04	2.05E+04	2.56E+04	2.98E+04	3.84E+04	4.37E+04	5.12E+04	5.12E+04	4.19E+04	4.00E+04	4.37E+04	3.26E+04
MI-17 Hip														
Hughes 500 D/E		8.04E+03	6.03E+03	8.04E+03	1.01E+04	1.17E+04	1.51E+04	1.72E+04	2.01E+04	2.01E+04	1.64E+04	1.57E+04	1.72E+04	1.28E+04
All		6.02E+04	4.52E+04	6.02E+04	7.53E+04	8.78E+04	1.13E+05	1.29E+05	1.51E+05	1.51E+05	1.23E+05	1.18E+05	1.29E+05	9.58E+04
		1.20E+06	8.24E+05	1.39E+06	1.57E+06	1.12E+06	1.39E+06	1.07E+06	1.40E+06	1.65E+06	1.17E+06	1.10E+06	1.24E+06	8.04E+05
		2.92E+05	2.22E+05	2.70E+05	2.90E+05	2.97E+05	3.34E+05	3.42E+05	3.98E+05	3.93E+05	3.71E+05	3.54E+05	3.89E+05	2.85E+05
<b>ALL AIRCRAFT</b>		1.49E+06	1.05E+06	1.66E+06	1.86E+06	1.42E+06	1.72E+06	1.41E+06	1.80E+06	2.04E+06	1.54E+06	1.45E+06	1.63E+06	1.09E+06
Air Force Personnel	80,000	3, 21												
Service Vehicles	6,235	16	3.95E+05	3.21E+05	3.46E+05	3.71E+05	3.71E+05	3.81E+05	4.90E+05	5.08E+05	5.26E+05	5.78E+05	5.64E+05	5.78E+05
<b>TOTAL: AIRCRAFT PLUS GROUND SUPPORT VEHICLE</b>			1.89E+06	1.37E+06	2.00E+06	2.23E+06	1.79E+06	2.10E+06	1.90E+06	2.31E+06	2.57E+06	2.12E+06	2.01E+06	2.21E+06

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### **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 transporters 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 transporters are assumed to use Aviation Gasoline.

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- 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.*
- 17 *North Korea Country Handbook, Marine Corps Intelligence Activity, 1997. (MCIA-2630-NK-016-97). File Nkor.pdf, obtained from Federation of American Scientists WWW site, 5/21/02, and dated May, 1997. Data on aircraft are mostly from pages 36 to 38 of this document.*
- 18 *North Korea. The Foundations for Military Strength -- Update 1995. US Defense Intelligence Agency (1995). Obtained from Federation of American Scientists WWW site, 5/21/02, and dated December, 1995.*
- 19 *As estimates of the numbers of aircraft from newer information sources (17 and 18) are not significantly different from those in earlier documents, we will continue to use the composite estimates of total aircraft shown here for 1996 and 2000 aircraft fuel use estimates.*
- 20 *Republic of Korea National Intelligence Service (1999), North Korea Military. The KPA: Troops & Equipment <http://www.fas.org/irp/world/rok/nis-docs/defense08.htm>, visited 5/21/02. This source lists the DPRK Air Force as having "a whopping 820 support aircraft and transopters", but does not indicate of what types are the approximately 200-plus aircraft beyond those listed in other sources (that is, apart from the AN-2 units and transopters, the totals of which are similar to the listings above).*
- 21 *Republic of Korea National Intelligence Service, "North Korea Military. The KPA: Troops & Equipment", from <http://www.fas.org/irp/world/rok/nis-docs/defense08.htm>, visited 5/21/02, lists the total air force personnel for the DPRK at a total of 103,000, somewhat above the figure used here, but as the personnel totals do not directly affect fuel use estimates for this branch of the service, the figure from source 3 is used.*
- 22 *Unclassified informaiton on fuel use in the DPRK military was not available, but the informal opinion or analysts familiar with the DPRK military situation suggests that air force activity in the DPRK is, if anything, declining slowly, perhaps due to lack of fuel, probably due to lack of spare parts, and probably due to a recognition on the part of the DPRK military command that in a real conflict, the DPRK Air Force is unlikely, given the age and condition of its equipment, to play a substantial role. Accordingly, we have assumed that DPRK Air Force training exercises have continued to decrease slowly since 1996, as reflected in the flight-hours estimates shown.*

- 23 *The article "Korean People's Army Air Force" (<http://www.globalsecurity.org/military/world/dprk/airforce.htm>) on the Global Security website includes the following passage on the topic of training time for DPRK flight crews:*

"Pilot proficiency is difficult to evaluate because it is crudely proportionate to hours and quality of flight time. Although the Republic of Korea Ministry of National Defense's Defense White Paper, 1990 states that flight training levels are 60 percent of South Korea's, other sources believe the figure is closer to 20 to 30 percent. Lower flight times are attributed to fuel shortages, a more conservative training philosophy, and perhaps a concern for older airframe life expectancies or maintenance infrastructure capacity. The training of pilots on the NKAF's most modern aircraft is much more significant than "seven flying hours per year" sometimes claimed in the West. But air crew are being trained in accordance with outdated procedures and, with lack of fuel, have very little experience."

*Although this article does not provide definitive information on aircraft use in training, it would seem to be consistent with the assumptions of limited, and slowly decreasing, training levels made in this analysis.*

*The same article also indicates that "Kazakhstan had transferred lethal military equipment, specifically about 40 MiG-21 fighter aircraft, to North Korea" in the late 1990s. We assume that this transfer has had little impact on overall usable stocks of that aircraft, or on training levels (and thus energy use).*



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24 Quoting from the US Department of Defense (USDOD) *Military and Security Developments Involving the Democratic People's Republic of Korea 2017*, Report to Congress Pursuant to the National Defense Authorization Act for Fiscal Year 2012, dated February 13, 2018, and available as <https://fas.org/irp/world/dprk/dod-2017.pdf>, Anthony H. Cordesman and Nick Harrington list 2012 (from an earlier version of the US DOD document) and 2017 values for DPRK Air Force troop strength and aviation equipment numbers as follows. Data are from the report by Cordesman and Harrington *The Korean Civil-Military Balance (3rd Major Revision: May 24, 2018)*, Center for Strategic and International Studies, available as [https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180524\\_Revised\\_Korea\\_Civil\\_Military\\_Balance.pdf?SmnEiJ6\\_TyH.ZuekRzXzBLYJBr1157K](https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180524_Revised_Korea_Civil_Military_Balance.pdf?SmnEiJ6_TyH.ZuekRzXzBLYJBr1157K). Lacking additional information, we assume as for ground forces that the tendency in recent years to grow the armed forces was balanced in 2018 by reductions in access to funds and fuels caused by UNSC sanctions, and thus the number of personnel and aircraft in 2018 were approximately the same as in 2017.

Category	Estimated number of personnel and aircraft						True-up relative to estimates through 2010					
	2012	2014	2015	2016	2017	2018	2012	2014	2015	2016	2017	2018
Personnel	92000	99200	1E+05	106400	110000	110000	1.150	1.2400	1.285	1.330	1.375	1.375
Combat Aircraft	730	762	778	794	810	810	0.880	0.918	0.937	0.957	0.976	0.976
Helicopters	300	300	300	300	300	300	####	1.091	1.091	1.091	1.091	1.091
Transport Aircraft	290	306	314	322	330	330	####	0.994	1.019	1.045	1.071	1.071

US DOD estimates for DPRK Combat aircraft and transport aircraft are "over 800" and "over 300" respectively for 2017. A South Korean military balance as of 12/2016 (also provided in the Cordesman Report) estimates 810 Combat aircraft and 330 transopters, and we use those figures in the table above.

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- 25 *No direct information is available on the number of flight hours for aircraft, although various authors suggest that the number of training and exercise hours for the DPRK's aging military aircraft continues to be low. We have assumed that the average hours flown for fighters and bombers is slightly higher in 2015 through 2017 due to overall better fuel availability in the DPRK, and possibly better availability of spare parts due to the improved economy. We assume that the use of transport aircraft increased slightly over 2014-2017 as the number of personnel in the air force (apparently) increased. The use of transporters is assumed to be slightly higher than in 2010, but constant from 2014 through 2017 as better fuel availability was balanced by a continuing aging of the fleet. The use of trucks per person in the Air Force is assumed to be somewhat higher in 2014-2017 than in 2010, again due to better overall availability of diesel in the DPRK during those years. The use of aircraft and supporting vehicles is assumed to have been slightly lower in 2018 than in 2017 due to tighter supplies of fuel caused by UNSC sanctions, although in general the military is expected to have had (and continue to have) priority access to petroleum fuels in the DPRK.*
- 26 *A Google Earth Pro image (below) of the new Wonsan-Kalma International Airport, taken on November 13, 2019, shows a number of military aircraft lined up for what might have been an airshow and/or inspection. Aircraft appear to include fighters and bombers, among others. Image coordinates are approximately 39.171, 127.479. Additional military aircraft, including helicopters and transport aircraft, also appear in parts of the airport not shown in this image. The report by Peter Makowsky and Jenny Town (2019), "Military Aircraft Lined Up at the Wonsan Airport", **38 North**, dated November 14, 2019, and available as <https://www.38north.org/2019/11/wonsan111419/>, lists the aircraft present as follows:*

"On imagery from November 11, there were four MiG-17 fighter aircraft, six MiG-15 fighter aircraft, fourteen Su-25 close support aircraft, six MiG-29 fighter aircraft and six Il-28 bomber aircraft observed on the tarmac north of the passenger terminal. On November 13, additional MiG-15 and MiG-17 were added to the display bringing their total to eleven MiG-15s and eight MiG-17s. Several small vehicles were parked on the tarmac near the MiG-29 and Il-28 aircraft. In addition, thirteen probable MiG-21 fighter aircraft were observed on the alert apron at the south end of the airfield, and six small, either Hughes 500 or Mi-2 Hoplite light helicopters, six medium, possibly Mi-8 or Mi-14, medium transport helicopters, and eight An-2 Colt light transport aircraft were parked along the auxiliary runway located on the southwest side of the airfield. Further to the south of the auxiliary runway at the rail transfer point, seven additional MiG-21 were parked on an adjacent apron."

