DEPARTMENT OF NATIONAL DEFENCE

CANADA

OPERATIONAL RESEARCH AND ANALYSIS ESTABLISHMENT

DIRECTORATE OF LOGISTICS ANALYSIS

ORAE PROJECT REPORT NO. PR 335

LIFE CYCLE COST ANALYSIS APPLICABLE TO THE 1992 5/4 TON TRUCK REPLACEMENT

by

J. Laskoski

Report prepared under
ORAE Project 96514-3

Approved by: John P. Hutchison
Director Logistics Analysis

OTTAWA, ONTARIO

OCTOBER 1985

ABSTRACT

This report provides a comparison of future life cycle costs for the replacement of the 1¼-ton truck fleet in 1992. The two vehicles considered were the Commercial Utility Cargo Carrier (CUCV), a successor to the current 1¼-ton truck, and the Hummer, which is a United States development of a standard military patterned vehicle in the same class. The DND Life Cycle Cost model was used to provide the comparison based on information derived from the acquisition and operation of the current 1¼-ton truck fleet assuming a CUCV life of 10 years and a Hummer life of twenty years.

This study was done in support of a study undertaken by DLOR for DLR on the load and mobility requirement of the 1¼-ton truck replacement vehicle.

RÉSUMÉ

Dans ce rapport, on établit une comparaison des coûts futurs du cycle de vie en ce qui concerne le remplacement, en 1992, du parc de camions de 1 tonne 1/4. L'étude a porté sur deux véhicules, soit le véhicule utilitaire commercial (CUCV), successeur du camion actuel de 1 tonne 1/4, et le Hummer, véhicule militaire standard de conception américaine de la même classe. Pour établir la comparaison, on a utilisé le modèle du coût du cycle de vie du MDN et on s'est basé sur les coûts d'acquisition et d'exploitation du parc actuel de camions de 1 tonne 1/4 en assumant que la durée de vie d'utilisation du CUCV est de dix ans, et que celle du Hummer est de vingt ans.

Cette étude a été menée dans le cadre d'une étude, effectuée par le DRO(T) pour le compte du DBRT, sur les exigences liées à la capacité de charge et à la mobilité du véhicule devant remplacer le camion de 1 tonne 1/4.

TABLE OF CONTENTS

LIFE CYCLE COST ANALYSIS APPLICABLE TO THE 1992 1¼-TON TRUCK REPLACEMENT

INTRODUCTION

1. In October of 1984, DLR 3 initiated a DLOR study request to "determine the optimum load capacity and mobility mix for the 1¼-ton replacement fleet" (Reference 1). Among the objectives of this study request was the development of "representative cost, both acquisition and O&M, associated with homogeneous and mixed fleets - assuming service lifespan of 20 years for SMP vehicles and 10 years for commercial ones". D Log A agreed to assist in the study by applying our life cycle costing models to supply answers to this latter aspect of the problem.

2. DLOR completed their portion of the study during the summer of 1985 and, since the two aspects of the study were not necessarily connected, published their finding (see Reference 1) in August 1985. Their study considered the load and mobility factors associated with the military requirement for the vehicle whereas D Log A were to consider the economic implication.

3. A base case for the 1¼-ton truck replacement was established by determining the values of parameters and costs to be used through an examination of the last major procurement of the 1¼-ton truck fleet. Reference 2 provides the results of this examination. References 3 and 4 provided some of the basic data used in the development of these figures. The latter reference (4) was the original comparison of the commercial vehicle and the standard military patterned vehicle made before the current 1¼-ton truck fleet was purchased.

AIM

4. The aim of this study is to forecast on a comparative basis the life cycle costs over a twenty year period of a commercial or military patterned replacement vehicle. These forecasts are based upon a historical cost analysis of the current 1¼-ton truck fleet purchased in 1976.

METHOD

5. Current life cycle cost techniques are used to estimate the vehicle life cycle costs and these are then compared. To this end, the cost estimates and cash flow values are based on the dollar value in the year that the expenditures are expected to be made. The basic data developed in Reference 2 along with current data on equipment costs are extrapolated to 1992 based on the assumption that the price index will increase on an average of 6% per year over the next few years. This same value was used in extrapolating the price index from 1992 to the year 2012. As was the case in Reference 4, a commercial patterned vehicle is assumed to require replacement mid-way through the life cycle of the military patterned vehicle. That is, there are actually two buys of commercially patterned vehicles compared to only one for the military patterned vehicle.

6. The development and use of the DND life cycle cost is described in References 5 to 10. The model was developed by Bell Northern Research Laboratories. These references are supplemented by a user's guide for data file construction produced by D Log A (Reference 11). A detailed description of the methodology and the input data format is also provided in Annex C of Reference 2.

7. The basic data on actual costs of maintenance manpower and parts, as reflected in Reference 2 came from the Land Ordnance Management Information System (LOMMIS) through the Directorate of Land Engineering Support (DLES). These data have been supplemented with information received from the Directorate of Costing Services (D Cost S).

DATA AND ASSUMPTIONS

8. Annex A of Reference 2 provides the "Basic Cost Data" used in the development of the base case. This annex is reproduced in paragraphs 1 and 2 of Annex A in this report for the convenience of the reader. The third paragraph in this annex indicates some changes made to these earlier assumptions. Note that the price index increase over

the period 1976 to 1984 was calculated to be about 10%. The value that has been used in this study for 1985 and succeeding years is 6% as was mentioned earlier.

9. It should be noted that some costs have not been considered (such as costs of support equipment) and other costs (such as maintenance of facilities and administrative costs) have been estimated in a cursory manner. These costs should be approximately the same for either equipments and therefore should not affect the comparative results materially. In view of the above, it should be stressed that only comparative results are valid since absolute values predicted so far into the future can only be tentative at best.

10. Current information from the Directorate of Procurement and Supply Land (DPSL) indicate that the 1985 price for the Commercial Utility Cargo Carrier (CUCV) built by General Motors (GM) is $23,000.00 per vehicle. This conforms reasonably with the base price quotation of about $22,000.00 provided by the GM representative at ARMEX 85. It should be noted that a recent contract for 42 of these vehicles by the Canadian Forces designated for use as ambulances was approximately $27,000.00. The higher value is probably due to specialized features required for the ambulance role. The CUCV is an improved version of the original Canadian Forces (CF) purchase. According to the GM representative it has improved features such as larger axels and heavier suspension. In view of the above, the base price for the CUCV was assumed to be $23,000.00

12. The Hummer, on the other hand, is an American Motors (AM) general product designed specifically for military use. The current US buy of 55,000 vehicles reportedly will cost 1.5 billion dollars in US currency (Reference 14). The above is $27,274.00 US per vehicle. Converting that value to Canadian dollars by multiplying by 1.35, a value of approximately $37,000.00 per vehicle is obtained.

13. Table I provides a summary of the acquisition costs, basic operations and maintenance costs and the maintenance labour that were used in developing the life cycle costs. The first column simply

indicates the cost categories. The second column of Table I indicates the costs and manpower requirements for the 1976 1¼-ton truck purchase. These columns indicate values for 1977, when the purchase was made and are those used in Reference 2. The third column provides an estimate of the 1985 costs, that is the estimated costs if these vehicles were repurchased in 1985. This column, with some exceptions, was obtained by multiplying the cost data in column 2 by 2.14359, a value obtained by assuming an average increase of 10% per year over the eight year period $[(1.10)^8]$. Two exceptions were the cost of vehicles (based on the current quoted price) in the non-recurring cost category and the cost of consumables in the recurring costs category. The latter is proportional to the ratio of vehicle costs for 1985 and 1977 (i.e. 1985 consumable costs = 1977 cost x 23,000.00/8,101.44). A third exception is the hourly wage of maintenance personnel (Repair Manpower) which is $33.90, the current value provided by the Directorate of Costing Services (D Cost S). It should be noted that the category Research and Development also includes Federal Sales Tax (Reference 2). The third section of the table refers to repair times and these are assumed to be the same for all commercial patterned vehicles as indicated in the table.

28 Oct. 85

TABLE I

PREDICTED FUTURE 5/4 TON TRUCK ACQUISITION COSTS

Equipment		1977 Commercial Truck Data	1985 Commercial Truck Data	1992 Commercial Truck Data	1992 SMP Truck Data	2002 Commercial Truck Data
Non-Recurring						
Res. & Dev.	$	$2100000.00	$5961903.07	$8964496.31	$14421146.24	$16054068.22
Vehicles	$/eqpt.	$8101.44	$23000.00	$34583.49	$55634.31	$61933.84
Disposal	$/eqpt.	$0.00	$0.00	$0.00	$0.00	$0.00
Manpower(O)	$/eqpt.	$88.05	$188.74	$283.80	$283.80	$508.24
Documents(O)	$/eqpt.	$28.17	$60.38	$90.80	$90.80	$162.60
Operations(O)	$/eqpt.	$10.00	$21.44	$32.23	$32.23	$57.72
Comsumables(O)	$/eqpt.	$100.00	$214.36	$322.32	$322.32	$577.22
Manpower(M)	$/facil.	$8621.00	$18479.89	$27786.92	$27786.92	$49762.20
Documents(M)	$/facil.	$2759.00	$5914.16	$8892.72	$8892.72	$15925.52
Repair	$/facil.	$5758.62	$12344.12	$18560.99	$18560.99	$33239.95
Shipping	$/ton-km	$0.10	$0.21	$0.32	$0.32	$0.58
Documents(L)	$	$18000.00	$38584.62	$58016.99	$58016.99	$103899.73
Administration	$	$1189000.00	$2548728.51	$3832344.65	$3832344.65	$6863154.42
Recurring Costs						
Comsumables(O)	$/eqpt.	$296.00	$840.34	$1263.54	$2032.65	$2262.81
Manpower(O)	$/eqpt.	$1680.16	$3601.57	$5415.33	$5415.43	$9698.04
Facil. Maint.(O)	$/eqpt.	$100.00	$214.36	$322.31	$322.32	$577.21
Comsumables(M)	$/facil.	$40732.34	$115639.17	$173875.06	$279712.05	$311384.15
Repair Manpower	$/hour	$17.43	$33.90	$50.97	$50.97	$91.28
Facil. Maint.(M)	$/facil.	$10000.00	$21435.90	$32231.02	$32231.66	$57720.92
Manpower(L)	$	$0.00	$0.00	$0.00	$0.00	$0.00
Administration	$	$100000.00	$214359.00	$322310.19	$322316.62	$577209.21
Repair Times						
Sched. Rep.	hours	2.00	2.00	2.00	2.00	2.00
1st Line Rep.	hours	2.00	2.00	2.00	3.82	2.00
2nd Line Rep.	hours	8.00	8.00	8.00	13.49	8.00
3rd Line Rep.	hours	10.00	10.00	10.00	11.33	10.00
Replacement	hours	2.00	2.00	2.00	3.82	2.00
Administration	hours	5.00	5.00	5.00	5.00	5.00
R&O Turnaround	months	3.00	3.00	3.00	3.00	3.00

14. The fourth column of Table I contains the cost and maintenance labour data for the 1992 commercial truck (based on the CUCV). The cost figures in this column were obtained by multiplying the cost figures in column three by 1.50363 or (1.06^7) assuming the price index is increasing at 6% per year for a period of 7 years. Note that the values for repair time remain the same as for the earlier years.

15. The fifth column contains the cost and maintenance labour data used for the 1992 standard military patterned vehicle. The cost figures were assumed to be the same as those for the 1992 commercial truck with the following exceptions:

a. Vehicle costs were the 1985 cost multiplied by 1.50363
= 37,000 x 1.50363 = 55,634.31.

b. Costs for Research and Development were proportional to the cost of the vehicles
= 8,964,496.31 x 55,634.31/34,583.48 = $14,421,146.24.

c. Recurring consumable costs were proportional to the cost of the vehicles
(i) Consumables (O) = 1,263.54 x 1.609 = $2,032.65
(ii) Consumables (M) = 173,875.06 x 1.609 = $279,712.05.

16. The repair time estimates in column 5 of Table I were based on data from Reference 4. This reference indicates that a study performed by analysts at 202 Base Workshop compared the respective amounts of labour required. The data derived are indicated in Table II below.

TABLE II
COMPARISON OF LABOUR REQUIREMENTS

Repair Level	Commercial Truck Work Units	Military Truck Work Units
1st Line	5.5	10.5
2nd Line	7.0	11.8
3rd Line	1.5	1.7
Aggregate	14.0	24.0

17. The repair times for each of the line items in column 5 were modified according to the above ratios (i.e. 1st line = 2.00 x 10.5/5.5 = 3.82). It may be of some interest to note that in June 1974, when Reference 4 was written, the estimated values for the commercial truck and the SMP were $6,485.00 and $10,494.00 respectively. Assuming that the ratio still holds and based on the $23,000.00 price for the CUCV, the cost of the SMP should be = 23,000.00 x 10,494/6,485 = $37,218.50. This value agrees fairly well with the $37,000.00 estimate made earlier in this study.

18. The last column of Table I contains the basic cost and repair time data for the purchase of the commercial replacement vehicle in 2002. Note that the commercial vehicles have been assumed to have a useful life of ten years, whereas the SMPs are assumed to be capable of operation for twenty years. Therefore the study considers the requirement to buy two fleets of commercial trucks versus one for the SMP. The cost values in this column were obtained by multiplying the cost values in column 3 by 1.79085 $[(1.06)^{10}]$ based on an annual growth rate of 6% for a ten year period.

19. There is some evidence to indicate that the manpower requirements per 1,000 kilometers of travel go up markedly as the vehicle gets older. In fact, Reference 4 indicates that the lifetime average for the commercial patterned vehicle is 8.6 hours per 1,000 Km (based on a seven year life) and the SMP is 23.4 hours per 1,000 Km (based on a 14 year life). Although the trend is recognized, apart from the increase in the ratio of differences in work units (para 16 above) no allowance has been made for the expected increase in maintenance labour requirements during the latter part of life cycle of the SMP.

DISCUSSION OF RESULTS

20. Annexes B, C and D contain the life cycle cost data for the 1992 commercial truck, the 1992 SMP and the 2002 commercial truck respectively. The yearly expenditures for the two options are provided in Table III. These values reflect cash flow costs in the year in which they occurred.

28 Oct. 85

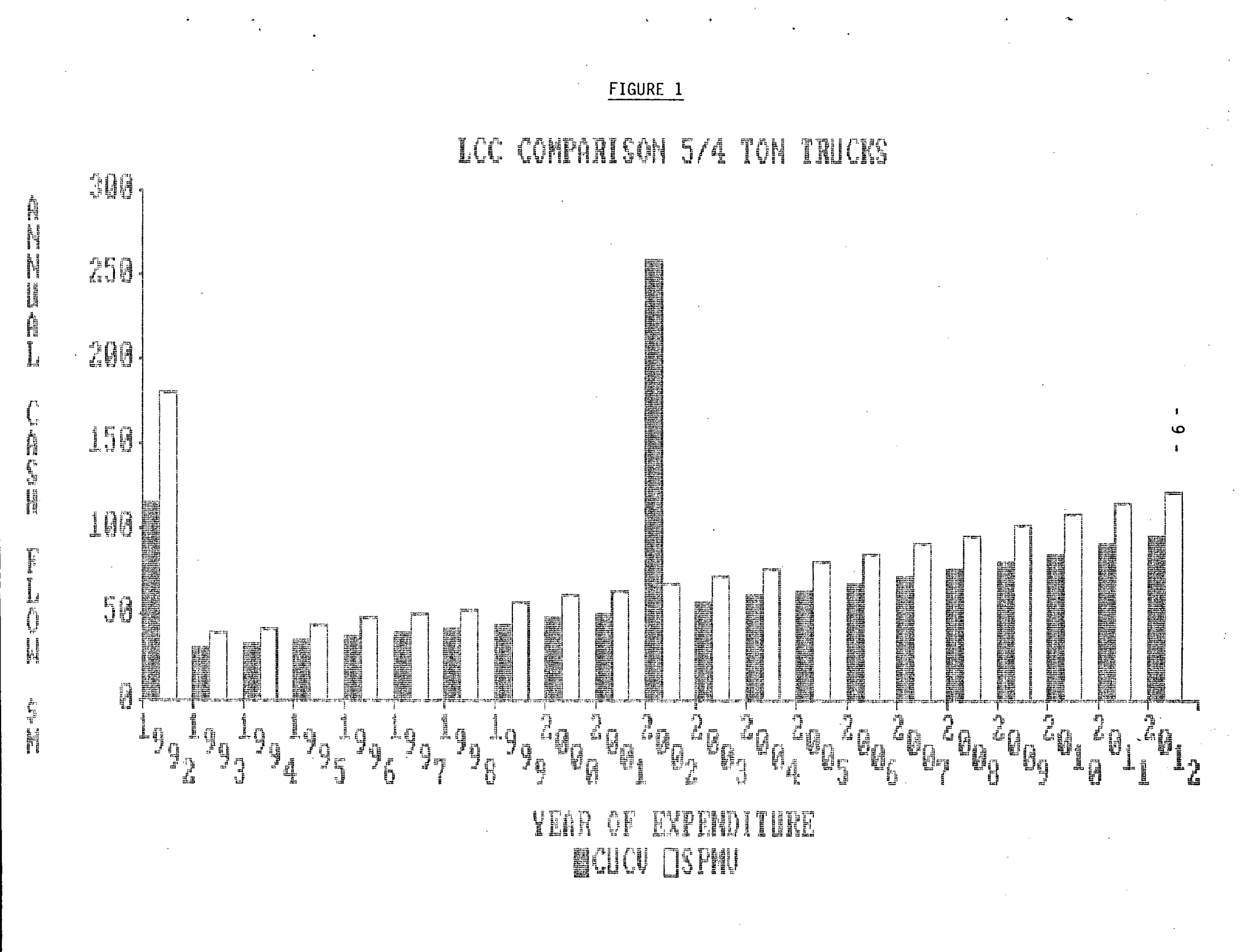
TABLE III

ANNUAL COST SUMMARY -COMMERCIAL vs SMP

(Millions of Dollars)

TYPE	YEAR	COMMERCIAL VEHICLE ANNUAL COST ($)	COMMERCIAL VEHICLE CUMULATIVE COST ($)	SMP VEHICLE ANNUAL COST ($)	SMP VEHICLE CUMULATIVE COST ($)	DIFFERENCES ANNUAL COST ($)	DIFFERENCES CUMULATIVE COST ($)
Acquisition	1992	$115.25		$180.62		$65.37	
O & M	1992	$32.15	$147.40	$40.55	$221.17	$8.39	$73.76
O & M	1993	$34.08	$181.49	$42.98	$264.15	$8.90	$82.66
O & M	1994	$36.13	$217.61	$45.56	$309.70	$9.43	$92.09
O & M	1995	$38.29	$255.91	$48.29	$358.00	$10.00	$102.09
O & M	1996	$40.59	$296.50	$51.19	$409.19	$10.60	$112.69
O & M	1997	$43.03	$339.53	$54.26	$463.45	$11.23	$123.92
O & M	1998	$45.61	$385.14	$57.52	$520.96	$11.91	$135.82
O & M	1999	$48.35	$433.48	$60.97	$581.93	$12.62	$148.45
O & M	2000	$51.25	$484.73	$64.62	$646.55	$13.38	$161.82
O & M	2001	$54.32	$539.05	$68.50	$715.05	$14.18	$176.00
Acquisition	2002	$206.19	$745.24	0	$715.05	($206.19)	($30.18)
O & M	2002	$57.55	$802.79	$72.61	$787.67	$15.06	($15.12)
O & M	2003	$61.01	$863.80	$76.97	$864.64	$15.96	$0.84
O & M	2004	$64.67	$928.46	$81.59	$946.22	$16.92	$17.76
O & M	2005	$68.55	$997.01	$86.48	$1032.71	$17.94	$35.69
O & M	2006	$72.66	$1069.67	$91.67	$1124.38	$19.01	$54.71
O & M	2007	$77.02	$1146.69	$97.17	$1221.55	$20.15	$74.86
O & M	2008	$81.64	$1228.33	$103.00	$1324.55	$21.36	$96.22
O & M	2009	$86.54	$1314.87	$109.18	$1433.73	$22.64	$118.86
O & M	2010	$91.73	$1406.60	$115.73	$1549.47	$24.00	$142.86
O & M	2011	$97.24	$1503.84	$122.68	$1672.14	$25.44	$168.30

FIGURE 1


LCC COMPARISON 5/4 TON TRUCKS
LCC $ THOUSANDS
300
250
200
150
100
50
0
FY 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
YEAR OF EXPENDITURE
CUCV
OSPMV

The 3rd and 4th columns indicate the annual and cumulative costs for the commercial truck option and the 5th and 6th columns the costs for the SMP option. One can compare costs in the years in which they occur by examining column 7 since a simple comparison on total costs may be deceiving. Column 8 indicates the differences in the cumulative costs on a year by year basis.

21. There is a year by year cost saving averaging $15.53 million for the CUCV in every year but the tenth when the requirement to replace this fleet imposes an expenditure differential for this option of $206.19 million. There is an overall saving of $168.30 million for the CUCV option which materializes in the last five years of the life cycle period. Figure 1 is a plot of the cost data in Table III indicating the annual cost expenditure graphically for the two options.

22. An examination of Table III or Figure 1 indicates that the SMP requires a major cash expenditure in the year of initial acquisition, whereas there are two major peaks (corresponding to the replacement times) in the case of the commercial truck.

CONCLUSIONS

23. There are some initial financial advantages in replacing the current 1¼-ton truck fleet with a vehicle similar to the CUCV since part of the major expenditures can be put off for ten years.

24. The data in Table III indicates that there is an over-all cost saving of about 10% in choosing the commercial over the SMP options. This assumes that maintenance labour does not increase excessively during the latter stages of SMP vehicle useful life. This later aspect should be examined further when more data becomes available.

REFERENCES

1. ORAE Project Report No. PR 316, "A Study of Load And Mobility Factors for the 1¼-Ton Truck Replacement Vehicle", by Maj H.L.G. Legault and Mr. D. Biggar, DLOR, August 1985.

2. ORAE Project Report No. PR 318, "Life Cycle Cost Analysis Applicable to the 1976 5/4-Ton Truck Purchase", by Mr. J. Laskoski D Log A, September 1985.

3. D Log A Staff Note 85/6, "Analysis of Cost Data for 1¼-Ton Trucks And Prediction of Future Costs", by Miss L.M. Jollota, September 1985.

4. D Log A Study entitled "Life Cycle Logistics Analysis For The 1¼-Ton Truck Program - Commercial Pattern and Military Pattern", August 1974.

5. "Proposed Methodology For Life Cycle Costing and Analysis of System Effectiveness", by K. Kiang, Bell-Northern Research, June 1975.

6. Technical Report No. 1, "Development of a Life Cycle Management Cost Model", by C.R. Brook, R.K. Barasia and R.B. Willians, Bell-Northern Research, June 1975.

7. Technical Report No. 2, "Methodology - Development of Life Cycle Management Cost Model", by R.K. Barasia and C.R. Brook, Bell-Northern Research, March 1978.

8. Technical Report No. 3, "Case Studies - Development of Life Cycle Management Cost Model", by R.K. Barasia and C.R. Brook, Bell-Northern Research, March 1978.

9. Technical Report No. 4, "User's Manual - Development of Life Cycle Management Cost Model", by R.K. Barasia and C.R. Brook, Bell-Northern Research, March 1978.

10. Technical Report No. 5, "Mathematical Model - Development of Life Cycle Management Cost Model", by R.K. Barasia, Bell-Northern Research, December 1977.

11. "A User's Guide For Data File Construction in the Bell-Northern Life Cycle Model", by A. Lizotte and I.W. Taylor, D Log A, June 1979.

12. ORAE Project Report No. PR 216, "Sparing Analysis of 5/4 and 5-Ton Trucks", by Mr. R. Bijoor, and Mr. M. Guibord, May 1983.

13. "The Coming Truck Shortage", by M. Duffy from the Military Logistics Forum, June 1985.

Annex A
to ORAE Project Report No. PR 335
dated October 1985

BASIC COST DATA

1. The 1976 cost data for the 5/4 ton truck were obtained from Reference 4 which was in turn modified where appropriate by the actual terms of the contract demand (CD Authorization TD 732710 dated 4 Feb 1975).

2. The major assumptions pertaining to the recurring operations and maintenance (O and M) costs were as follows:

a. Vehicle usage 6,200 km/yr (LOMMIS data).

b. Vehicle average speed (when in use) 30 km/hr.

c. Operations were based on a driver being with the vehicle while in use (6200 ÷ 30 = 207 hrs/yr).

d. Cost of operations manpower = ½ cost of technician manpower (1984/85 = $34.00/2 = $17.00 per hr).

e. Initial training both operations and maintenance $500,000.00 (split equally between the two).

f. Maintenance manpower requirement developed from LOMMIS data (Reference 16).

g. Spare parts cost developed from LOMMIS data ((Reference 16).

h. POL estimates are based on data from Reference 2 and extrapolated to reflect current costs.