*Thus, based on 38 North's count, there were about 85 aircraft present at Wonsan at that time, a total about 6 percent of the air force inventory shown above. A similar count of the aircraft present at Wonsan in the 11/13/2019 image, carried out for Nautilus by Liam Tasa and Guy Tasa in May of 2020, offers a similar total and allocation, as follows:*

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Aircraft	Possible Origin	Type	Number
MIG-21 or Chengdu J-7	Soviet Union or China	Fighter	20
MIG-29	Soviet Union	Multirole	6
Shenyang F-5 or FT-2	China	Training Plane or Fighter	21
SU-25	Soviet Union	Attack Plane	14
IL-28 or H-5	Soviet Union or China	Medium Bomber	6
AN-2	Soviet Union	Transport	8
MD 500	United States	Light Utility Helicopter	6
PZL MI-2	Polish People's Republic	Utility Helicopter	6
<b>TOTAL OF ABOVE</b>			<b>87</b>

*Near the bottom of the image below, on the main runway near where the helipad access road meets the runway, what appears to be MIG-17 or F-5 (the Chinese version of the MIG-17) parked next to what appears to be a tour bus, with several people nearby. This could be an indication of an inspection by a high government official in process, which is consistent with some of the possible reasons for the assembly of aircraft that have been suggested by Makowsky and Town. By the time that the next available Google Earth image was taken, 12/5/2019, all of the military aircraft had been removed from the tarmac and aprons, and none were visible except for two older fighters, possibly decommissioned, present among some trees off of an access road in the southern part of the airport. We assume that as a result of moving planes to attend this, and perhaps other similar events, and thanks to better fuel availability, the use of aircraft and of ground vehicles servicing them was somewhat higher in 2018 than in 2019.*



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- 27 *For 2020, we assume that the combination of the large reduction in military activity in early 2020 due to the coronavirus, plus lingering military quarantines in some areas and a reduction in annual fuel supplies, means that 2020 overall fuel use for aircraft will be significantly less than in 2018 and 2019.*
- 27 *Another example of a location where military aircraft are stored is a base adjacent to an airport near Sinuiju, in the Northwest of the DPRK a few kilometers from the Yalu River and the Chinese border. Several dozen aircraft appear here in most images taken over the last decade, including bombers, fighters, and transport aircraft. The Google Earth Pro image below was taken on 11/27/2019, at approximate coordinates 40.155, 124.532. The metal-roofed hangers at the left of the image appear to be used for fighter jets. The second image below shows additional aircraft, probably transport planes, at the nearby main airport that is connected to the base by an access road/taxiway. The coordinates of the latter image are approximately 40.144, 124.495.*









**Detailed Inputs and Results: Military Naval Vessels**

**ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK  
MILITARY SHIPS AND BOATS UPDATE 2020**

<b>Detailed Data and Results</b>		<b>COMMON ASSUMPTIONS &amp; PARAMETERS--NAVAL ENERGY USE</b>						
Prepared By: David Von Hippel		<i>(Notes 30, 36)</i>						
Date Last Modified: 5/20/2020		<b>Active Hours Per Year in:</b>						
		<b>1990</b>	<b>1996</b>	<b>2000</b>	<b>2005</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Amphibious		50	50	45	45	40	35	45
Submarines		100	100	90	90	80	80	80
Other Vessels		800	570	565	575	430	400	460
Ave. power use--Fract. of Max.		50%	50%	50%	50%	50%	50%	50%
		<b>Active Hours Per Year in:</b>						
		<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
Amphibious		45	45	45	45	42	42	24
Submarines		80	80	80	70	65	65	38
Other Vessels		410	410	420	300	280	280	150
Ave. power use--Fract. of Max.		50%	50%	50%	50%	50%	50%	50%
Marine Diesel Fuel Cons. (15)		0.38	lb/hp-hr	Liters per gallon <span style="border: 1px solid black; padding: 2px;">3.78</span>				
Sub Diesel Fuel Cons. (16)		0.5	lb/hp-hr					
Diesel Energy Content:		0.04	GJ/liter					
Conversion Factor		2.2	lb/kg					
Diesel Fuel Density		0.87	kg/liter					

True-Up Factors (see Note 14)	
Missile Attack Boats:	1.50
Amphibious:	1.46
Other Sm. Surface Vessels:	1.04

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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)
			1	2	3	4	5	22	23					
Nanjin Class	Frigate	21			4	2		2	2	3	1800	4000	14	15000
T (Tral) Class	Lg Patrol				2					2	475		18	3000
Sariwon Class	Lg Patrol	33			3	4			4	4	450		21	3000
SO 1 Class	Lg Patrol				15	15				16	250	1100	13	7500
Artillerist Class	Lg Patrol	17			2					2	240		25	7500
Hainan Class	Lg Patrol				4	6			6	6	400	1000	10	8800
Taechong Class	Lg Patrol				2	7				7	400			7500
OSA 1 Class	Missile Att.				8	16	12		26	24	200	800	25	12000
Komar Class	Missile Att.				10	8		39?	6	15	80	400	30	4800
Shanghi Class--Gun	Fast Att.				8	12			14	13	155	800	17	4800
Swatow Class--Gun	Fast Att.				8	8				8	80	500	28	3000
Chodo Class--Gun	Fast Att.				4	4				4	130	2000	10	6000
K-48 Class--Gun	Fast Att.				4	4				4	100		24	5000
MO IV Class--Gun	Fast Att.	13			20					21	56		25	3000
Chongjin Class--Gun	Fast Att.	7			30	45	31		51	47	80		40	4800
P 6--Torpedo	Fast Att.	26			62				30	65	75	450	30	4800
P 4--Torpedo	Fast Att.				12	60				13	25		50	4800
Iwon--Torpedo	Fast Att.	10			15	15				16	40			3600
An Ju--Torpedo	Fast Att.				6	6				6	35	1300	20	4800
Chaho Class--Torpedo	Fast Att.		>60		60	66	62		52	69	80		40	4800
Sin Hung/Kosong--Torp.	Fast Att.	8			60	72			98	75	35			2400
Shersen Class--Torpedo	Fast Att.				4	3				4	160		41	12000
KM 4--Torpedo	Fast Att.				10	10				10	10			146
Torpedo Boats	Patrol			150	229		200	320						
Light Patrol	Patrol	19				20				21	2			146
Hantaе	Landing	12, 18		8		8	8		10	12	150		40	5000
Nampo	Landing		>100		70	100	100	130	95	146	82	375		4800
Hanchon	Landing	9, 18, 24, 27, 35			5	25			7	36	150		10	5000
Kong Bang (Hovercraft)	Landing						125	130	135	130			52	8000
Whiskey	Submarine			4		4	15		4	4	1030	13,000	8	4000
Romeo, Chinese	Submarine			4						4	1100	16,000	10	4000
Romeo, NK	Submarine			16		11			26	22	1100	16,000	10	4000
YUGO mini-sub	Submarine	25							48+	40+	25		4	160
Sang-O coastal infiltration	Submarine	29							3	22	277		8.8	800
Frigates				1	1				1	3				
Corvettes				2	2				2	2				
Missile Attack Boats				39	39	18				39				
Coastal Patrol Craft				388	388									
Mine Warfare Craft		11		23	23	42			23	56				
Amphibious Craft				194	194	75				324				
Submarines				24	24	15				84				
Trawlers						105								
<b>TOTAL, ALL VESSELS</b>				671	671	568				803	92,816			
<b>Those Using Heavy Fuel Oil</b>										3	1,800			
Naval Personnel	60,000	34												
<b>Service Vehicles</b>	4,077	20												
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>														