First line consumables were estimated to cost $100.00 in FY 74/75 and scaled up at 10% per year for every year thereafter.

j. Technicians labour which was $13.01 in FY 1974/75 (D Cost S data) was scaled up at 10% per year. The calculated value is $33.97 for FY 1984/85 which compares favourably with $33.90, the current figure in use by D Cost S.

k. Consumable parts costs for repairables were taken directly from LOMMIS data for each year as these were incurred. Note that some work was done under contract (i.e. both material and labour supplied). This contract cost has been allotted to the two categories of labour and materials according to the ratio of material and labour provided for normal corrective maintenance.

m. Maintenance of operations facilities were assumed to be $100.00 per vehicle in 1977 and increased at 10% per year thereafter (actual costs are not available).

n. Maintenance of maintenance facilities were assumed to cost $1,000.00 per facility in 1977 and increased at 10% per year thereafter (actual costs are not available).

p. Transportation and packaging in the DND LCC has been assumed to be $0.10 per ton-kilometer in 1977 and increased at 10% per year thereafter (actual costs are not available). Estimated values were used in the Multiplan method.

q. Supply manpower has not been costed since actual figures were not available.

r. Disposal costs or credits have not been considered.

3. Note that the increase of 10% referred to in paragraphs 2.h, j, m, n, and p, were assumed to be 10% per year up to and including 1984 (see values quoted in Table I for 1985 commercial truck data). In the succeeding period the increase was reduced to 6% which is in line with current estimates of the increse in the price index.

Annex B
to ORAE Project Report No. PR 335
dated October 1985

DND LIFE CYCLE COST
1992 COMMERCIAL 1¼-TON TRUCK

1. The first few tables of this annex provide the input data used to run the DND LCC model. These tables provide the computer interpretation of the input data. The actual input data format is explained in Annex C of Reference 2.

2. Table B-1 provides the Hardware Breakdown Structure by providing a listing of the LRUs. In each case the line listing provides the nomenclature of the item and the detail on the cost, mean failures per million hours and the weight. The remaining portion of the line refers to the coding for the repair fraction, the repair time and the order and shipping time between repair echelons. The interpretation of the code is provided in Table B-2.

3. Table B-2 is the coded repair table. Each of these codes can vary from 1 to 10. They indicate the repair fraction (RFR) at the various repair levels (i.e. 1, 2 or 3), the Order-Shipping-Time (OST) between repair levels (in months), the repair time (RT) at each repair level in months, and the diagnostic time (in hours). In interpreting the code, it will be noted that, in this case, 80% of the repairs are done at 1st line, 10% at second line, and a further 10% at 3rd line. The average repair time at 1st line (RT1) is 3 days and the average repair time at 2nd line (RT2) is 0.5 months.

4. Table B-3 defines the Maintenance Logistics Support (MLS) system. It indicates distances from second line and depot facilities as well as indicating the number of prime equipments serviced at each second line facility. Note that in this program each base facility is treated as

having a first line repair capability. The major bases (Edmonton, Toronto, Montreal, Moncton and Lahr) have the second line capability. Third line is 202 Base Workshop.

5. The input data for test equipment has been essentially relegated a zero value and therefore is not a consideration in this study. It was shown in Table C-4 of Reference 2 indicating that the diagnosis time was 1 hour; there are no conditions where no fault was found; and the repair bases do not have any test equipment.

6. A list of the spares at each repair level location for each LRU has been initially assumed to be zero. This implies that for the initial condition there are no spare parts in the system. The computer program is used to optimize the number of spares in each location. These data are provided in Table B-5.

7. Table B-4 contains the cost and repair time data. Operational costs are based on numbers of equipment whereas maintenance costs are provided based on the number of facilities. The items are self explanatory. Note that there are separate values used for inflation rates of consumables, manpower, maintenance, transportation and administration. Since these are all the same value it will not affect the cases studied. This is one of the latest modifications that was made to the program. For a more detailed explanation, see Annex C of Reference 2.

8. Table B-5 indicates the spares requirement and the distribution of the spares for each of the LRUs considered.

9. Table B-6 contains an operational readiness summary for the 1992 truck fleet. The over-all readiness factor is 0.873.

10. Table B-7 contains a breakdown of costs with each year of expenditure for Operations, Maintenance, Logistics and Administration. These categories can now be increased at different rates if required.

11. Table B-8 provides the life cycle cost summary indicating the total acquisition (non-recurring) costs and the operations and maintenance (recurring) costs for the first year of operation. It also provides detail as to where these costs were incurred.

12. Table B-9 provides an annual cost summary for the acquisition costs and yearly expenditures. The second column indicates the expenditures required each year while the third column provides the accumulated total. Note that the increased costs in this column have been adjusted according to the increase in the price index. The older version of the program (see Table C-XIII of Reference 2) indicated a constant value based on the first year of operation in the second column. The table indicates that the total acquisition costs are approximately 115 million dollars; however, the total expenditures after ten years of operation are expected to be 539 million dollars.

1992 11/4 TON TRUCK - 22 Oct. 85

TABLE B-1

HARDWARE BREAKDOWN STRUCTURE

LRU	MOD	SUB	NAME	COST $	FAILRATE PER M HRS	WEIGHT KGS	CODES RT3	RFR3	DIAG	OST23	RT2	RFR2	OST12	RT1	RFR1
1			ENGINE ASSEMBLY	3200.	970.00	600.0	1	1	0	1	1	2	1	1	1
2			CYLINDER HEAD (Comp)	390.	1600.00	10.0	1	1	0	1	1	2	1	1	1
3			CARBURETOR	320.	1186.00	6.0	1	1	0	1	1	2	1	1	1
4			RADIATOR ASSY	430.	640.00	10.0	1	1	0	1	1	2	1	1	1
5			WATER PUMP	130.	1066.00	4.0	1	1	0	1	1	2	1	1	1
6			STARTER MOTOR	320.	1056.00	10.0	1	1	0	1	1	2	1	1	1
7			ALTERNATOR (12 V)	230.	640.00	10.0	1	1	0	1	1	2	1	1	1
8			ALTERNATOR (24 V,60	560.	1560.00	15.0	1	1	0	1	1	2	1	1	1
9			DISTRIBUTOR ASSEMBLY	300.	711.00	6.0	1	1	0	1	1	2	1	1	1
10			ALTERNATOR (24 V, 10	1014.	582.00	15.0	1	1	0	1	1	2	1	1	1
11			MOTOR ASSY W/S WIPER	120.	522.00	5.0	1	1	0	1	1	2	1	1	1
12			TRANSMISSION	1200.	914.00	110.0	1	1	0	1	1	2	1	1	1
13			TRANSFERE CASE	1980.	640.00	50.0	1	1	0	1	1	2	1	1	1
14			AXLE - FNT - 2" TUBE	4230.	582.00	70.0	1	1	0	1	1	2	1	1	1
15			AXLE 2.75" TUBE	3680.	205.00	60.0	1	1	0	1	1	2	1	1	1
16			AXLE ASSY REAR	4236.	522.00	70.0	1	1	0	1	1	2	1	1	1
17			PUMP ASSY PWRS	160.	522.00	15.0	1	1	0	1	1	2	1	1	1
18			STEERING GEAR	700.	640.00	17.0	1	1	0	1	1	2	1	1	1
19			BOOSTER ASSY	320.	492.00	10.0	1	1	0	1	1	2	1	1	1
20			CYLINDER ASSY (MASTE	150.	400.00	5.0	1	1	0	1	1	2	1	1	1
21			CYLINDER ASSY (RWBR)	40.	400.00	5.0	1	1	0	1	1	2	1	1	1
22			BLOWER ASSEMBLY	240.	492.00	10.0	1	1	0	1	1	2	1	1	1
23			FRONT CALIPERS	250.	800.00	8.0	1	1	0	1	1	2	1	1	1
24			HEAT DEFROSTER	400.	400.00	10.0	1	1	0	1	1	2	1	1	1

TABLE B-2

CODED REPAIR TABLE

PARAMETER	CODE	VALUE AT EACH 1ST LINE
		EDMO ESQU CHIL CALG MSJW SHLO WNPG TRTO PETW BRDN LNDN MSTG MONT KING OTWA VALC BGTV GAGT HLFX LSTG LAHR BADN CYPS
RFR1	0	0.000 0.000
RFR1	1	0.800 0.800
RT1	0	0.000 0.000
RT1	1	0.100 0.100
OST1	0	0.000 0.000
OST1	1	0.100 0.100

		VALUE AT EACH 2ND LINE
		EDMO TRTO MONT MCTN EROP
RFR2	0	0.000 0.000 0.000 0.000 0.000
RFR2	1	0.100 0.100 0.100 0.100 0.100
RFR2	2	1.000 1.000 1.000 1.000 1.000
RT2	0	0.000 0.000 0.000 0.000 0.000
RT2	1	0.500 0.500 0.500 0.500 0.500
OST2	0	0.000 0.000 0.000 0.000 0.000
OST2	1	1.500 1.500 1.500 1.500 1.500
OST2	2	2.000 2.000 2.000 2.000 2.000
OST2	3	2.500 2.500 2.500 2.500 2.500
LRU DIAG	0	0.000 0.000 0.000 0.000 0.000
DIAG	1	0.500 0.500 0.500 0.500 0.500

		VALUE AT THE 3RD LINE
		2028
RFR3	0	0.000
RFR3	1	0.100
RFR3	2	1.000
RT3	0	0.000
RT3	1	1.000

1992 11/4 TON TRUCK - 22 Oct. 85

TABLE B-3

MLS SYSTEM DIAGRAM

3RD LINE : 2028

IPE LOCI NO.	2ND LINE FACILITIES NO.	NAME	DIST FROM 3RD	1ST LINE FACILITIES NO.	NAME	DIST FROM 2ND	NO. OF EQPT	OPER. HR/MO	FR. OP. ACTIVITY
	1	EDMO	2880.0						
1				1	EDMO	0.0	64	1280.00	0.023
2				2	ESQU	1100.0	80	1600.00	0.028
3				3	CHIL	1100.0	87	1740.00	0.031
4				4	CALG	300.0	300	6000.00	0.106
5				5	MSJW	800.0	13	260.00	0.005
6				6	SHLO	1200.0	86	1720.00	0.030
7				7	WNPG	1160.0	92	1840.00	0.032
	2	TRTO	700.0						
8				1	TRTO	0.0	80	1600.00	0.028
9				2	PETW	500.0	513	10260.00	0.181
10				3	BRDN	120.0	36	720.00	0.013
11				4	LNDN	120.0	70	1400.00	0.025
	3	MONT	20.0						
12				1	MSTG	1.0	2	1.00	0.000
13				2	MONT	0.0	55	1100.00	0.019
14				3	KING	200.0	144	2880.00	0.051
15				4	OTWA	200.0	50	1000.00	0.018
16				5	VALC	200.0	516	10320.00	0.182
17				6	BGTV	400.0	14	280.00	0.005
	4	MCTN	1200.0						
18				1	GAGT	500.0	254	5080.00	0.090
19				2	HLFX	200.0	34	680.00	0.012
	5	EROP	4900.0						
20				1	LSTG	1.0	2	1.00	0.000
21				2	LAHR	0.0	227	4540.00	0.080
22				3	BADN	60.0	100	2000.00	0.035
23				4	CYPS	1700.0	20	440.00	0.008

TABLE B-4

MISC COST & TIME DATA

LIFE:	10	YR	
INFLATION RATES:			
CONSUMABLES:	6.00	%	
MANPOWER:	6.00	%	
MAINTENANCE:	6.00	%	
TRANSPORT:	6.00	%	
ADMIN:	6.00	%	
NON-RECURRING COSTS			
RES & DEV:	8964496.00		
HARDWARE:	34583.00	/EQ	
DISPOSAL:	0.00	/EQ	
MANPOWER:	284.00	/EQ	
DOCUMENT:	91.00	/EQ	
OPERATION:	32.00	/EQ	
CONSUMABLES:	322.00	/EQ	
MANPOWER:	27787.00	/FAC	
DOCUMENT:	8893.00	/FAC	
REPAIR:	18561.00	/FAC	
SHIPPING:	0.32	/TON-KM	
DOCUMENT:	58017.00		
ADMINISTRATION:	3832345.00		
OTHER COSTS	0.0		
RECURRING COSTS			
CONSUMABLES:	1264.00	/EQ	
MANPOWER:	5415.00	/EQ	
MAINTENANCE:	322.00	/EQ	
CONSUMABLES:	173875.00	/FAC	
REPAIR 0 :	51.00	/HR	
REPAIR 1 :	51.00	/HR	
REPAIR 2 :	51.00	/HR	
REPAIR 3 :	51.00	/HR	
MAINTENANCE:	32231.00	/FAC	
MANPOWER :	0.00		
ADMINISTRATION:	322310.00		
TIMES			
SCHED. REP.:	2.00	HR	
1ST LINE REP.:	2.00	HR(LRU)	
2ND LINE REP.:	8.00	HR(LRU)	8.00 HR(MOD)
3RD LINE REP.:	10.00	HR(LRU)	10.00 HR(MOD)
R&O TURN:	3.00	MO	
REPLACE:	2.00	HR	
ADMINISTRATION:	5.00	HR	