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Type of Vessel	Class	1990			1996		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjin Class	Frigate	1,191,223	3.57E+06	1.34E+05	848,746	2.55E+06	9.57E+04
T (Tral) Class	Lg Patrol	238,245	4.76E+05	1.79E+04	169,749	3.39E+05	1.28E+04
Sariwon Class	Lg Patrol	238,245	9.53E+05	3.58E+04	169,749	6.79E+05	2.55E+04
SO 1 Class	Lg Patrol	595,611	9.53E+06	3.58E+05	424,373	6.79E+06	2.55E+05
Artillerist Class	Lg Patrol	595,611	1.19E+06	4.48E+04	424,373	8.49E+05	3.19E+04
Hainan Class	Lg Patrol	698,851	4.19E+06	1.58E+05	497,931	2.99E+06	1.12E+05
Taechong Class	Lg Patrol	595,611	4.17E+06	1.57E+05	424,373	2.97E+06	1.12E+05
OSA 1 Class	Missile Att.	952,978	2.29E+07	8.60E+05	678,997	1.63E+07	6.12E+05
Komar Class	Missile Att.	381,191	5.72E+06	2.15E+05	271,599	4.07E+06	1.53E+05
Shanghi Class--Gun	Fast Att.	381,191	4.96E+06	1.86E+05	271,599	3.53E+06	1.33E+05
Swatow Class--Gun	Fast Att.	238,245	1.91E+06	7.16E+04	169,749	1.36E+06	5.10E+04
Chodo Class--Gun	Fast Att.	476,489	1.91E+06	7.16E+04	339,498	1.36E+06	5.10E+04
K-48 Class--Gun	Fast Att.	397,074	1.59E+06	5.97E+04	282,915	1.13E+06	4.25E+04
MO IV Class--Gun	Fast Att.	238,245	5.00E+06	1.88E+05	169,749	3.56E+06	1.34E+05
Chongjin Class--Gun	Fast Att.	381,191	1.79E+07	6.73E+05	271,599	1.28E+07	4.80E+05
P 6--Torpedo	Fast Att.	381,191	2.48E+07	9.31E+05	271,599	1.77E+07	6.64E+05
P 4--Torpedo	Fast Att.	381,191	4.96E+06	1.86E+05	271,599	3.53E+06	1.33E+05
Iwon--Torpedo	Fast Att.	285,893	4.57E+06	1.72E+05	203,699	3.26E+06	1.22E+05
An Ju--Torpedo	Fast Att.	381,191	2.29E+06	8.60E+04	271,599	1.63E+06	6.12E+04
Chaho Class--Torpedo	Fast Att.	381,191	2.63E+07	9.89E+05	271,599	1.87E+07	7.04E+05
Sin Hung/Kosong--Torp.	Fast Att.	190,596	1.43E+07	5.37E+05	135,799	1.02E+07	3.83E+05
Shersen Class--Torpedo	Fast Att.	952,978	3.81E+06	1.43E+05	678,997	2.72E+06	1.02E+05
KM 4--Torpedo	Fast Att.	11,595	1.16E+05	4.36E+03	8,261	8.26E+04	3.10E+03
Torpedo Boats	Patrol						
Light Patrol	Patrol	11,595	2.43E+05	9.15E+03	8,261	1.73E+05	6.52E+03
Hantaе	Landing	24,817	2.98E+05	1.12E+04	24,817	2.98E+05	1.12E+04
Nampo	Landing	23,824	3.48E+06	1.31E+05	23,824	3.48E+06	1.31E+05
Hanchon	Landing	24,817	8.93E+05	3.36E+04	24,817	8.93E+05	3.36E+04
Kong Bang (Hovercraft)	Landing	113,400	1.47E+06	5.54E+04	113,400	7.37E+06	2.77E+05
Whiskey	Submarine	52,247	2.09E+05	7.85E+03	52,247	2.09E+05	7.85E+03
Romeo, Chinese	Submarine	52,247	2.09E+05	7.85E+03	52,247	2.09E+05	7.85E+03
Romeo, NK	Submarine	52,247	8.36E+05	3.14E+04	52,247	8.36E+05	3.14E+04
YUGO mini-sub	Submarine	2,090	1.00E+05	3.77E+03	2,090	1.00E+05	3.77E+03
Sang-O coastal infiltration	Submarine	10,449	1.25E+05	4.71E+03	10,449	1.25E+05	4.71E+03
Frigates			3.57E+06	1.34E+05		2.55E+06	9.57E+04
Corvettes			4.76E+05	1.79E+04		3.39E+05	1.28E+04
Missile Attack Boats			2.86E+07	1.07E+06		2.04E+07	7.66E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			6.14E+06	2.31E+05		1.20E+07	4.53E+05
Submarines			1.48E+06	5.56E+04		1.48E+06	5.56E+04
Trawlers							
<b>TOTAL, VESSELS</b>			1.75E+08	6.57E+06		1.33E+08	4.98E+06
<b>Those Using Heavy Fuel Oil</b>			3.57E+06	1.34E+05		2.55E+06	9.57E+04
<b>Service Vehicles</b>			1.14E+07	3.71E+05		8.62E+06	2.81E+05
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			1.86E+08	6.94E+06		1.41E+08	5.26E+06

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Type of Vessel	Class	2000			2005		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjin Class	Frigate	841,301	2.52E+06	9.49E+04	856,191	2.57E+06	96,537
T (Tral) Class	Lg Patrol	168,260	3.37E+05	1.26E+04	171,238	342,476	12,872
Sariwon Class	Lg Patrol	168,260	6.73E+05	2.53E+04	171,238	6.85E+05	2.57E+04
SO 1 Class	Lg Patrol	420,650	6.73E+06	2.53E+05	428,096	6.85E+06	2.57E+05
Artillerist Class	Lg Patrol	420,650	8.41E+05	3.16E+04	428,096	8.56E+05	3.22E+04
Hainan Class	Lg Patrol	493,563	2.96E+06	1.11E+05	502,299	3.01E+06	1.13E+05
Taechong Class	Lg Patrol	420,650	2.94E+06	1.11E+05	428,096	3.00E+06	1.13E+05
OSA 1 Class	Missile Att.	673,041	1.62E+07	6.07E+05	684,953	1.64E+07	617,839
Komar Class	Missile Att.	269,216	4.04E+06	1.52E+05	273,981	4.11E+06	154,460
Shanghi Class--Gun	Fast Att.	269,216	3.50E+06	1.32E+05	273,981	3.56E+06	1.34E+05
Swatow Class--Gun	Fast Att.	168,260	1.35E+06	5.06E+04	171,238	1.37E+06	5.15E+04
Chodo Class--Gun	Fast Att.	336,520	1.35E+06	5.06E+04	342,476	1.37E+06	5.15E+04
K-48 Class--Gun	Fast Att.	280,434	1.12E+06	4.22E+04	285,397	1.14E+06	4.29E+04
MO IV Class--Gun	Fast Att.	168,260	3.53E+06	1.33E+05	171,238	3.60E+06	1.35E+05
Chongjin Class--Gun	Fast Att.	269,216	1.27E+07	4.76E+05	273,981	1.29E+07	4.84E+05
P 6--Torpedo	Fast Att.	269,216	1.75E+07	6.58E+05	273,981	1.78E+07	6.69E+05
P 4--Torpedo	Fast Att.	269,216	3.50E+06	1.32E+05	273,981	3.56E+06	1.34E+05
Iwon--Torpedo	Fast Att.	201,912	3.23E+06	1.21E+05	205,486	3.29E+06	1.24E+05
An Ju--Torpedo	Fast Att.	269,216	1.62E+06	6.07E+04	273,981	1.64E+06	6.18E+04
Chaho Class--Torpedo	Fast Att.	269,216	1.86E+07	6.98E+05	273,981	1.89E+07	7.11E+05
Sin Hung/Kosong--Torp.	Fast Att.	134,608	1.01E+07	3.79E+05	136,991	1.03E+07	3.86E+05
Shersen Class--Torpedo	Fast Att.	673,041	2.69E+06	1.01E+05	684,953	2.74E+06	1.03E+05
KM 4--Torpedo	Fast Att.	8,189	8.19E+04	3.08E+03	8,334	8.33E+04	3.13E+03
Torpedo Boats	Patrol						
Light Patrol	Patrol	8,189	1.72E+05	6.46E+03	8,334	1.75E+05	6.58E+03
Hantaе	Landing	22,335	2.68E+05	1.01E+04	22,335	2.68E+05	1.01E+04
Nampo	Landing	21,442	3.13E+06	1.18E+05	21,442	3.13E+06	1.18E+05
Hanchon	Landing	22,335	8.04E+05	3.02E+04	22,335	8.04E+05	3.02E+04
Kong Bang (Hovercraft)	Landing	102,060	1.33E+07	4.99E+05	102,060	1.33E+07	4.99E+05
Whiskey	Submarine	47,022	1.88E+05	7.07E+03	47,022	1.88E+05	7.07E+03
Romeo, Chinese	Submarine	47,022	1.88E+05	7.07E+03	47,022	1.88E+05	7.07E+03
Romeo, NK	Submarine	47,022	7.52E+05	2.83E+04	47,022	7.52E+05	2.83E+04
YUGO mini-sub	Submarine	1,881	9.03E+04	3.39E+03	1,881	9.03E+04	3.39E+03
Sang-O coastal infiltration	Submarine	9,404	1.13E+05	4.24E+03	9,404	1.13E+05	4.24E+03
Frigates			2.52E+06	9.49E+04		2.57E+06	9.65E+04
Corvettes			3.37E+05	1.26E+04		3.42E+05	1.29E+04
Missile Attack Boats			2.02E+07	7.59E+05		2.05E+07	7.72E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			1.75E+07	6.57E+05		1.75E+07	6.57E+05
Submarines			1.33E+06	5.00E+04		1.33E+06	5.00E+04
Trawlers							
<b>TOTAL, VESSELS</b>			<b>1.37E+08</b>	<b>5.14E+06</b>		<b>1.39E+08</b>	<b>5.22E+06</b>
<b>Those Using Heavy Fuel Oil</b>			<b>2.52E+06</b>	<b>9.49E+04</b>		<b>2.57E+06</b>	<b>9.65E+04</b>
<b>Service Vehicles</b>			<b>8.90E+06</b>	<b>2.90E+05</b>		<b>9.04E+06</b>	<b>2.95E+05</b>
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			<b>1.46E+08</b>	<b>5.43E+06</b>		<b>1.48E+08</b>	<b>5.51E+06</b>

*Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21*

Type of Vessel	Class	2008			2009		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjin Class	Frigate	640,282	1.92E+06	7.22E+04	595,611	1.79E+06	6.72E+04
T (Tral) Class	Lg Patrol	128,056	2.56E+05	9.63E+03	119,122	2.38E+05	8.95E+03
Sariwon Class	Lg Patrol	128,056	5.12E+05	1.93E+04	119,122	4.76E+05	1.79E+04
SO 1 Class	Lg Patrol	320,141	5.12E+06	1.93E+05	297,806	4.76E+06	1.79E+05
Artillerist Class	Lg Patrol	320,141	6.40E+05	2.41E+04	297,806	5.96E+05	2.24E+04
Hainan Class	Lg Patrol	375,632	2.25E+06	8.47E+04	349,425	2.10E+06	7.88E+04
Taechong Class	Lg Patrol	320,141	2.24E+06	8.42E+04	297,806	2.08E+06	7.83E+04
OSA 1 Class	Missile Att.	512,226	1.23E+07	4.62E+05	476,489	1.14E+07	4.30E+05
Komar Class	Missile Att.	204,890	3.07E+06	1.16E+05	190,596	2.86E+06	1.07E+05
Shanghi Class--Gun	Fast Att.	204,890	2.66E+06	1.00E+05	190,596	2.48E+06	9.31E+04
Swatow Class--Gun	Fast Att.	128,056	1.02E+06	3.85E+04	119,122	9.53E+05	3.58E+04
Chodo Class--Gun	Fast Att.	256,113	1.02E+06	3.85E+04	238,245	9.53E+05	3.58E+04
K-48 Class--Gun	Fast Att.	213,427	8.54E+05	3.21E+04	198,537	7.94E+05	2.98E+04
MO IV Class--Gun	Fast Att.	128,056	2.69E+06	1.01E+05	119,122	2.50E+06	9.40E+04
Chongjin Class--Gun	Fast Att.	204,890	9.63E+06	3.62E+05	190,596	8.96E+06	3.37E+05
P 6--Torpedo	Fast Att.	204,890	1.33E+07	5.01E+05	190,596	1.24E+07	4.66E+05
P 4--Torpedo	Fast Att.	204,890	2.66E+06	1.00E+05	190,596	2.48E+06	9.31E+04
Iwon--Torpedo	Fast Att.	153,668	2.46E+06	9.24E+04	142,947	2.29E+06	8.60E+04
An Ju--Torpedo	Fast Att.	204,890	1.23E+06	4.62E+04	190,596	1.14E+06	4.30E+04
Chaho Class--Torpedo	Fast Att.	204,890	1.41E+07	5.31E+05	190,596	1.32E+07	4.94E+05
Sin Hung/Kosong--Torp.	Fast Att.	102,445	7.68E+06	2.89E+05	95,298	7.15E+06	2.69E+05
Shersen Class--Torpedo	Fast Att.	512,226	2.05E+06	7.70E+04	476,489	1.91E+06	7.16E+04
KM 4--Torpedo	Fast Att.	6,232	6.23E+04	2.34E+03	5,797	5.80E+04	2.18E+03
Torpedo Boats	Patrol						
Light Patrol	Patrol	6,232	1.31E+05	4.92E+03	5,797	1.22E+05	4.58E+03
Hantaе	Landing	19,854	2.38E+05	8.95E+03	17,372	2.08E+05	7.83E+03
Nampo	Landing	19,060	2.78E+06	1.05E+05	16,677	2.43E+06	9.15E+04
Hanchon	Landing	19,854	7.15E+05	2.69E+04	17,372	6.25E+05	2.35E+04
Kong Bang (Hovercraft)	Landing	90,720	1.18E+07	4.43E+05	79,380	1.03E+07	3.88E+05
Whiskey	Submarine	41,797	1.67E+05	6.28E+03	41,797	1.67E+05	6.28E+03
Romeo, Chinese	Submarine	41,797	1.67E+05	6.28E+03	41,797	1.67E+05	6.28E+03
Romeo, NK	Submarine	41,797	6.69E+05	2.51E+04	41,797	6.69E+05	2.51E+04
YUGO mini-sub	Submarine	1,672	8.03E+04	3.02E+03	1,672	8.03E+04	3.02E+03
Sang-O coastal infiltration	Submarine	8,359	1.00E+05	3.77E+03	8,359	1.00E+05	3.77E+03
Frigates			1.92E+06	7.22E+04		1.79E+06	6.72E+04
Corvettes			2.56E+05	9.63E+03		2.38E+05	8.95E+03
Missile Attack Boats			1.54E+07	5.78E+05		1.43E+07	5.37E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			1.55E+07	5.84E+05		1.36E+07	5.11E+05
Submarines			1.18E+06	4.45E+04		1.18E+06	4.45E+04
Trawlers							
<b>TOTAL, VESSELS</b>			<b>1.06E+08</b>	<b>4.00E+06</b>		<b>9.82E+07</b>	<b>3.69E+06</b>
<b>Those Using Heavy Fuel Oil</b>			<b>1.92E+06</b>	<b>7.22E+04</b>		<b>1.79E+06</b>	<b>6.72E+04</b>
<b>Service Vehicles</b>			<b>6.93E+06</b>	<b>2.26E+05</b>		<b>6.39E+06</b>	<b>2.08E+05</b>
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			<b>1.13E+08</b>	<b>4.23E+06</b>		<b>1.05E+08</b>	<b>3.90E+06</b>

*Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21*

Type of Vessel	Class	2010			2014		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjin Class	Frigate	684,953	2.05E+06	7.72E+04	610,502	1.83E+06	68,835
T (Tral) Class	Lg Patrol	136,991	2.74E+05	1.03E+04	56,444	1.13E+05	4,243
Sariwon Class	Lg Patrol	136,991	5.48E+05	2.06E+04	56,444	2.26E+05	8.49E+03
SO 1 Class	Lg Patrol	342,476	5.48E+06	2.06E+05	141,110	2.26E+06	8.49E+04
Artillerist Class	Lg Patrol	342,476	6.85E+05	2.57E+04	330,892	6.62E+05	2.49E+04
Hainan Class	Lg Patrol	401,839	2.41E+06	9.06E+04	165,569	9.93E+05	3.73E+04
Taechong Class	Lg Patrol	342,476	2.40E+06	9.01E+04	141,110	9.88E+05	3.71E+04
OSA 1 Class	Missile Att.	547,962	1.32E+07	4.94E+05	529,427	1.27E+07	477,552
Komar Class	Missile Att.	219,185	3.29E+06	1.24E+05	211,771	3.18E+06	119,388
Shanghi Class--Gun	Fast Att.	219,185	2.85E+06	1.07E+05	90,310	1.17E+06	4.41E+04
Swatow Class--Gun	Fast Att.	136,991	1.10E+06	4.12E+04	132,357	1.06E+06	3.98E+04
Chodo Class--Gun	Fast Att.	273,981	1.10E+06	4.12E+04	112,888	4.52E+05	1.70E+04
K-48 Class--Gun	Fast Att.	228,318	9.13E+05	3.43E+04	94,073	3.76E+05	1.41E+04
MO IV Class--Gun	Fast Att.	136,991	2.88E+06	1.08E+05	132,357	2.78E+06	1.04E+05
Chongjin Class--Gun	Fast Att.	219,185	1.03E+07	3.87E+05	211,771	9.95E+06	3.74E+05
P 6--Torpedo	Fast Att.	219,185	1.42E+07	5.35E+05	211,771	1.38E+07	5.17E+05
P 4--Torpedo	Fast Att.	219,185	2.85E+06	1.07E+05	211,771	2.75E+06	1.03E+05
Iwon--Torpedo	Fast Att.	164,389	2.63E+06	9.89E+04	158,828	2.54E+06	9.55E+04
An Ju--Torpedo	Fast Att.	219,185	1.32E+06	4.94E+04	211,771	1.27E+06	4.78E+04
Chaho Class--Torpedo	Fast Att.	219,185	1.51E+07	5.68E+05	211,771	1.46E+07	5.49E+05
Sin Hung/Kosong--Torp.	Fast Att.	109,592	8.22E+06	3.09E+05	105,885	7.94E+06	2.98E+05
Shersen Class--Torpedo	Fast Att.	547,962	2.19E+06	8.24E+04	529,427	2.12E+06	7.96E+04
KM 4--Torpedo	Fast Att.	6,667	6.67E+04	2.51E+03	6,441	6.44E+04	2.42E+03
Torpedo Boats	Patrol						
Light Patrol	Patrol	6,667	1.40E+05	5.26E+03	5,942	1.25E+05	4.69E+03
Hantaе	Landing	22,335	2.68E+05	1.01E+04	17,923	2.15E+05	8.08E+03
Nampo	Landing	21,442	3.13E+06	1.18E+05	17,207	2.51E+06	9.44E+04
Hanchon	Landing	22,335	8.04E+05	3.02E+04	17,923	6.45E+05	2.43E+04
Kong Bang (Hovercraft)	Landing	102,060	1.33E+07	4.99E+05	81,900	1.06E+07	4.00E+05
Whiskey	Submarine	41,797	1.67E+05	6.28E+03	34,831	1.39E+05	5.24E+03
Romeo, Chinese	Submarine	41,797	1.67E+05	6.28E+03	34,831	1.39E+05	5.24E+03
Romeo, NK	Submarine	41,797	6.69E+05	2.51E+04	34,831	5.57E+05	2.09E+04
YUGO mini-sub	Submarine	1,672	8.03E+04	3.02E+03	1,393	6.69E+04	2.51E+03
Sang-O coastal infiltration	Submarine	8,359	1.00E+05	3.77E+03	6,966	83,595	3,142
Frigates			2.05E+06	7.72E+04		1.83E+06	6.88E+04
Corvettes			2.74E+05	1.03E+04		1.13E+05	4.24E+03
Missile Attack Boats			1.64E+07	6.18E+05		1.59E+07	5.97E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			1.75E+07	6.57E+05		1.40E+07	5.27E+05
Submarines			1.18E+06	4.45E+04		9.86E+05	3.71E+04
Trawlers							
<b>TOTAL, VESSELS</b>			<b>1.15E+08</b>	<b>4.31E+06</b>		<b>9.88E+07</b>	<b>3.71E+06</b>
<b>Those Using Heavy Fuel Oil</b>			<b>2.05E+06</b>	<b>7.72E+04</b>		<b>1.83E+06</b>	<b>6.88E+04</b>
<b>Service Vehicles</b>			<b>6.93E+06</b>	<b>2.43E+05</b>		<b>6.43E+06</b>	<b>2.10E+05</b>
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			<b>1.22E+08</b>	<b>4.55E+06</b>		<b>1.05E+08</b>	<b>3.92E+06</b>



**Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21**

Type of Vessel	Class	2015			2016		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjin Class	Frigate	610,502	1.83E+06	68,835	625,392	1.88E+06	70,514
T (Tral) Class	Lg Patrol	52,102	1.04E+05	3,916	48,925	9.79E+04	3,678
Sariwon Class	Lg Patrol	52,102	2.08E+05	7.83E+03	48,925	1.96E+05	7.36E+03
SO 1 Class	Lg Patrol	130,255	2.08E+06	7.83E+04	122,313	1.96E+06	7.36E+04
Artillerist Class	Lg Patrol	335,520	6.71E+05	2.52E+04	348,444	6.97E+05	2.62E+04
Hainan Class	Lg Patrol	152,833	9.17E+05	3.45E+04	143,514	8.61E+05	3.24E+04
Taechong Class	Lg Patrol	130,255	9.12E+05	3.43E+04	122,313	8.56E+05	3.22E+04
OSA 1 Class	Missile Att.	536,832	1.29E+07	484,231	557,510	1.34E+07	502,883
Komar Class	Missile Att.	214,733	3.22E+06	121,058	223,004	3.35E+06	125,721
Shanghi Class--Gun	Fast Att.	83,363	1.08E+06	4.07E+04	78,280	1.02E+06	3.82E+04
Swatow Class--Gun	Fast Att.	134,208	1.07E+06	4.04E+04	139,378	1.12E+06	4.19E+04
Chodo Class--Gun	Fast Att.	104,204	4.17E+05	1.57E+04	97,850	3.91E+05	1.47E+04
K-48 Class--Gun	Fast Att.	86,837	3.47E+05	1.31E+04	81,542	3.26E+05	1.23E+04
MO IV Class--Gun	Fast Att.	134,208	2.82E+06	1.06E+05	139,378	2.93E+06	1.10E+05
Chongjin Class--Gun	Fast Att.	214,733	1.01E+07	3.79E+05	223,004	1.05E+07	3.94E+05
P 6--Torpedo	Fast Att.	214,733	1.40E+07	5.25E+05	223,004	1.45E+07	5.45E+05
P 4--Torpedo	Fast Att.	214,733	2.79E+06	1.05E+05	223,004	2.90E+06	1.09E+05
Iwon--Torpedo	Fast Att.	161,050	2.58E+06	9.68E+04	167,253	2.68E+06	1.01E+05
An Ju--Torpedo	Fast Att.	214,733	1.29E+06	4.84E+04	223,004	1.34E+06	5.03E+04
Chaho Class--Torpedo	Fast Att.	214,733	1.48E+07	5.57E+05	223,004	1.54E+07	5.78E+05
Sin Hung/Kosong--Torp.	Fast Att.	107,366	8.05E+06	3.03E+05	111,502	8.36E+06	3.14E+05
Shersen Class--Torpedo	Fast Att.	536,832	2.15E+06	8.07E+04	557,510	2.23E+06	8.38E+04
KM 4--Torpedo	Fast Att.	6,531	6.53E+04	2.45E+03	6,783	6.78E+04	2.55E+03
Torpedo Boats	Patrol						
Light Patrol	Patrol	5,942	1.25E+05	4.69E+03	6,087	1.28E+05	4.80E+03
Hantaе	Landing	17,923	2.15E+05	8.08E+03	17,923	2.15E+05	8.08E+03
Nampo	Landing	17,207	2.51E+06	9.44E+04	17,207	2.51E+06	9.44E+04
Hanchon	Landing	17,923	6.45E+05	2.43E+04	17,923	6.45E+05	2.43E+04
Kong Bang (Hovercraft)	Landing	81,900	1.06E+07	4.00E+05	81,900	1.06E+07	4.00E+05
Whiskey	Submarine	34,831	1.39E+05	5.24E+03	34,831	1.39E+05	5.24E+03
Romeo, Chinese	Submarine	34,831	1.39E+05	5.24E+03	34,831	1.39E+05	5.24E+03
Romeo, NK	Submarine	34,831	5.57E+05	2.09E+04	34,831	5.57E+05	2.09E+04
YUGO mini-sub	Submarine	1,393	6.69E+04	2.51E+03	1,393	6.69E+04	2.51E+03
Sang-O coastal infiltration	Submarine	6,966	83,595	3,142	6,966	83,595	3,142
Frigates			1.83E+06	6.88E+04		1.88E+06	7.05E+04
Corvettes			1.04E+05	3.92E+03		9.79E+04	3.68E+03
Missile Attack Boats			1.61E+07	6.05E+05		1.67E+07	6.29E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			1.40E+07	5.27E+05		1.40E+07	5.27E+05
Submarines			9.86E+05	3.71E+04		9.86E+05	3.71E+04
Trawlers							
<b>TOTAL, VESSELS</b>			<b>9.93E+07</b>	<b>3.73E+06</b>		<b>1.02E+08</b>	<b>3.83E+06</b>
<b>Those Using Heavy Fuel Oil</b>			<b>1.83E+06</b>	<b>6.88E+04</b>		<b>1.88E+06</b>	<b>7.05E+04</b>
<b>Service Vehicles</b>			<b>6.46E+06</b>	<b>2.11E+05</b>		<b>6.63E+06</b>	<b>2.16E+05</b>
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			<b>1.06E+08</b>	<b>3.94E+06</b>		<b>1.09E+08</b>	<b>4.05E+06</b>



**Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21**

Type of Vessel	Class	2017			2018		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjin Class	Frigate	446,708	1.34E+06	50,367	416,928	1.25E+06	47,009
T (Tral) Class	Lg Patrol	31,770	6.35E+04	2,388	29,652	5.93E+04	2,229
Sariwon Class	Lg Patrol	31,770	1.27E+05	4.78E+03	29,652	1.19E+05	4.46E+03
SO 1 Class	Lg Patrol	79,424	1.27E+06	4.78E+04	74,129	1.19E+06	4.46E+04
Artillerist Class	Lg Patrol	252,275	5.05E+05	1.90E+04	235,456	4.71E+05	1.77E+04
Hainan Class	Lg Patrol	93,191	5.59E+05	2.10E+04	86,978	5.22E+05	1.96E+04
Taechong Class	Lg Patrol	79,424	5.56E+05	2.09E+04	74,129	5.19E+05	1.95E+04
OSA 1 Class	Missile Att.	403,640	9.69E+06	364,089	376,730	9.04E+06	339,817
Komar Class	Missile Att.	161,456	2.42E+06	91,022	150,692	2.26E+06	84,954
Shanghi Class--Gun	Fast Att.	50,831	6.61E+05	2.48E+04	47,442	6.17E+05	2.32E+04
Swatow Class--Gun	Fast Att.	100,910	8.07E+05	3.03E+04	94,183	7.53E+05	2.83E+04
Chodo Class--Gun	Fast Att.	63,539	2.54E+05	9.55E+03	59,303	2.37E+05	8.92E+03
K-48 Class--Gun	Fast Att.	52,949	2.12E+05	7.96E+03	49,419	1.98E+05	7.43E+03
MO IV Class--Gun	Fast Att.	100,910	2.12E+06	7.96E+04	94,183	1.98E+06	7.43E+04
Chongjin Class--Gun	Fast Att.	161,456	7.59E+06	2.85E+05	150,692	7.08E+06	2.66E+05
P 6--Torpedo	Fast Att.	161,456	1.05E+07	3.94E+05	150,692	9.79E+06	3.68E+05
P 4--Torpedo	Fast Att.	161,456	2.10E+06	7.89E+04	150,692	1.96E+06	7.36E+04
Iwon--Torpedo	Fast Att.	121,092	1.94E+06	7.28E+04	113,019	1.81E+06	6.80E+04
An Ju--Torpedo	Fast Att.	161,456	9.69E+05	3.64E+04	150,692	9.04E+05	3.40E+04
Chaho Class--Torpedo	Fast Att.	161,456	1.11E+07	4.19E+05	150,692	1.04E+07	3.91E+05
Sin Hung/Kosong--Torp.	Fast Att.	80,728	6.05E+06	2.28E+05	75,346	5.65E+06	2.12E+05
Shersen Class--Torpedo	Fast Att.	403,640	1.61E+06	6.07E+04	376,730	1.51E+06	5.66E+04
KM 4--Torpedo	Fast Att.	4,911	4.91E+04	1.85E+03	4,584	4.58E+04	1.72E+03
Torpedo Boats	Patrol						
Light Patrol	Patrol	4,348	9.13E+04	3.43E+03	4,058	8.52E+04	3.20E+03
Hantaе	Landing	17,923	2.15E+05	8.08E+03	16,729	2.01E+05	7.54E+03
Nampo	Landing	17,207	2.51E+06	9.44E+04	16,059	2.34E+06	8.81E+04
Hanchon	Landing	17,923	6.45E+05	2.43E+04	16,729	6.02E+05	2.26E+04
Kong Bang (Hovercraft)	Landing	81,900	1.06E+07	4.00E+05	76,440	9.94E+06	3.73E+05
Whiskey	Submarine	30,477	1.22E+05	4.58E+03	28,300	1.13E+05	4.25E+03
Romeo, Chinese	Submarine	30,477	1.22E+05	4.58E+03	28,300	1.13E+05	4.25E+03
Romeo, NK	Submarine	30,477	4.88E+05	1.83E+04	28,300	4.53E+05	1.70E+04
YUGO mini-sub	Submarine	1,219	5.85E+04	2.20E+03	1,132	5.43E+04	2.04E+03
Sang-O coastal infiltration	Submarine	6,095	73,145	2,749	5,660	67,921	2,553
Frigates			1.34E+06	5.04E+04		1.25E+06	4.70E+04
Corvettes			6.35E+04	2.39E+03		5.93E+04	2.23E+03
Missile Attack Boats			1.21E+07	4.55E+05		1.13E+07	4.25E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			1.40E+07	5.27E+05		1.31E+07	4.92E+05
Submarines			8.63E+05	3.24E+04		8.01E+05	3.01E+04
Trawlers							
<b>TOTAL, VESSELS</b>			<b>7.74E+07</b>	<b>2.91E+06</b>		<b>7.22E+07</b>	<b>2.71E+06</b>
<b>Those Using Heavy Fuel Oil</b>			<b>1.34E+06</b>	<b>5.04E+04</b>		<b>1.25E+06</b>	<b>4.70E+04</b>
<b>Service Vehicles</b>			<b>5.03E+06</b>	<b>1.64E+05</b>		<b>4.70E+06</b>	<b>1.53E+05</b>
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			<b>8.24E+07</b>	<b>3.07E+06</b>		<b>7.69E+07</b>	<b>2.87E+06</b>