1992 11/4 TON TRUCK - 22 Oct. 85

TABLE B-5

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY	DISTRIBUTION
							2028
							EDMO TRTO MONT MCTN EROP
							EDMO ESQU CHIL CALG MSJW SHLO WNPG TRTO PETW BRDN LNDN MSTG MONT KING
							OTWA VALC BGTV GAGT HLFX LSTG LAHR BADN CYPS
LRU 1	0	1.00	3	0.295	661	25	0
ENGINE ASSEMBLY							2 2 2 0 1
							1 1 1 2 0 1 1 1 2 0 1 0 0 0
							1 2 0 2 0 1 1 0
LRU 2	0	1.00	4	0.862	1090	59	0
CYLINDER HEAD (Comp)							4 3 4 1 2
							2 2 2 3 1 2 2 2 5 1 2 0 1 2
							1 5 1 4 1 0 3 2 1
LRU 3	0	1.00	4	0.893	808	52	0
CARBURETOR							3 3 3 1 2
							1 2 2 3 1 2 2 2 4 1 1 0 1 2
							1 4 1 3 1 0 3 2 1
LRU 4	0	1.00	4	0.878	436	35	0
RADIATOR ASSY							2 2 2 1 1
							1 1 1 2 0 1 1 1 3 1 1 0 2 1 1 0
							1 3 1 2 1 1 2 1
LRU 5	0	1.00	4	0.958	726	57	0
WATER PUMP							3 3 3 1 2
							2 2 2 3 1 2 2 2 4 1 2 0 2 2
							2 5 1 3 1 0 3 2 1
LRU 6	0	1.00	4	0.915	726	51	0
STARTER MOTOR							3 2 3 1 2
							1 2 2 3 1 2 2 2 4 1 1 0 1 2
							1 4 1 3 1 0 3 2 1
LRU 7	0	1.00	3	0.918	436	38	0
ALTERNATOR (12 V)							2 2 2 1 1
							1 1 1 2 1 1 1 1 3 1 1 0 2 2 1
							1 3 1 2 1 0 2 2 1
LRU 8	0	1.00	4	0.831	1063	56	0
ALTERNATOR (24 V,60							4 3 3 1 2
							1 2 2 3 1 2 2 2 5 1 2 0 1 2
							1 5 1 3 1 0 3 2 1

TABLE B-5 (CONT'D)

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY		DISTRIBUTION
					DISTRIBUTOR ASSEMBLY			
LRU 9	0	1.00	3	0.881	485	37	0	2 2 2 1 1 1 1 1 2 1 1 1 1 3 1 1 0 2 1 3 1 1 0 1 2
					ALTERNATOR (24 V, 10			
LRU10	0	1.00	4	0.789	397	30	0	2 2 2 1 1 1 1 1 2 0 1 1 1 2 1 1 0 1 1 1 2 0 2 1 0 1 1 0
					MOTOR ASSY W/S WIPER			
LRU11	0	1.00	4	0.951	356	38	0	2 2 2 1 1 1 1 1 2 1 1 1 1 3 1 1 0 2 1 3 1 1 0 1 2
					TRANSMISSION			
LRU12	0	1.00	3	0.674	623	33	0	2 2 2 1 1 1 1 1 2 0 1 1 1 3 1 1 0 2 1 3 0 1 1
					TRANSFERE CASE			
LRU13	0	1.00	3	0.505	436	23	0	2 1 2 1 1 1 1 1 1 0 1 1 0 2 0 1 0 0 1 1 0 1 1 0 0 0 1
					AXLE - FNT - 2" TUBE			
LRU14	0	1.00	3	0.142	397	11	0	1 1 2 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 1 0 0 0 0 1
					AXLE 2.75" TUBE			
LRU15	0	1.00	3	0.452	140	7	0	1 1 1 0 1 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0
					AXLE ASSY REAR			
LRU16	0	1.00	3	0.172	356	10	0	1 1 1 0 1 0 0 0 1 0 0 0 1 0 1 0 0 0 0 1 0 1 0 0 0 0 1
					PUMP ASSY PWRS			
LRU17	0	1.00	4	0.945	356	37	0	2 2 2 1 1 1 1 1 2 1 1 1 1 3 1 1 0 2 1 3 1 1 0 1 2

TABLE B-5 (CONT'D)

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY		DISTRIBUTION
				STEERING GEAR				
LRU18	0	1.00	4	0.861	436	34	0	2 2 2 1 1 1 1 1 2 0 1 1 1 3 0 2 1 0 1 3 1 1 0 1 1 2 1 1 3 0 2 1 0 1 2 1 1
				BOOSTER ASSY				
LRU19	0	1.00	4	0.930	336	35	0	2 2 2 1 1 1 1 1 2 0 1 1 1 3 1 2 1 0 1 3 1 1 0 1 1 2 1 1
				CYLINDER ASSY (MASTE				
LRU20	0	1.00	3	0.969	273	36	0	2 1 2 1 1 1 1 1 2 1 1 1 3 1 2 1 0 1 3 1 1 0 1 2 1 1
				CYLINDER ASSY (RWBR)				
LRU21	0	1.00	4	0.958	273	44	0	2 2 2 1 1 1 2 2 3 1 2 2 1 3 1 2 1 0 1 3 1 1 0 2 2 1 1 2
				BLOWER ASSEMBLY				
LRU22	0	1.00	4	0.943	336	36	0	2 2 2 1 1 1 1 1 2 1 1 1 3 1 2 1 0 1 3 1 1 0 1 1 2 1 1
				FRONT CALIPERS				
LRU23	0	1.00	3	0.920	545	44	0	2 2 2 1 1 1 1 2 3 1 1 2 1 4 1 0 1 4 1 1 3 1 2 2 1 1 0 1 2
				HEAT DEFROSTER				
LRU24	0	1.00	3	0.921	273	31	0	2 1 2 1 1 1 1 1 2 0 1 1 1 2 0 2 1 0 1 2 1 1 0 1 1 2 1 1

1992 11/4 TON TRUCK - 22 Oct. 85

TABLE B-6

OPERATIONAL READINESS SUMMARY

PE LOCATION	MEAN UPTIME (210) HOURS			MEAN DOWNTIME (220) HOURS							OPERATIONAL READINESS
				CORRECTIVE (221)				SCHEDULED			
	MTBF (211)	MTBSM (214)	(210)	TE TIME (230)	SPARES (260)	REPLACE (240)	ADMIN (250)	(221)	(222)	(220)	EACH PE
EDMO	56.97	200.00	55.27	1.00	0.29	2.00	5.00	8.29	4.00	8.16	0.8714
ESQU	56.97	200.00	55.27	1.00	0.26	2.00	5.00	8.26	4.00	8.14	0.8717
CHIL	56.97	200.00	55.27	1.00	0.26	2.00	5.00	8.26	4.00	8.14	0.8717
CALG	56.97	200.00	55.27	1.00	0.11	2.00	5.00	8.11	4.00	7.99	0.8737
MSJW	56.97	200.00	55.27	1.00	0.88	2.00	5.00	8.88	4.00	8.73	0.8636
SHLO	56.97	200.00	55.27	1.00	0.27	2.00	5.00	8.27	4.00	8.14	0.8716
WNPG	56.97	200.00	55.27	1.00	0.27	2.00	5.00	8.27	4.00	8.14	0.8716
TRTO	56.97	200.00	55.27	1.00	0.27	2.00	5.00	8.27	4.00	8.14	0.8716
PETW	56.97	200.00	55.27	1.00	0.10	2.00	5.00	8.10	4.00	7.98	0.8739
BRDN	56.97	200.00	55.27	1.00	0.48	2.00	5.00	8.48	4.00	8.35	0.8687
LNDN	56.97	200.00	55.27	1.00	0.28	2.00	5.00	8.28	4.00	8.15	0.8714
MSTG	2278.94	8000.00	2210.84	1.00	2.22	2.00	5.00	10.22	4.00	10.03	0.9955
MONT	56.97	200.00	55.27	1.00	0.48	2.00	5.00	8.48	4.00	8.35	0.8688
KING	56.97	200.00	55.27	1.00	0.14	2.00	5.00	8.14	4.00	8.02	0.8733
OTWA	56.97	200.00	55.27	1.00	0.47	2.00	5.00	8.47	4.00	8.34	0.8689
VALC	56.97	200.00	55.27	1.00	0.09	2.00	5.00	8.09	4.00	7.97	0.8740
BGTV	56.97	200.00	55.27	1.00	0.73	2.00	5.00	8.73	4.00	8.59	0.8654
GAGT	56.97	200.00	55.27	1.00	0.13	2.00	5.00	8.13	4.00	8.01	0.8734
HLFX	56.97	200.00	55.27	1.00	0.69	2.00	5.00	8.69	4.00	8.55	0.8661
LSTG	2278.94	8000.00	2210.84	1.00	2.31	2.00	5.00	10.31	4.00	10.12	0.9954
LAHR	56.97	200.00	55.27	1.00	0.13	2.00	5.00	8.13	4.00	8.00	0.8735
BADN	56.97	200.00	55.27	1.00	0.26	2.00	5.00	8.26	4.00	8.13	0.8717
CYPS	51.79	181.82	50.25	1.00	0.65	2.00	5.00	8.65	4.00	8.51	0.8552

OVERALL PRIME EQUIPMENT OPERATIONAL READINESS IN THE SYSTEM = 0.872873

TABLE B-7

SUMMARY OF RECURRING COSTS

YEAR	(160) OPERATING	(170) MAINTENANCE	(180) LOGISTICS	(190) ADMINISTRATION
1	$ 21.068389 M	$ 10.709512 M	$ 0.033195 M	$ 0.341649 M
2	$ 22.332493 M	$ 11.352082 M	$ 0.035187 M	$ 0.362148 M
3	$ 23.672442 M	$ 12.033208 M	$ 0.037298 M	$ 0.383876 M
4	$ 25.092789 M	$ 12.755200 M	$ 0.039536 M	$ 0.406909 M
5	$ 26.598356 M	$ 13.520512 M	$ 0.041908 M	$ 0.431323 M
6	$ 28.194258 M	$ 14.331743 M	$ 0.044422 M	$ 0.457203 M
7	$ 29.885914 M	$ 15.191647 M	$ 0.047088 M	$ 0.484635 M
8	$ 31.679068 M	$ 16.103146 M	$ 0.049913 M	$ 0.513713 M
9	$ 33.579813 M	$ 17.069335 M	$ 0.052908 M	$ 0.544536 M
10	$ 35.594601 M	$ 18.093495 M	$ 0.056082 M	$ 0.577208 M

1992 11/4 TON TRUCK - 22 Oct. 85

TABLE B-8

LIFE CYCLE COST SUMMARY

LCC: $ 539.050496 M LIFE: 10 YR

CONSUMABLES INFLATION: 6.00 %
MANPOWER INFLATION: 6.00 %
MAINTENANCE INFLATION: 6.00 %
TRANSPORT INFLATION: 6.00 %
ADMIN INFLATION: 6.00 %

NON-RECURRING(104): (PRESENT VALUE)			$ 115.251754 M
RES & DEV(105):			$ 8.964496
HARD. ACQ.(106):			$ 98.181137
DISPOSAL(107):			$ 0.000000
OPERATING(110):			$ 2.069631
MANPOWER(111):		$ 0.806276	
DOCUMENT(112):		$ 0.258349	
OPERATING(113):		$ 0.090848	
CONSUMABLES(114):		$ 0.914158	
OTHER COSTS(115):			$ 0.000000
MAINTENANCE(120):			$ 1.601989
MANPOWER(121):		$ 0.805823	
DOCUMENT(122):		$ 0.257897	
TEST EQUIPMENT(123):		$ 0.000000	
REP FACILITIES(124):		$ 0.538269	
LOGISTICS(130):			$ 0.602156
INITIAL SPARES(131):		$ 0.524520	
TRANSPORT(132):		$ 0.019619	
DOCUMENT(133):		$ 0.058017	
ADMINISTRATION(140):			$ 3.832345
RECURRING(150):			$ 30.332778 M/YEAR
OPERATING(160):			$ 19.875839
CONSUMABLES(161):		$ 3.588496	
MANPOWER(162):		$ 15.373185	
MAINTENANCE(163):		$ 0.914158	
MAINTENANCE(170):			$ 10.103313
CONSUMABLES(171):		$ 5.042375	
MANPOWER(172):		$ 4.126239	
SCHED. REPAIR:	$ 0.347261		
PE REPAIR:	$ 1.828538		
1ST REPAIR:	$ 0.975220		
2ND REPAIR:	$ 0.975220		
3RD REPAIR:	$ 0.000000		
MAINTENANCE(173):		$ 0.934699	
LOGISTICS(180):			$ 0.031316
SPARES REPLACE(181):		$ 0.000000	
TRANSPORT(182):		$ 0.031316	
MANPOWER(183):		$ 0.000000	
ADMINISTRATION(190):			$ 0.322310

OVERALL PRIME EQUIPMENT OPERATIONAL

TABLE B-9

ANNUAL COST SUMMARY

YEAR	ANNUAL COST	CUMULATIVE LCC (PRESENT VALUE)
0	$ 115.251754 M	$ 115.251754 M
1	32.152745	147.404500
2	34.081910	181.486410
3	36.126825	217.613234
4	38.294434	255.907568
5	40.592130	296.499768
6	43.027626	339.527396
7	45.609284	385.135680
8	48.345841	433.482520
9	51.246592	484.729112
10	54.321387	539.050496

Annex C
to ORAE Project Report No. PR 335
dated October 1985

DND LIFE CYCLE COST
2002 COMMERCIAL 1¼-TON TRUCK

1. The first few tables of this annex provide the input data used to run the DND LCC model. These tables provide the computer interpretation of the input data. The actual input data format is explained in Annex C of Reference 2.

2. Table C-1 provides the Hardware Breakdown Structure by providing a listing of the LRUs. In each case the line listing provides the nomenclature of the item and the detail on the cost, mean failures per million hours and the weight. The remaining portion of the line refers to the coding for the repair fraction, the repair time and the order and shipping time between repair echelons. The interpretation of the code is provided in Table C-2.

3. Table C-2 is the coded repair table. Each of these codes can vary from 1 to 10. They indicate the repair fraction (RFR) at the various repair levels (i.e. 1, 2 or 3), the Order-Shipping-Time (OST) between repair levels (in months), the repair time (RT) at each repair level in months, and the diagnostic time (in hours). In interpreting the code, it will be noted that, in this case, 80% of the repairs are done at 1st line, 10% at second line, and a further 10% at 3rd line. The average repair time at 1st line (RT1) is 3 days and the average repair time at 2nd line (RT2) is 0.5 months.

4. Table C-3 defines the Maintenance Logistics Support (MLS) system. It indicates distances from second line and depot facilities as well as indicating the number of prime equipments serviced at each second line facility. Note that in this program each base facility is treated as

having a first line repair capability. The major bases (Edmonton, Toronto, Montreal, Moncton and Lahr) have the second line capability. Third line is 202 Base Workshop.

5. The input data for test equipment has been essentially relegated a zero value and therefore is not a consideration in this study. It was shown in Table C-4 of Reference 2 indicating that the diagnosis time was 1 hour; there are no conditions where no fault was found; and the repair bases do not have any test equipment.

6. A list of the spares at each repair level location for each LRU has been initially assumed to be zero. This implies that for the initial condition there are no spare parts in the system. The computer program is used to optimize the number of spares in each location. These data are provided in Table C-5.

7. Table C-4 contains the cost and repair time data. Operational costs are based on numbers of equipment whereas maintenance costs are provided based on the number of facilities. The items are self explanatory. For a more detailed explanation, see Annex C of Reference 2.

8. Table C-5 indicates the spares requirement and the distribution of the spares for each of the LRUs considered.

9. Table C-6 contains an operational readiness summary for the 1992 truck fleet. The over-all readiness factor is 0.873.

10. Table C-7 contains a breakdown of costs with each year of expenditure for Operations, Maintenance, Logistics and Administration.

11. Table C-8 provides the life cycle cost summary indicating the total acquisition (non-recurring) costs and the operations and maintenance (recurring) costs for the first year of operation. It also provides detail as to where these costs were incurred.

12. Table C-9 provides an annual cost summary for the acquisition costs and yearly expenditures. The first column indicates the expenditures required each year while the second column provides the accumulated total. The table indicates that the total acquisition costs are approximately 206 million dollars; however, the total expenditures after ten years of operation are expected to be 965 million dollars.

2002 11/4 TON TRUCK - 22 Oct 85

TABLE C-1

HARDWARE BREAKDOWN STRUCTURE

LRU	MOD	SUB	NAME	COST $	FAILRATE PER M HRS	WEIGHT KGS	CODES RT3	RFR3	DIAG	OST23	RT2	RFR2	OST12	RT1	RFR1
1			ENGINE ASSEMBLY	5767.	970.00	600.0	1	1	0	1	1	2	1	1	1
2			CYLINDER HEAD (Comp)	702.	1600.00	10.0	1	1	0	1	1	2	1	1	1
3			CARBURETOR	576.	1186.00	6.0	1	1	0	1	1	2	1	1	1
4			RADIATOR ASSY	774.	640.00	10.0	1	1	0	1	1	2	1	1	1
5			WATER PUMP	234.	1056.00	4.0	1	1	0	1	1	2	1	1	1
6			STARTER MOTOR	577.	1066.00	10.0	1	1	0	1	1	2	1	1	1
7			ALTERNATOR (12 V)	414.	640.00	10.0	1	1	0	1	1	2	1	1	1
8			ALTERNATOR (24 V,60	1368.	1560.00	15.0	1	1	0	1	1	2	1	1	1
9			DISTRIBUTOR ASSEMBLY	540.	711.00	6.0	1	1	0	1	1	2	1	1	1
10			ALTERNATOR (24 V, 10	1825.	582.00	15.0	1	1	0	1	1	2	1	1	1
11			MOTOR ASSY W/S WIPER	216.	522.00	5.0	1	1	0	1	1	2	1	1	1
12			TRANSMISSION	2160.	914.00	110.0	1	1	0	1	1	2	1	1	1
13			TRANSFERE CASE	3564.	640.00	50.0	1	1	0	1	1	2	1	1	1
14			AXLE - FNT - 2" TUBE	7614.	582.00	70.0	1	1	0	1	1	2	1	1	1
15			AXLE 2.75" TUBE	5624.	205.00	60.0	1	1	0	1	1	2	1	1	1
16			AXLE ASSY REAR	7625.	522.00	70.0	1	1	0	1	1	2	1	1	1
17			PUMP ASSY PWRS	288.	522.00	15.0	1	1	0	1	1	2	1	1	1
18			STEERING GEAR	1260.	640.00	17.0	1	1	0	1	1	2	1	1	1
19			BOOSTER ASSY	576.	492.00	10.0	1	1	0	1	1	2	1	1	1
20			CYLINDER ASSY (MASTE	270.	430.00	5.0	1	1	0	1	1	2	1	1	1
21			CYLINDER ASSY (RWBR)	72.	430.00	5.0	1	1	0	1	1	2	1	1	1
22			BLOWER ASSEMBLY	432.	492.00	10.0	1	1	0	1	1	2	1	1	1
23			FRONT CALIPERS	450.	830.00	8.0	1	1	0	1	1	2	1	1	1
24			HEAT DEFROSTER	720.	430.00	10.0	1	1	0	1	1	2	1	1	1

2302 11/4 TON TRUCK - 22 Oct 85

TABLE C-2

CODED REPAIR TABLE

VALUE AT EACH 1ST LINE

PARAMETER	CODE	EDMO ESQU CHIL CALG MSJW SHLO WNPG TRTO PETW BRDN LNDN MSTG MONT KING OTWA VALC BGTV GAGT HLFX LSTG LAHR BADN CYPS
RFR1	0	0.000 0.000
RFR1	1	0.800 0.800
RT1	0	0.000 0.000
RT1	1	0.100 0.100
OST1	0	0.000 0.000
OST1	1	0.100 0.100

VALUE AT EACH 2ND LINE

		EDMO TRTO MONT MCTN EROP
RFR2	0	0.000 0.000 0.000 0.000 0.000
RFR2	1	0.100 0.100 0.100 0.100 0.100
RFR2	2	1.000 1.000 1.000 1.000 1.000
RT2	0	0.000 0.000 0.000 0.000 0.000
RT2	1	0.500 0.500 0.500 0.500 0.500
OST2	0	0.000 0.000 0.000 0.000 0.000
OST2	1	1.500 1.500 1.500 1.500 1.500
OST2	2	2.000 2.000 2.000 2.000 2.000
OST2	3	2.500 2.500 2.500 2.500 2.500
LRU DIAG	0	0.000 0.000 0.000 0.000 0.000
DIAG	1	0.500 0.500 0.500 0.500 0.500

VALUE AT THE 3RD LINE

		2028
RFR3	0	0.000
RFR3	1	0.100
RFR3	2	1.000
RT3	0	0.000
RT3	1	1.000

2002 11/4 TON TRUCK - 22 Oct 85

TABLE C-3

MLS SYSTEM DIAGRAM

3RD LINE : 202B

IPE LOCI NO.	2ND LINE FACILITIES NO.	NAME	DIST FROM 3RD	1ST LINE FACILITIES NO.	NAME	DIST FROM 2ND	NO. OF EQPT	OPER. HR/MO	FR. OP. ACTIVITY
	1	EDMO	2980.0						
1				1	EDMO	0.0	64	1280.00	0.023
2				2	ESQU	1100.0	80	1600.00	0.028
3				3	CHIL	1100.0	87	1740.00	0.031
4				4	CALG	300.0	300	6000.00	0.106
5				5	MSJW	800.0	13	260.00	0.005
6				6	SHLO	1200.0	86	1720.00	0.030
7				7	WNPG	1160.0	92	1840.00	0.032
	2	TRTO	700.0						
8				1	TRTO	0.0	80	1600.00	0.028
9				2	PETW	500.0	513	10260.00	0.181
10				3	BRDN	120.0	36	720.00	0.013
11				4	LNDN	120.0	70	1400.00	0.025
	3	MONT	20.0						
12				1	MSTG	1.0	2	1.00	0.000
13				2	MONT	0.0	55	1100.00	0.019
14				3	KING	200.0	144	2880.00	0.051
15				4	OTWA	200.0	50	1000.00	0.018
16				5	VALC	200.0	516	10320.00	0.182
17				6	BGTV	400.0	14	280.00	0.005
	4	MCTN	1200.0						
18				1	GAGT	500.0	254	5080.00	0.090
19				2	HLFX	200.0	34	680.00	0.012
	5	EROP	4900.0						
20				1	LSTG	1.0	2	1.00	0.000
21				2	LAHR	0.0	227	4540.00	0.080
22				3	BADN	60.0	100	2000.00	0.035
23				4	CYPS	1700.0	20	440.00	0.008

TABLE C-4

MISC COST & TIME DATA

LIFE:	10	YR		
INFLATION RATES:				
CONSUMABLES:	6.00	%		
MANPOWER:	6.00	%		
MAINTENANCE:	6.00	%		
TRANSPORT:	6.00	%		
ADMIN:	6.00	%		
NON-RECURRING COSTS				
RES & DEV:	**********			
HARDWARE:	61934.00	/EQ		
DISPOSAL:	0.00	/EQ		
MANPOWER:	508.00	/EQ		
DOCUMENT:	163.00	/EQ		
OPERATION:	58.00	/EQ		
CONSUMABLES:	577.00	/EQ		
MANPOWER:	49762.00	/FAC		
DOCUMENT:	15926.00	/FAC		
REPAIR:	33240.00	/FAC		
SHIPPING:	0.58	/TON-KM		
DOCUMENT:	103900.00			
ADMINISTRATION:	6863154.00			
OTHER COSTS	0.0			
RECURRING COSTS				
CONSUMABLES:	2263.00	/EQ		
MANPOWER:	9698.00	/EQ		
MAINTENANCE:	577.00	/EQ		
CONSUMABLES:	311384.00	/FAC		
REPAIR 0 :	91.00	/HR		
REPAIR 1 :	91.00	/HR		
REPAIR 2 :	91.00	/HR		
REPAIR 3 :	91.00	/HR		
MAINTENANCE:	57721.00	/FAC		
MANPOWER :	0.00			
ADMINISTRATION:	577209.00			
TIMES				
SCHED. REP.:	2.00	HR		
1ST LINE REP.:	2.00	HR(LRU)		
2ND LINE REP.:	8.00	HR(LRU)	8.00	HR(MOD)
3RD LINE REP.:	10.00	HR(LRU)	10.00	HR(MOD)
R&O TURN:	3.00	MO		
REPLACE:	2.00	HR		
ADMINISTRATION:	5.00	HR		