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Type of Vessel	Class	2019			2020		
		Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year	Per Vessel Fuel Cons. liters/year	Per Class Fuel Cons. liters/year	Per Class Fuel Cons. GJ/year
Nanjing Class	Frigate	416,928	1.25E+06	47,009	223,354	6.70E+05	25,184
T (Tral) Class	Lg Patrol	29,652	5.93E+04	2,229	15,885	3.18E+04	1,194
Sariwon Class	Lg Patrol	29,652	1.19E+05	4.46E+03	15,885	6.35E+04	2.39E+03
SO 1 Class	Lg Patrol	74,129	1.19E+06	4.46E+04	39,712	6.35E+05	2.39E+04
Artillerist Class	Lg Patrol	235,456	4.71E+05	1.77E+04	126,137	2.52E+05	9.48E+03
Hainan Class	Lg Patrol	86,978	5.22E+05	1.96E+04	46,595	2.80E+05	1.05E+04
Taechong Class	Lg Patrol	74,129	5.19E+05	1.95E+04	39,712	2.78E+05	1.04E+04
OSA 1 Class	Missile Att.	376,730	9.04E+06	339,817	201,820	4.84E+06	182,045
Komar Class	Missile Att.	150,692	2.26E+06	84,954	80,728	1.21E+06	45,511
Shanghi Class--Gun	Fast Att.	47,442	6.17E+05	2.32E+04	25,416	3.30E+05	1.24E+04
Swatow Class--Gun	Fast Att.	94,183	7.53E+05	2.83E+04	50,455	4.04E+05	1.52E+04
Chodo Class--Gun	Fast Att.	59,303	2.37E+05	8.92E+03	31,770	1.27E+05	4.78E+03
K-48 Class--Gun	Fast Att.	49,419	1.98E+05	7.43E+03	26,475	1.06E+05	3.98E+03
MO IV Class--Gun	Fast Att.	94,183	1.98E+06	7.43E+04	50,455	1.06E+06	3.98E+04
Chongjin Class--Gun	Fast Att.	150,692	7.08E+06	2.66E+05	80,728	3.79E+06	1.43E+05
P 6--Torpedo	Fast Att.	150,692	9.79E+06	3.68E+05	80,728	5.25E+06	1.97E+05
P 4--Torpedo	Fast Att.	150,692	1.96E+06	7.36E+04	80,728	1.05E+06	3.94E+04
Iwon--Torpedo	Fast Att.	113,019	1.81E+06	6.80E+04	60,546	9.69E+05	3.64E+04
An Ju--Torpedo	Fast Att.	150,692	9.04E+05	3.40E+04	80,728	4.84E+05	1.82E+04
Chaho Class--Torpedo	Fast Att.	150,692	1.04E+07	3.91E+05	80,728	5.57E+06	2.09E+05
Sin Hung/Kosong--Torp.	Fast Att.	75,346	5.65E+06	2.12E+05	40,364	3.03E+06	1.14E+05
Shersen Class--Torpedo	Fast Att.	376,730	1.51E+06	5.66E+04	201,820	8.07E+05	3.03E+04
KM 4--Torpedo	Fast Att.	4,584	4.58E+04	1.72E+03	2,455	2.46E+04	9.23E+02
Torpedo Boats	Patrol						
Light Patrol	Patrol	4,058	8.52E+04	3.20E+03	2,174	4.57E+04	1.72E+03
Hantaе	Landing	16,729	2.01E+05	7.54E+03	9,559	1.15E+05	4.31E+03
Nampo	Landing	16,059	2.34E+06	8.81E+04	9,177	1.34E+06	5.04E+04
Hanchon	Landing	16,729	6.02E+05	2.26E+04	9,559	3.44E+05	1.29E+04
Kong Bang (Hovercraft)	Landing	76,440	9.94E+06	3.73E+05	43,680	5.68E+06	2.13E+05
Whiskey	Submarine	28,300	1.13E+05	4.25E+03	16,545	6.62E+04	2.49E+03
Romeo, Chinese	Submarine	28,300	1.13E+05	4.25E+03	16,545	6.62E+04	2.49E+03
Romeo, NK	Submarine	28,300	4.53E+05	1.70E+04	16,545	2.65E+05	9.95E+03
YUGO mini-sub	Submarine	1,132	5.43E+04	2.04E+03	662	3.18E+04	1.19E+03
Sang-O coastal infiltration	Submarine	5,660	6.79E+04	2,553	3,309	3.97E+04	1,492
Frigates			1.25E+06	4.70E+04		6.70E+05	2.52E+04
Corvettes			5.93E+04	2.23E+03		3.18E+04	1.19E+03
Missile Attack Boats			1.13E+07	4.25E+05		6.05E+06	2.28E+05
Coastal Patrol Craft							
Mine Warfare Craft							
Amphibious Craft			1.31E+07	4.92E+05		7.48E+06	2.81E+05
Submarines			8.01E+05	3.01E+04		4.69E+05	1.76E+04
Trawlers							
<b>TOTAL, VESSELS</b>			<b>7.22E+07</b>	<b>2.71E+06</b>		<b>3.92E+07</b>	<b>1.47E+06</b>
<b>Those Using Heavy Fuel Oil</b>			<b>1.25E+06</b>	<b>4.70E+04</b>		<b>6.70E+05</b>	<b>2.52E+04</b>
<b>Service Vehicles</b>			<b>4.70E+06</b>	<b>1.53E+05</b>		<b>2.55E+06</b>	<b>8.31E+04</b>
<b>TOTAL: VESSELS PLUS SERVICE VEHICLES</b>			<b>7.69E+07</b>	<b>2.87E+06</b>		<b>4.17E+07</b>	<b>1.56E+06</b>

## ***Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21***

### **Notes:**

- 1 North Korea Handbook, US Department of Defense, 1994. (PC-2600-6421-94). Pages 6-165 - 6-178.
- 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. True-up factors are not applied to Kong Bang hovercraft or mini-sub.
- 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)

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- 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 Frigates are assumed to be fueled with heavy oil. All other vessels are assumed to be diesel-fueled.
- 22 North Korea Country Handbook, Marine Corps Intelligence Activity, 1997. (MCIA-2630-NK-016-97). File Nkor.pdf, obtained from Federation of American Scientists WWW site, 5/21/02, and dated May, 1997. Data on naval vessels are mostly from pages 39 and 40 of this document.
- 23 North Korea. The Foundations for Military Strength -- Update 1995. US Defense Intelligence Agency (1995). Obtained from Federation of American Scientists WWW site, 5/21/02, and dated December, 1995.
- 24 World Navies Today: North Korea, from [www.hazegray.org/worldnav/](http://www.hazegray.org/worldnav/) (visited 5/22/02) suggests that the DPRK has "135 Kongbang class assault hovercraft, carrying 35-55 troops". Source 22 lists three types of these craft, with sizes ranging from 23 x 60.7 feet to 29.5 x 75.5 feet. Source 22 lists the speed of these vessels as 52 knots. No specific information on the propulsion systems used in these craft was included in either of these sources, but a somewhat larger troop landing hovercraft (47 x 88 feet) used by the US Navy, and with a slightly lower speed, is listed as having 16,000 hp (total?) in four turbine engines. <http://www.fas.org/man/dod-101/sys/ship/lcac.htm> (visited 5/22/02) lists the US "LCAC" as having 12,280 bhp, and "Fuel capacity is 5000 gallons. The LCAC uses an average of 1000 gallons per hour." Assume that the somewhat smaller DPRK vessels would have lower fuel consumption and power ratings perhaps  gallons per hour. According to source 23, production of the Kong Bang type II and III craft began in 1988, suggesting that the major portion of the Kong Bang fleet was produced after 1990. Assume that  of the fleet shown was in service by 1990, and  was in service by 1996.
- 25 Source 23 suggests that there are "over 48" YUGO submarines and 3 SANGO coastal submarines in the DPRK fleet.
- 26 Source 24 lists 18 "Sinpo class" small patrol boats, with 66.5 tons full load displacement, and 4800 hp diesels, and "up to 12" P-6 class small torpedo boats.
- 27 Estimate of 8000 bhp shown here for the Kong Bang hovercraft is a rough figure based on the specifications for the larger US vessel described in note 24. Fuel consumption, however, is based on the estimate given in note 24, not on the horsepower estimate. See also notes 31 and 32.
- 28 Republic of Korea National Intelligence Service, "North Korea Military. The KPA: Troops & Equipment", from <http://www.fas.org/irp/world/rok/nis-docs/defense08.htm>, visited 5/21/02, lists the total naval force personnel for the DPRK at a total of 48,000, somewhat above the figure used here, but as the personnel totals do not directly affect fuel use estimates for this branch of the service, the figure from source 3 is used.