2302 11/4 TON TRUCK - 22 Oct 85

TABLE C-5

SPARING SUMMARY

ITEM ID	ND	TYP	NI	SYS OR	DEM/YR	QTY	DISTRIBUTION
							2028 EDMO TRTO MONT MCTN EROP EDMO ESQU CHIL CALG MSJW SHLO WNPG TRTO PETW BRDN LNDN MSTG MONT KING OTWA VALC BGTV GAGT HLFX LSTG LAHR BADN CYPS
					ENGINE ASSEMBLY		
LRU 1	0	1.00	3	0.054	661	15	0
							2 1 2 0 1 0 0 0 1 0 0 0 0 2 0 0 0 1 0 2 0 1 0 0 1 1 0
					CYLINDER HEAD (Comp)		
LRU 2	0	1.00	4	0.775	1090	54	0
							4 3 3 1 2 1 1 2 3 1 2 2 2 5 1 1 0 1 2 1 5 1 3 1 0 3 2 1
					CARBURETOR		
LRU 3	0	1.00	4	0.783	808	45	0
							3 2 3 1 2 1 1 1 3 1 1 1 1 4 1 1 0 1 2 1 4 1 3 1 0 2 2 1
					RADIATOR ASSY		
LRU 4	0	1.00	4	0.809	436	32	0
							2 2 2 1 1 1 1 1 2 0 1 1 1 2 1 1 0 1 1 1 2 0 2 1 0 2 1 1
					WATER PUMP		
LRU 5	0	1.00	4	0.927	726	52	0
							3 2 3 1 2 1 2 2 3 1 2 2 2 4 1 2 0 1 2 1 4 1 3 1 0 3 2 1
					STARTER MOTOR		
LRU 6	0	1.00	4	0.822	726	44	0
							3 2 3 1 1 1 1 1 3 1 1 1 1 4 1 1 0 1 2 1 4 1 3 1 0 2 2 1
					ALTERNATOR (12 V)		
LRU 7	0	1.00	4	0.893	436	36	0
							2 2 2 1 1 1 1 1 2 1 1 1 1 3 1 1 0 1 1 1 3 1 2 1 0 2 1 1
					ALTERNATOR (24 V,60		
LRU 8	0	1.00	4	0.535	1063	43	0
							3 3 3 1 2 1 1 1 3 0 1 1 1 4 1 1 0 1 2 1 4 0 3 1 0 2 1 1

TABLE C-5 (CONT'D)

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY	DISTRIBUTION
				DISTRIBUTOR ASSEMBLY			
LRU 9	0	1.00	4	0.827	485	34	0 2 2 2 1 1 1 1 1 2 0 1 1 1 3 1 1 0 1 1 1 3 0 2 1 0 2 1 1
				ALTERNATOR (24 V, 10			
LRU10	0	1.00	3	0.560	397	23	0 2 1 2 1 1 1 1 1 1 0 1 1 1 2 0 1 0 0 1 0 2 0 1 0 0 1 1 0
				MOTOR ASSY W/S WIPER			
LRU11	0	1.00	4	0.945	356	37	0 2 2 2 1 1 1 1 1 2 1 1 1 1 3 1 1 0 1 2 1 3 1 2 1 0 2 1 1
				TRANSMISSION			
LRU12	0	1.00	4	0.458	623	28	0 2 2 2 1 1 1 1 1 2 0 1 1 1 2 0 1 0 1 1 1 2 0 2 0 0 1 1 0
				TRANSFERE CASE			
LRU13	0	1.00	3	0.203	436	15	0 2 1 2 0 1 0 0 0 1 0 0 0 0 2 0 0 0 0 1 0 2 0 1 0 0 1 1 0
				AXLE - FNT - 2" TUBE			
LRU14	0	1.00	3	0.079	397	8	0 1 1 1 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0
				AXLE 2.75" TUBE			
LRU15	0	1.00	3	0.213	140	3	0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
				AXLE ASSY REAR			
LRU16	0	1.00	3	0.112	356	8	0 1 1 1 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0
				PUMP ASSY PWRS			
LRU17	0	1.00	4	0.935	356	36	0 2 2 2 1 1 1 1 1 2 1 1 1 1 3 1 1 0 1 1 1 3 1 2 1 0 2 1 1

TABLE C-5 (CONT'D)

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY	DISTRIBUTION
				STEERING GEAR			
LRU18	0	1.00	4	0.645	436	27	0
							2 2 2 1 1
							1 1 1 2 0 1 1 1 2 0 1
							1 2 0 1 0 0 1 1 2 0 1
				BOOSTER ASSY			
LRU19	0	1.00	3	0.877	336	31	0
							2 1 2 1 1
							1 1 1 2 0 1 1 1 2 1 1
							1 2 0 2 1 0 2 1 1
				CYLINDER ASSY (MASTE			
LRU20	0	1.00	3	0.944	273	33	0
							2 1 2 1 1
							1 1 1 2 0 1 1 1 3 1 1
							1 2 1 2 1 0 2 1 1
				CYLINDER ASSY (RWBR)			
LRU21	0	1.00	3	0.972	273	37	0
							2 1 2 1 1
							1 1 1 2 1 1 1 1 3 1 1
							1 3 1 2 1 0 2 2 1
				BLOWER ASSEMBLY			
LRU22	0	1.00	4	0.889	336	32	0
							2 2 2 1 1
							1 1 1 2 0 1 1 1 2 1 1
							1 2 0 2 1 0 2 1 1
				FRONT CALIPERS			
LRU23	0	1.00	3	0.840	545	37	0
							2 2 2 1 1
							1 1 1 2 1 1 1 1 3 1 1
							1 3 1 2 1 0 2 1 1
				HEAT DEFROSTER			
LRU24	0	1.00	3	0.823	273	26	0
							2 1 2 1 1
							1 1 1 1 0 1 1 1 2 1 1
							1 2 0 1 0 0 1 1 2 0 1

2002 11/4 TON TRUCK - 22 Oct 85

TABLE C-6

OPERATIONAL READINESS SUMMARY

PE LOCATION	MEAN UPTIME (210) HOURS			MEAN DOWNTIME (220) HOURS							OPERATIONAL READINESS
					CORRECTIVE (221)				SCHEDULED		
	MTBF (211)	MTBSM (214)	(210)	TE TIME (230)	SPARES (260)	REPLACE (240)	ADMIN (250)	(221)	(222)	(220)	EACH PE
EDMO	56.97	200.00	55.27	1.00	0.51	2.00	5.00	8.51	4.00	8.38	0.8684
ESQU	56.97	200.00	55.27	1.00	0.53	2.00	5.00	8.53	4.00	8.39	0.8682
CHIL	56.97	200.00	55.27	1.00	0.52	2.00	5.00	8.52	4.00	8.38	0.8683
CALG	56.97	200.00	55.27	1.00	0.16	2.00	5.00	8.16	4.00	8.04	0.8730
MSJW	56.97	200.00	55.27	1.00	1.27	2.00	5.00	9.27	4.00	9.11	0.8585
SHLO	56.97	200.00	55.27	1.00	0.52	2.00	5.00	8.52	4.00	8.38	0.8683
WNPG	56.97	200.00	55.27	1.00	0.52	2.00	5.00	8.52	4.00	8.39	0.8682
TRTO	56.97	200.00	55.27	1.00	0.57	2.00	5.00	8.57	4.00	8.43	0.8677
PETW	56.97	200.00	55.27	1.00	0.17	2.00	5.00	8.17	4.00	8.04	0.8730
BRDN	56.97	200.00	55.27	1.00	0.80	2.00	5.00	8.80	4.00	8.66	0.8646
LNDN	56.97	200.00	55.27	1.00	0.57	2.00	5.00	8.57	4.00	8.44	0.8676
MSTG	2278.94	8000.00	2210.84	1.00	2.25	2.00	5.00	10.25	4.00	10.07	0.9955
MONT	56.97	200.00	55.27	1.00	0.58	2.00	5.00	8.58	4.00	8.44	0.8675
KING	56.97	200.00	55.27	1.00	0.32	2.00	5.00	8.32	4.00	8.19	0.8709
OTWA	56.97	200.00	55.27	1.00	0.57	2.00	5.00	8.57	4.00	8.43	0.8676
VALC	56.97	200.00	55.27	1.00	0.15	2.00	5.00	8.15	4.00	8.03	0.8732
BGTV	56.97	200.00	55.27	1.00	1.24	2.00	5.00	9.24	4.00	9.08	0.8598
GAGT	56.97	200.00	55.27	1.00	0.29	2.00	5.00	8.29	4.00	8.16	0.8713
HLFX	56.97	200.00	55.27	1.00	1.08	2.00	5.00	9.08	4.00	8.92	0.8610
LSTG	2278.94	8000.00	2210.84	1.00	2.36	2.00	5.00	10.36	4.00	10.17	0.9954
LAHR	56.97	200.00	55.27	1.00	0.34	2.00	5.00	8.34	4.00	8.21	0.8706
BADN	56.97	200.00	55.27	1.00	0.33	2.00	5.00	8.33	4.00	8.20	0.8708
CYPS	51.79	181.82	50.25	1.00	0.81	2.00	5.00	8.81	4.00	8.66	0.8529

OVERALL PRIME EQUIPMENT OPERATIONAL READINESS IN THE SYSTEM = 0.870985

TABLE C-7

SUMMARY OF RECURRING COSTS

YEAR	(160) OPERATING	(170) MAINTENANCE	(180) LOGISTICS	(190) ADMINISTRATION
1	$ 37.731105 M	$ 19.150543 M	$ 0.060166 M	$ 0.611842 M
2	$ 39.394971 M	$ 20.299576 M	$ 0.063776 M	$ 0.648552 M
3	$ 42.394670 M	$ 21.517550 M	$ 0.067602 M	$ 0.687465 M
4	$ 44.938350 M	$ 22.808604 M	$ 0.071659 M	$ 0.728713 M
5	$ 47.634651 M	$ 24.177120 M	$ 0.075958 M	$ 0.772436 M
6	$ 50.492731 M	$ 25.627747 M	$ 0.080516 M	$ 0.818782 M
7	$ 53.522294 M	$ 27.165412 M	$ 0.085347 M	$ 0.867909 M
8	$ 56.733633 M	$ 28.795337 M	$ 0.090467 M	$ 0.919983 M
9	$ 60.137650 M	$ 30.523057 M	$ 0.095895 M	$ 0.975182 M
10	$ 63.745910 M	$ 32.354441 M	$ 0.101649 M	$ 1.033693 M

2002 11/4 TON TRUCK - 22 Oct 85

TABLE C-8

LIFE CYCLE COST SUMMARY

LCC:	$ 964.738184 M	LIFE:	10 YR
		CONSUMABLES INFLATION:	6.00 %
		MANPOWER INFLATION:	6.00 %
		MAINTENANCE INFLATION:	6.00 %
		TRANSPORT INFLATION:	6.00 %
		ADMIN INFLATION:	6.00 %

NON-RECURRING(104): (PRESENT VALUE)		$ 206.185236 M	
RES & DEV(105):		$ 16.054068	
HARD. ACQ.(106):		$ 175.830626	
DISPOSAL(107):		$ 0.000000	
OPERATING(110):		$ 3.707734	
MANPOWER(111):	$ 1.442212		
DOCUMENT(112):	$ 0.462757		
OPERATING(113):	$ 0.164562		
CONSUMABLES(114):	$ 1.638103		
OTHER COSTS(115):		$ 0.000000	
MAINTENANCE(120):		$ 2.868912	
MANPOWER(121):	$ 1.443098		
DOCUMENT(122):	$ 0.461854		
TEST EQUIPMENT(123):	$ 0.000000		
REP FACILITIES(124):	$ 0.963960		
LOGISTICS(130):		$ 0.860742	
INITIAL SPARES(131):	$ 0.733448		
TRANSPORT(132):	$ 0.023394		
DOCUMENT(133):	$ 0.103900		
ADMINISTRATION(140):		$ 6.863154	
RECURRING(150):		$ 54.295902 M/YEAR	
OPERATING(160):		$ 35.595382	
CONSUMABLES(161):	$ 6.424657		
MANPOWER(162):	$ 27.532622		
MAINTENANCE(163):	$ 1.638103		
MAINTENANCE(170):		$ 18.066550	
CONSUMABLES(171):	$ 9.030136		
MANPOWER(172):	$ 7.362505		
SCHED. REPAIR:	$ 0.619623		
PE REPAIR:	$ 3.262685		
1ST REPAIR:	$ 1.740099		
2ND REPAIR:	$ 1.740099		
3RD REPAIR:	$ 0.000000		
MAINTENANCE(173):	$ 1.673909		
LOGISTICS(180):		$ 0.056760	
SPARES REPLACE(181):	$ 0.000000		
TRANSPORT(182):	$ 0.056760		
MANPOWER(183):	$ 0.000000		
ADMINISTRATION(190):		$ 0.577209	

OVERALL PRIME EQUIPMENT OPERATIONAL
READINESS IN THE SYSTEM = 0.870985

TABLE C-9

ANNUAL COST SUMMARY

YEAR	ANNUAL COST	CUMULATIVE LCC (PRESENT VALUE)
0	$ 206.185236 M	$ 206.185236 M
1	57.553656	263.738892
2	61.006876	324.745768
3	64.667288	389.413056
4	68.547325	457.960380
5	72.660165	530.620544
6	77.019775	607.640320
7	81.640962	689.281280
8	86.539420	775.820704
9	91.731785	867.552488
10	97.235693	964.788184

Annex D
to ORAE Project Report No. PR 335
dated October 1985

DND LIFE CYCLE COST
1992 SMP 1¼-TON TRUCK

1. The first few tables of this annex provide the input data used to run the DND LCC model. These tables provide the computer interpretation of the input data. The actual input data format is explained in Annex C of Reference 2.

2. Table D-1 provides the Hardware Breakdown Structure by providing a listing of the LRUs. In each case the line listing provides the nomenclature of the item and the detail on the cost, mean failures per million hours and the weight. The remaining portion of the line refers to the coding for the repair fraction, the repair time and the order and shipping time between repair echelons. The interpretation of the code is provided in Table D-2.

3. Table D-2 is the coded repair table. Each of these codes can vary from 1 to 10. They indicate the repair fraction (RFR) at the various repair levels (i.e. 1, 2 or 3), the Order-Shipping-Time (OST) between repair levels (in months), the repair time (RT) at each repair level in months, and the diagnostic time (in hours). In interpreting the code, it will be noted that, in this case, 80% of the repairs are done at 1st line, 10% at second line, and a further 10% at 3rd line. The average repair time at 1st line (RT1) is 3 days and the average repair time at 2nd line (RT2) is 0.5 months.

4. Table D-3 defines the Maintenance Logistics Support (MLS) system. It indicates distances from second line and depot facilities as well as indicating the number of prime equipments serviced at each second line facility. Note that in this program each base facility is treated as

having a first line repair capability. The major bases (Edmonton, Toronto, Montreal, Moncton and Lahr) have the second line capability. Third line is 202 Base Workshop.

5. The input data for test equipment has been essentially relegated a zero value and therefore is not a consideration in this study. It was shown in Table C-4 of Reference 2 indicating that the diagnosis time was 1 hour; there are no conditions where no fault was found; and the repair bases do not have any test equipment.

6. A list of the spares at each repair level location for each LRU has been initially assumed to be zero. This implies that for the initial condition there are no spare parts in the system. The computer program is used to optimize the number of spares in each location. These data are provided in Table C-5.

7. Table D-4 contains the cost and repair time data. Operational costs are based on numbers of equipment whereas maintenance costs are provided based on the number of facilities. The items are self explanatory. For a more detailed explanation, see Annex C of Reference 2.

8. Table D-5 indicates the spares requirement and the distribution of the spares for each of the LRUs considered.

9. Table D-6 contains an operational readiness summary for the 1992 truck fleet. The over-all readiness factor is 0.873.

10. Table D-7 contains a breakdown of costs with each year of expenditure for Operations, Maintenance, Logistics and Administration.

11. Table D-8 provides the life cycle cost summary indicating the total acquisition (non-recurring) costs and the operations and maintenance (recurring) costs for the first year of operation. It also provides detail as to where these costs were incurred.

12. Table D-9 provides an annual cost summary for the acquisition costs and yearly expenditures. The first column indicates the expenditures required each year while the second column provides the accumulated total. The table indicates that the total acquisition costs are approximately 180 million dollars; however, the total expenditures after twenty years of operation are expected to be 1,672 million dollars.

TABLE D-1

HARDWARE BREAKDOWN STRUCTURE

LRU	MOD	SUB	NAME	COST $	FAILRATE PER M HRS	WEIGHT KGS	CODES RT3	RFR3	DIAG	OST23	RT2	RFR2	OST12	RT1	RFR1
1			ENGINE ASSEMBLY	4800.	970.00	600.0	1	1	0	1	1	2	1	1	1
2			CYLINDER HEAD (Comp)	585.	1600.00	10.0	1	1	0	1	1	2	1	1	1
3			CARBURETOR	480.	1186.00	6.0	1	1	0	1	1	2	1	1	1
4			RADIATOR ASSY	645.	640.00	10.0	1	1	0	1	1	2	1	1	1
5			WATER PUMP	195.	1066.00	4.0	1	1	0	1	1	2	1	1	1
6			STARTER MOTOR	480.	1066.00	10.0	1	1	0	1	1	2	1	1	1
7			ALTERNATOR (12 V)	345.	640.00	10.0	1	1	0	1	1	2	1	1	1
8			ALTERNATOR (24 V,60	1140.	1560.00	15.0	1	1	0	1	1	2	1	1	1
9			DISTRIBUTOR ASSEMBLY	450.	711.00	6.0	1	1	0	1	1	2	1	1	1
10			ALTERNATOR (24 V, 10	1521.	582.00	15.0	1	1	0	1	1	2	1	1	1
11			MOTOR ASSY W/S WIPER	180.	522.00	5.0	1	1	0	1	1	2	1	1	1
12			TRANSMISSION	1800.	914.00	110.0	1	1	0	1	1	2	1	1	1
13			TRANSFERE CASE	2970.	640.00	50.0	1	1	0	1	1	2	1	1	1
14			AXLE - FNT - 2" TUBE	6345.	582.00	70.0	1	1	0	1	1	2	1	1	1
15			AXLE 2.75" TUBE	5520.	205.00	60.0	1	1	0	1	1	2	1	1	1
16			AXLE ASSY REAR	6354.	522.00	70.0	1	1	0	1	1	2	1	1	1
17			PUMP ASSY PWRS	240.	522.00	15.0	1	1	0	1	1	2	1	1	1
18			STEERING GEAR	1050.	640.00	17.0	1	1	0	1	1	2	1	1	1
19			BOOSTER ASSY	480.	492.00	10.0	1	1	0	1	1	2	1	1	1
20			CYLINDER ASSY (MASTE	225.	400.00	5.0	1	1	0	1	1	2	1	1	1
21			CYLINDER ASSY (RWBR)	60.	400.00	5.0	1	1	0	1	1	2	1	1	1
22			BLOWER ASSEMBLY	360.	492.00	10.0	1	1	0	1	1	2	1	1	1
23			FRONT CALIPERS	375.	800.00	8.0	1	1	0	1	1	2	1	1	1
24			HEAT DEFROSTER	600.	400.00	10.0	1	1	0	1	1	2	1	1	1

TABLE D-2

CODED REPAIR TABLE

PARAMETER	CODE	VALUE AT EACH 1ST LINE
		EDMO ESQU CHIL CALG MSJW SHLO WNPG TRTO PETW BRDN LNDN MSTG MONT KING OTWA VALC BGTV GAGT HLFX LSTG LAHR BADN CYPS
RFR1	0	0.000 0.000
RFR1	1	0.800 0.800
RT1	0	0.000 0.000
RT1	1	0.100 0.100
OST1	0	0.000 0.000
OST1	1	0.100 0.100

		VALUE AT EACH 2ND LINE
		EDMO TRTO MONT MCTN EROP
RFR2	0	0.000 0.000 0.000 0.000 0.000
RFR2	1	0.100 0.100 0.100 0.100 0.100
RFR2	2	1.000 1.000 1.000 1.000 1.000
RT2	0	0.000 0.000 0.000 0.000 0.000
RT2	1	0.500 0.500 0.500 0.500 0.500
OST2	0	0.000 0.000 0.000 0.000 0.000
OST2	1	1.500 1.500 1.500 1.500 1.500
OST2	2	2.000 2.000 2.000 2.000 2.000
OST2	3	2.500 2.500 2.500 2.500 2.500
LRU DIAG	0	0.000 0.000 0.000 0.000 0.000
DIAG	1	0.500 0.500 0.500 0.500 0.500

		VALUE AT THE 3RD LINE
		2028
RFR3	0	0.000
RFR3	1	0.100
RFR3	2	1.000
RT3	0	0.000
RT3	1	1.000

TABLE D-3

MLS SYSTEM DIAGRAM

3RD LINE : 2028

IPE LOCI NO.	2ND LINE FACILITIES NO.	NAME	DIST FROM 3RD	1ST LINE FACILITIES NO.	NAME	DIST FROM 2ND	NO. OF EQPT	OPER. HR/MO	FR. OP. ACTIVITY
	1	EDMO	2380.0						
1				1	EDMO	0.0	64	1280.00	0.023
2				2	ESQU	1100.0	80	1600.00	0.028
3				3	CHIL	1100.0	87	1740.00	0.031
4				4	CALG	300.0	300	6000.00	0.106
5				5	MSJW	800.0	13	260.00	0.005
6				6	SHLO	1200.0	86	1720.00	0.030
7				7	WNPG	1160.0	92	1840.00	0.032
	2	TRTO	700.0						
8				1	TRTO	0.0	80	1600.00	0.028
9				2	PETW	500.0	513	10260.00	0.181
10				3	BRDN	120.0	36	720.00	0.013
11				4	LNDN	120.0	70	1400.00	0.025
	3	MONT	20.0						
12				1	MSTG	1.0	2	1.00	0.000
13				2	MONT	0.0	55	1100.00	0.019
14				3	KING	200.0	144	2880.00	0.051
15				4	OTWA	200.0	50	1000.00	0.018
16				5	VALC	200.0	516	10320.00	0.182
17				6	BGTV	400.0	14	280.00	0.005
	4	MCTN	1200.0						
18				1	GAGT	500.0	254	5080.00	0.090
19				2	HLFX	200.0	34	680.00	0.012
	5	EROP	4900.0						
20				1	LSTG	1.0	2	1.00	0.000
21				2	LAHR	0.0	227	4540.00	0.080
22				3	BADN	60.0	100	2000.00	0.035
23				4	CYPS	1700.0	20	440.00	0.008

TABLE D-4

MISC COST & TIME DATA

LIFE:	20	YR	
INFLATION RATES:			
CONSUMABLES:	6.00	%	
MANPOWER:	6.00	%	
MAINTENANCE:	6.00	%	
TRANSPORT:	6.00	%	
ADMIN:	6.00	%	
NON-RECURRING COSTS			
RES & DEV:	**********		
HARDWARE:	55634.00	/EQ	
DISPOSAL:	0.00	/EQ	
MANPOWER:	284.00	/EQ	
DOCUMENT:	91.00	/EQ	
OPERATION:	32.00	/EQ	
CONSUMABLES:	322.00	/EQ	
MANPOWER:	27787.00	/FAC	
DOCUMENT:	8893.00	/FAC	
REPAIR:	18561.00	/FAC	
SHIPPING:	0.32	/TON-KM	
DOCUMENT:	58017.00		
ADMINISTRATION:	3832345.00		
OTHER COSTS	0.0		
RECURRING COSTS			
CONSUMABLES:	2033.00	/EQ	
MANPOWER:	5415.00	/EQ	
MAINTENANCE:	322.00	/EQ	
CONSUMABLES:	279712.00	/FAC	
REPAIR 0 :	51.00	/HR	
REPAIR 1 :	51.00	/HR	
REPAIR 2 :	51.00	/HR	
REPAIR 3 :	51.00	/HR	
MAINTENANCE:	32231.00	/FAC	
MANPOWER :	0.00		
ADMINISTRATION:	322310.00		
TIMES			
SCHED. REP.:	2.00	HR	
1ST LINE REP.:	3.82	HR(LRU)	
2ND LINE REP.:	13.49	HR(LRU)	13.49 HR(MOD)
3RD LINE REP.:	11.33	HR(LRU)	11.33 HR(MOD)
R&O TURN:	3.00	MO	
REPLACE:	3.82	HR	
ADMINISTRATION:	5.00	HR	