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- 29 Engine size for the Sang-O submarines is a rough estimate based on reported engine size for other DPRK subs and the relative size of the different submarine models.
- 30 There does not appear to be any available definitive information of an unclassified nature that could be used to even qualitatively estimate the level of activity in the DPRK naval forces as of 2000 or 2005. Analysts contacted in researching this update, however, indicate that the DPRK Navy did not, as of about 2002 seem to be operating under any particular fuel restrictions, and that the level of incursions (from DPRK vessels) experienced in ROK waters seems to be fairly consistent with prior years. As a result, we have assumed that DPRK naval activity was about the same (in terms of activity per vessel) as in 1996 for vessels other than submarines and amphibious craft. We have assumed that submarine and amphibious craft activity in the DPRK navy declined slightly in the period after 1996, in part, in the case of amphibious craft, in keeping with our assumption of reduced training levels for ground forces, as well as taking into account reported restrictions on fuel availability in the general economy.
- 31 <http://www.globalsecurity.org/military/world/dprk/navy.htm> states "[t]he North Korean navy has built over 140 hovercraft capable of carrying platoon-size units ashore..." which is on the same order as the estimates of the number of these craft provided in other sources, but slightly higher.
- 32 Two recent ROK media reports--"North Korea Deploys Air Cushion Warships", Seoul, *The Korea Times* (Internet Version-WWW) in English, by Cho'ng Su'ng-ki, dated April 1, 2007 (and quoting the 2006 ROK Defense White Paper); and "N.Korea Develops High-Speed Military Hovercraft", Seoul. *Chosun Ilbo* WWW-Text in English, dated April 2, 2007--report the development of DPRK hovercraft, but these appear to be the same as the Kong Bang hovercraft developed deployed during the 1990s, with no apparent change in the number of such vessels (both of the 2007 articles give a number of 130 hovercraft) since about 2000.
- 33 Jason W. Henson, "FFL Sariwon class", Harpoon Head Quarters (undated, but probably 2000s), available as <http://www.harpoondatabases.com/encyclopedia/Entry1164.aspx>, provides a description of Sariwon class ships, and lists their displacement at a larger 580 to 650 tons. The DPRK, according to the source, built three of these ships in the 1960s based on a World War II era soviet design.
- 34 Quoting from the US Department of Defense (USDOD) *Military and Security Developments Involving the Democratic People's Republic of Korea 2017, Report to Congress Pursuant to the National Defense Authorization Act for Fiscal Year 2012*, dated February 13, 2018, and available as <https://fas.org/irp/world/dprk/dod-2017.pdf>, Anthony H. Cordesman and Nick Harrington list 2012 (from an earlier version of the US DOD document) and 2017 values for DPRK Navy troop strength and naval equipment numbers as follows. Data are from the report by Cordesman and Harrington *The Korean Civil-Military Balance (3rd Major Revision: May 24, 2018)*, Center for Strategic and International Studies, available as [https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180524\\_Revised\\_Korea\\_Civil\\_Military\\_Balance.pdf?SmnEiJ6\\_TyH.ZuekRzXzBLYJBr1157K](https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180524_Revised_Korea_Civil_Military_Balance.pdf?SmnEiJ6_TyH.ZuekRzXzBLYJBr1157K). Lacking additional information, we assume as for air forces that the tendency in recent years to grow the armed forces was slightly more than offset in 2018 by reductions in access to funds and fuels caused by UNSC sanctions, and thus the number of personnel and aircraft in 2018 were approximately the same as in 2017, and their hours of use were slightly lower.

Category	Total Numbers				Implied True-up from 1990-2010 figures					
	2012	2017	2017		2012	2014	2015	2016	2017	2018
Personnel Strength	60,000	60,000	60,000		1.00	1.00	1.00	1.00	1.00	1.00
Submarines	70	70	70		0.83	0.83	0.83	0.83	0.83	0.83
Patrol Combatants	420	430	430							
Amphibious Landing Craft	260	260	260		0.80	0.80	0.80	0.80	0.80	0.80
Mine Warfare Vessels	30	20	20		0.53	0.46	0.43	0.39	0.36	0.36
Support/Auxiliary Vessels	30	40	40							
All other vessels except frigates					1.05	1.08	1.10	1.11	1.13	1.13



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35 A facility hosting amphibious vessels that are probably similar to the "Kong Bang" craft is located near the northern border of the DPRK. See the Google Earth image below, which was taken in late November, 2019. A review of earlier images in Google Earth indicates that this facility has been in use since at least 2010, including the structures housing the 16 vessels. In 2010 there were a few additional vessels at the site. The hovercraft vessels are about 20 m long. Location is 39.808390, 124.412620. The following image, just north of the hovercraft port, shows what appears to be a drydock (or possibly production?) facility for small patrol craft, about 22.5 m. Location of the second image (also taken in late November, 2019) is approximately 39.819, 124.413. The two facilities are located just south of the city of Yongju-gun, about 15 km south of the outlet of the Yalu river.





36 We assume that naval forces activity was sharply curtailed during the DPRK military lockdown in early 2020 in response to the coronavirus pandemic, but that it will slowly recover to near-typical (for recent years) levels by the end of 2020, assuming no major new outbreak of the virus in the DPRK or adjacent territory occurs. Overall, for 2020 we assume that naval forces activity will total slightly more than half of levels in recent years.



## Detailed Inputs and Results: Military Equipment Manufacturing

### ESTIMATE OF ANNUAL FUEL USE BY THE MILITARY SECTOR IN THE DPRK ENERGY USE IN MANUFACTURING MILITARY EQUIPMENT **UPDATE 2020**

<b>Detailed Data and Results</b>	
Prepared By:	David Von Hippel
Date Last Modified:	5/20/2020

<b>COMMON ASSUMPTIONS &amp; PARAMETERS, MILITARY MANUFACTURING</b>	
Lifetime of Ground Forces Equipment (yrs):	20
Lifetime of Small Armaments (yrs):	10
Lifetime of Naval Vessels (yrs):	30
Fract. of Weight of Equipment 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)
<b>GROUND FORCES: VEHICLES</b>	<b>Notes:</b>		1				
<b>Tanks</b>							
	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
<b>Amphibious Vehicles +</b>							
	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
<b>Armored Fighting Vehicles</b>							
	BTR-60	3,622	10	Yes?	20	3.62E+04	1.63E+03
	BRDM	393	5	Yes?	20	1.96E+03	8.84E+01
<b>Truck/Tank Mtd Guns &amp; Missiles</b>							
	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
<b>Light Vehicles</b>							
	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
<b>2 1/2 T Trucks</b>							
<b>Trucks and Utility Vehicles</b>							
	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
<b>TOTAL-GROUND FORCES VEHICLES</b>		<b>94,343</b>				<b>5.05E+05</b>	<b>2.25E+04</b>

	Estimated Number in Service	Average Weight Each (t)	Made in DPRK?	Equip. Lifetime (years)	Total Weight (t)	Estimated Iron&Steel Needed (t)
<b>Notes:</b>		1				
<b>GROUND FORCES: OTHER ARMAMENTS</b>						
Towed Guns and Missile Launchers	3	10,000	6	Yes?	20 6.00E+04	2.70E+03
Light Arms, Various	4			Yes?	10 42,640	3.84E+03
<b>TOTAL-GROUND FORCES OTHER</b>					1.03E+05	6.54E+03
<b>NAVAL FORCES</b>						
Total Tonnage of Naval Vessels	5			Yes	30 9.28E+04	2.78E+03
Service Vehicles	7	4,077		(varies)	20 1.29E+04	5.66E+02
<b>TOTAL-NAVAL FORCES</b>					1.06E+05	3.35E+03
<b>AIR FORCES</b>						
AIRCRAFT	6			No		0
Service Vehicles	7	6,235		(varies)	20 1.72E+04	7.55E+02
<b>TOTAL-AIR FORCES</b>					1.72E+04	7.55E+02
<b>TOTAL IRON&amp;STEEL REQUIRED/YR FOR MILITARY EQUIPMENT</b>						3.31E+04

<b>CALCULATION OF ENERGY REQUIRMENTS FOR MILITARY PRODUCT MANUFACTURING, 1990</b>		
Energy Required to melt iron for steel	250	kgce/te crude steel <i>Note 8</i>
Average number of melts to produce military products	2	<i>Note 9</i>
DPRK Steelmaking processes assumed to be	10%	more energy intensive than in China
Conversion Factor:	29.3	GJ/tce
<b>ESTIMATED COAL TO MANUFACTURE IRON AND STEEL MILITARY EQUIPMENT</b>		5.34E+05 GJ
Fract. Energy Use in Production of Military Equipment Represented by Iron and Steel	60%	<i>Note 9</i>
<b>ESTIMATED TOTAL COAL USED IN MILITARY EQUIPMENT MANUFACTURE</b>		8.90E+05 GJ
Ratio of Electricity Use to Coal Use in DPRK (Non-Military) Iron and Steel Industry	0.054	<i>Note 10</i>
<b>ESTIMATED TOTAL ELECTRICITY USED IN MILITARY EQUIPMENT MANUFACTURE</b>		4.77E+04 GJ

**PROJECTION OF ENERGY REQUIRMENTS FOR MILITARY PRODUCT MANUFACTURING**

Ratio of Military Equipment Output in 1996 versus 1990:	0.70	
Ratio of Military Equipment Output in 2000 versus 1990:	0.45	(See Notes 11 - 13)
Ratio of Military Equipment Output in 2005 versus 1990:	0.45	(See Notes 11 - 13)
Ratio of Military Equipment Output in 2008 versus 1990:	0.45	
Ratio of Military Equipment Output in 2009 versus 1990:	0.45	
Ratio of Military Equipment Output in 2010 versus 1990:	0.45	(See Note 14)
Ratio of Military Equipment Output in 2014 versus 1990:	0.48	(See Note 14)
Ratio of Military Equipment Output in 2015 versus 1990:	0.49	(See Note 14)
Ratio of Military Equipment Output in 2016 versus 1990:	0.50	(See Note 14)
Ratio of Military Equipment Output in 2017 versus 1990:	0.50	(See Note 14)
Ratio of Military Equipment Output in 2018 versus 1990:	0.50	(See Note 14)
Ratio of Military Equipment Output in 2019 versus 1990:	0.50	(See Note 14)
Ratio of Military Equipment Output in 2020 versus 1990:	0.25	(See Note 14)

	1996	2000	2005	
Projection of Coal Use in Military Manufacturing (GJ)	6.23E+05	4.01E+05	4.01E+05	
Projection of Electricity Use in Military Manufacturing (GJ)	3.34E+04	2.15E+04	2.15E+04	
	2008	2009	2010	2014
Projection of Coal Use in Military Manufacturing (GJ)	4.01E+05	4.01E+05	4.01E+05	4.27E+05
Projection of Electricity Use in Military Manufacturing (GJ)	2.15E+04	2.15E+04	2.15E+04	2.29E+04
	2015	2016	2017	2018
Projection of Coal Use in Military Manufacturing (GJ)	4.36E+05	4.45E+05	4.45E+05	4.45E+05
Projection of Electricity Use in Military Manufacturing (GJ)	2.34E+04	2.38E+04	2.38E+04	2.38E+04
	2019	2020		
Projection of Coal Use in Military Manufacturing (GJ)	4.45E+05	2.23E+05		
Projection of Electricity Use in Military Manufacturing (GJ)	2.38E+04	1.19E+04		

## *Nautilus Institute, Foundations of Energy Security for the DPRK, Attachments, 4/26/21*

### **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.
- 11 There has been little direct or quantitative information available on the intensity of military manufacturing in the DPRK in recent years. There have been some reports of missile exports from the DPRK. The Seoul *Tongil Kyongje* article referenced below (13) suggests that exports of SCUD-C missiles in the "early 1990s" were on the order of 100-150 per year. The same article also suggests that "weapons exports at the 15 to 20 percent [presumably of total national exports] in the Cold War...dropped to less than 5 percent after the mid 1990s". It seems unlikely that such exports of relatively high-value armaments would have a substantial effect on overall military sector manufacturing. We assume that the level of military manufacturing is approximately the same as in 1996, though even that level may be difficult for the DPRK to sustain given the reported difficulties in the DPRK coal sector.
- 12 A description of SCUD missiles ("Weapons of Mass Destruction (WMD): R-11 / SS-1B SCUD-A R-300 9K72 Elbrus / SS-1C SCUD-B") from <http://www.globalsecurity.org/wmd/world/russia/r-11.htm> suggests that the typical weight of a SCUD missile is about 6.5 tonnes, of which "3,500 kilograms (7,700 pounds) of IRFNA [inhibited red fuming nitric acid, a fuel oxidant] and about 1,000 kilograms (2,200 pounds) of fuel". An article in *Janes.com*, "SS-1 `Scud' (R-11/8K11, R-11FM (SS-N-1B) and R-17/8K14)", dated April 26, 2001, lists the SCUD-C as having a launch weight of 6.4 tonnes and a warhead weight of 600 kg ([http://www.janes.com/security/international\\_security/news/misc/sws\\_scud010426.shtml](http://www.janes.com/security/international_security/news/misc/sws_scud010426.shtml)). these figures together suggest that the weight of the missile hardware itself is about 1.3 tonnes. Assuming that most or all of this mass is steel, exports of SCUD-C missiles in the early-1990s imply a use of iron/steel of about 130-200 tonnes--which amounts to on the order of half of 1 percent of the iron/steel needed for routine replacement of DPRK equipment (as of 1990), as calculated above. Thus, exports of these missiles, at least, would seem to have little impact on overall DPRK Military manufacturing energy use.

- 13 The journal *Seoul Tongil Kyongje*, dated July 2002, contains an article (pages 28-36) by So Chu-sok entitled "North Korean Industries (Part X): Munitions Industry". Among the information in this article is the following: "...North Korean military power has not changed greatly since....the mid 1990s", apart from some missile development and "expanded forward deployment of long-range artillery". The article estimates the size of the military at 1.7 million people, consuming much more than 5% of food in the country, and more than 15 percent of fuel oil used in the DPRK. Military stockpiles of food and fuel are "100 to 120 days worth", but it is not stated whether this refers to days under typical non-combat or combat conditions. The article states that there are about 180 munitions factories in the DPRK, including about 40 gun factories, 10 armored vehicle factories, 50 ammunition factories, and 10 naval shipyards, producing a total of 25 percent of GNP. Exports of SCUD-C missiles in the early 1990s are estimated at 100 to 150 per year. Factories, largely based on Soviet/East Bloc technology, have become "technologically obsolete and their facilities are run down", resulting in "extremely low" efficiency and high rates of consumption of energy and materials that, coupled with fuel and materials shortages, have "caused production setbacks" in some factories. This general description, together with the information in notes 11 and 12, leads us to believe that military manufacturing has fallen fairly substantially since 1996, in part due to further loss of exports since then, but also due to fuels, material, and parts shortages. We assume that military manufacturing activity was 45 percent of (estimated) 1990 levels in 2005. This would mean that military-sector manufacturing, while substantially less than in 1990, has not fallen by as much as average industrial sector output in the DPRK.
- 14 We have little direct evidence regarding DPRK military manufacturing in recent years, but assume that it was at similar levels in 2008 through 2010 as in 2005, given only small changes in overall economic activity and fuel availability during that time, but has probably increased somewhat since with better fuel availability (including for generators, many of which are probably used in military equipment factories), better electricity availability, and a greater emphasis on the military.
- 15 For 2020, we assume that the military and civilian lockdown with which the DPRK responded to the coronavirus pandemic resulted in several months of lost output by factories producing military equipment, although output is assumed to rise to typical levels by the end of 2020. As a result, we assume that overall output for 2020 will have been about half of output (and energy use) in 2019.

## Estimate of Petroleum Fuels Use in a Conflict by the DPRK Military

### ESTIMATES OF OIL FUEL USE IN A CONFLICT BY THE MILITARY SECTOR IN THE DPRK

Prepared by: D. Von Hippel, 5/20/20

(Updated 4/12/07, 10/16/2011, 8/22/12, 5/1/2013, 3/8/16, 12/9/18, and 3/12/20)

Based on our estimates of 1990 Fuel Use (from this workbook), total use of fuel per hour of exercise-level activity are as follows:

Conversions from GJ to tonnes assume 43 GJ/tonne fuel

Service	GJ/hr	Tonnes/hr	Notes
Ground Forces	7,638	178	Per hour overall ground forces activity*
Air Forces	110,342	2,566	Per hour fighter/bomber activity
Naval Forces	8,671	202	Per hour "other vessels" activity

\*Assumes armaments (including tanks) move 4 times as much as during routine exercises.

Assuming a 30-day conflict in which:  
 50% of ground forces are destroyed/rendered inoperable by the end of the period,  
 and ground forces are moving about 50% of the time,  
 100% of air forces are destroyed/rendered inoperable or placed in deep storage within  
 24 hours of the start of the conflict, and  
 90% of naval forces are destroyed/rendered inoperable/placed in deep storage within  
 120 hours of the start of the conflict, but the remainder stay active through 30 days.

Total fuel use during a 30-day conflict would be: 104,159 tonnes

Based on our estimates of year 2018 diesel plus gasoline production plus imports in the DPRK, it would take on the order of 3.0 months to replenish the stocks consumed in the conflict, even if A) all domestic production and imports were diverted to the war effort, and B) all supply lines remained intact.

Running the two most frequently operating refineries (northwest and smaller west coast) at full capacity (only possible if sufficient imported crude oil supplies are available) would increase the total output of gasoline plus diesel by about 1,750 tonnes per month, meaning that the stocks consumed could be replenished in about 2.8 months

The rate of fuel use by the forces remaining after a 30-day war as above would be 108.97 tonnes/hr  
 This is about 224% of the total average year 2018 rate of diesel plus gasoline production and imports, or about 214% of the total rate of diesel plus gasoline production and imports with refineries running to full capacity.