SMP 11/4 TON TRUCK - 22 Oct. 85

TABLE D-5

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY	DISTRIBUTION
LRU 1	0	1.00	3	ENGINE ASSEMBLY 0.100	661	18	2028 EDMO TRTO MONT MCTN EROP 0 2 1 2 0 1 0 0 0 1 0 0 1 0 2 0 2 0
LRU 2	0	1.00	4	CYLINDER HEAD (Comp) 0.817	1090	56	EDMO ESQU CHIL CALG MSJW SHLO WNPG TRTO PETW BRDN LNDN MSTG MONT KING OTWA VALC BGTV GAGT HLFX LSTG LAHR BADN CYPS 0 1 2 0 0 0 1 2 4 3 3 1 2
LRU 3	0	1.00	4	CARBURETOR 0.818	808	47	1 2 2 2 5 1 2 0 1 2 1 5 1 3 1 3 2 1 3 2 3 1 2
LRU 4	0	1.00	4	RADIATOR ASSY 0.861	436	34	1 1 1 3 1 1 2 2 4 1 1 0 1 2 1 4 1 3 1 2 2 1 2 2 2 1 1
LRU 5	0	1.00	4	WATER PUMP 0.940	726	54	1 1 1 2 0 1 1 1 3 1 1 0 1 1 1 3 0 2 1 2 1 1 3 3 3 1 2
LRU 6	0	1.00	4	STARTER MOTOR 0.832	726	45	2 2 2 3 1 2 2 2 4 1 2 0 1 2 1 4 1 3 1 3 2 1 3 2 3 1 2
LRU 7	0	1.00	4	ALTERNATOR (12 V) 0.909	436	37	1 1 1 3 1 1 1 1 4 1 1 0 1 2 1 4 1 3 1 2 2 1 2 2 2 1 1
LRU 8	0	1.00	4	ALTERNATOR (24 V,60 0.562	1063	44	1 1 1 2 1 1 1 1 3 1 1 0 1 2 1 3 1 2 1 2 1 1 3 3 3 1 2
							1 1 1 3 0 1 1 1 4 1 1 0 1 2 1 4 1 3 1 2 1 1

TABLE D-5 (CONT'D)

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY		DISTRIBUTION
					DISTRIBUTOR ASSEMBLY			
LRU 9	0	1.00	3	0.881	485	37	0	2 2 2 1 1 1 1 1 1 1 1 0 1 2 1 1 0 1 2 1 3 1 2 1 0 2 1 1 1 3 1 2 1
					ALTERNATOR (24 V, 10			
LRU10	0	1.00	3	0.599	397	24	0	2 1 2 1 1 1 1 1 1 0 1 1 0 1 0 1 2 0 1 0 2 0 1 0 0 1 1 1 2 1 0
					MOTOR ASSY W/S WIPER			
LRU11	0	1.00	4	0.945	356	37	0	2 2 2 1 1 1 1 1 1 1 1 0 1 2 1 1 0 1 2 1 3 1 2 1 0 2 1 1 1 3 1 2 1
					TRANSMISSION			
LRU12	0	1.00	3	0.583	623	31	0	2 2 2 1 1 1 1 1 1 0 1 1 0 1 0 1 2 0 1 0 2 0 1 0 0 1 1 1 2 1 0
					TRANSFERE CASE			
LRU13	0	1.00	3	0.294	436	18	0	2 2 2 1 1 1 1 1 1 0 1 1 0 1 0 1 2 0 1 0 2 0 1 0 0 1 1 1 2 1 0
					AXLE - FNT - 2" TUBE			
LRU14	0	1.00	3	0.104	397	9	0	2 1 2 0 1 0 0 1 0 0 0 1 2 0 0 0 2 0 0 1 1 0 0 0 0 1 0 0 0 0 0 0
					AXLE 2.75" TUBE			
LRU15	0	1.00	3	0.327	140	5	0	1 1 1 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0
					AXLE ASSY REAR			
LRU16	0	1.00	3	0.143	356	9	0	1 1 1 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0
					PUMP ASSY PWRS			
LRU17	0	1.00	4	0.945	356	37	0	1 1 1 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0
								2 2 2 1 1 1 1 1 1 1 1 0 1 2 1 1 0 1 2 1 3 1 2 1 0 2 1 1 1 3 1 2 1

TABLE D-5 (CONT'D)

SPARING SUMMARY

ITEM ID	ND	TY2	NI	SYS OR	DEM/YR	QTY		DISTRIBUTION
				STEERING GEAR				
LRU18	0	1.00	4	0.782	436	31	0	2 2 2 1 1 1 1 1 2 0 1 1 1 2 1 1 0 1 1 1 2 0 2 1 0
				BOOSTER ASSY				
LRU19	0	1.00	4	0.889	336	32	0	2 2 2 1 1 1 1 1 2 0 1 1 1 2 1 1 0 1 1 1 2 0 2 1 1
				CYLINDER ASSY (MASTE				
LRU20	0	1.00	3	0.954	273	34	0	2 1 2 1 1 1 1 1 2 1 1 1 3 1 1 0 1 1 1 2 1 2 1 1
				CYLINDER ASSY (RWBR)				
LRU21	0	1.00	4	0.977	273	39	0	2 2 2 1 1 1 1 1 2 1 1 1 3 1 1 0 1 2 1 3 1 2 2 1
				BLOWER ASSEMBLY				
LRU22	0	1.00	4	0.903	336	33	0	2 2 2 1 1 1 1 1 2 0 1 1 1 2 1 1 0 1 1 1 3 0 2 1 1
				FRONT CALIPERS				
LRU23	0	1.00	3	0.854	545	38	0	2 2 2 1 1 1 1 1 2 1 1 1 3 1 1 0 1 2 1 3 1 2 2 1
				HEAT DEFROSTER				
LRU24	0	1.00	3	0.848	273	27	0	2 1 2 1 1 1 1 1 1 0 1 1 1 2 1 1 0 1 1 1 2 0 1 1 0

TABLE D-6

OPERATIONAL READINESS SUMMARY

PE LOCATION	MEAN UPTIME (210) HOURS			MEAN DOWNTIME (220) HOURS							OPERATIONAL READINESS
					CORRECTIVE (221)				SCHEDULED		
	MTBF (211)	MTBSM (214)	(210)	TE TIME (230)	SPARES (260)	REPLACE (240)	ADMIN (250)	(221)	(222)	(220)	EACH PE
EDMO	56.97	200.00	55.27	1.00	0.50	3.82	5.00	10.32	4.00	10.14	0.8450
ESQU	56.97	200.00	55.27	1.00	0.51	3.82	5.00	10.33	4.00	10.14	0.8450
CHIL	56.97	200.00	55.27	1.00	0.52	3.82	5.00	10.34	4.00	10.15	0.8449
CALG	56.97	200.00	55.27	1.00	0.16	3.82	5.00	9.98	4.00	9.80	0.8494
MSJW	56.97	200.00	55.27	1.00	1.13	3.82	5.00	10.95	4.00	10.75	0.8372
SHLO	56.97	200.00	55.27	1.00	0.52	3.82	5.00	10.34	4.00	10.15	0.8449
WNPG	56.97	200.00	55.27	1.00	0.32	3.82	5.00	10.14	4.00	9.95	0.8474
TRTO	56.97	200.00	55.27	1.00	0.31	3.82	5.00	10.13	4.00	9.95	0.8474
PETW	56.97	200.00	55.27	1.00	0.13	3.82	5.00	9.95	4.00	9.77	0.8498
BRDN	56.97	200.00	55.27	1.00	0.72	3.82	5.00	10.54	4.00	10.34	0.8424
LNDN	56.97	200.00	55.27	1.00	0.55	3.82	5.00	10.37	4.00	10.18	0.8445
MSTG	2278.94	8000.00	2210.84	1.00	2.25	3.82	5.00	12.07	4.00	11.83	0.9947
MONT	56.97	200.00	55.27	1.00	0.51	3.82	5.00	10.33	4.00	10.14	0.8450
KING	56.97	200.00	55.27	1.00	0.30	3.82	5.00	10.12	4.00	9.94	0.8476
OTWA	56.97	200.00	55.27	1.00	0.57	3.82	5.00	10.39	4.00	10.20	0.8442
VALC	56.97	200.00	55.27	1.00	0.11	3.82	5.00	9.93	4.00	9.75	0.8500
BGTV	56.97	200.00	55.27	1.00	0.95	3.82	5.00	10.77	4.00	10.57	0.8395
GAGT	56.97	200.00	55.27	1.00	0.19	3.82	5.00	10.01	4.00	9.83	0.8490
HLFX	56.97	200.00	55.27	1.00	0.94	3.82	5.00	10.76	4.00	10.56	0.8396
LSTG	2278.94	8000.00	2210.84	1.00	2.33	3.82	5.00	12.15	4.00	11.91	0.9946
LAHR	56.97	200.00	55.27	1.00	0.17	3.82	5.00	9.99	4.00	9.82	0.8492
BADN	56.97	200.00	55.27	1.00	0.32	3.82	5.00	10.14	4.00	9.96	0.8473
CYPS	51.79	181.82	50.25	1.00	0.81	3.82	5.00	10.63	4.00	10.43	0.8281

OVERALL PRIME EQUIPMENT OPERATIONAL READINESS IN THE SYSTEM = 0.848188

TABLE D-7

SUMMARY OF RECURRING COSTS

YEAR	(160) OPERATING	(170) MAINTENANCE	(180) LOGISTICS	(190) ADMINISTRATION
1	$ 23.382572 M	$ 16.788909 M	$ 0.033195 M	$ 0.341649 M
2	$ 24.785526 M	$ 17.796244 M	$ 0.035187 M	$ 0.362148 M
3	$ 26.272658 M	$ 18.864019 M	$ 0.037298 M	$ 0.383876 M
4	$ 27.849017 M	$ 19.995860 M	$ 0.039536 M	$ 0.406909 M
5	$ 29.519958 M	$ 21.195612 M	$ 0.041908 M	$ 0.431323 M
6	$ 31.291156 M	$ 22.467349 M	$ 0.044422 M	$ 0.457203 M
7	$ 33.168625 M	$ 23.815389 M	$ 0.047088 M	$ 0.484635 M
8	$ 35.158743 M	$ 25.244313 M	$ 0.049913 M	$ 0.513713 M
9	$ 37.268268 M	$ 26.758971 M	$ 0.052908 M	$ 0.544536 M
10	$ 39.504364 M	$ 28.364510 M	$ 0.056082 M	$ 0.577208 M
11	$ 41.874626 M	$ 30.066381 M	$ 0.059447 M	$ 0.611841 M
12	$ 44.387104 M	$ 31.870363 M	$ 0.063014 M	$ 0.648551 M
13	$ 47.050330 M	$ 33.782586 M	$ 0.066795 M	$ 0.687464 M
14	$ 49.873350 M	$ 35.809540 M	$ 0.070803 M	$ 0.728712 M
15	$ 52.865750 M	$ 37.958114 M	$ 0.075051 M	$ 0.772435 M
16	$ 56.037696 M	$ 40.235600 M	$ 0.079554 M	$ 0.818781 M
17	$ 59.399958 M	$ 42.649736 M	$ 0.084327 M	$ 0.867908 M
18	$ 62.963955 M	$ 45.208721 M	$ 0.089387 M	$ 0.919982 M
19	$ 66.741793 M	$ 47.921244 M	$ 0.094750 M	$ 0.975181 M
20	$ 70.746301 M	$ 50.796518 M	$ 0.100435 M	$ 1.033692 M

TABLE D-8

LIFE CYCLE COST SUMMARY

LCC:	$ 1672.142288 M	LIFE:	20 YR
		CONSUMABLES INFLATION:	6.00 %
		MANPOWER INFLATION:	6.00 %
		MAINTENANCE INFLATION:	6.00 %
		TRANSPORT INFLATION:	6.00 %
		ADMIN INFLATION:	6.00 %

NON-RECURRING(104): (PRESENT VALUE)			$ 180.621692 M	
RES & DEV(105):			$ 14.421146	
HARD. ACQ.(106):			$ 157.944926	
DISPOSAL(107):			$ 0.000000	
OPERATING(110):			$ 2.069631	
MANPOWER(111):	$ 0.806276			
DOCUMENT(112):	$ 0.258349			
OPERATING(113):	$ 0.090848			
CONSUMABLES(114):	$ 0.914158			
OTHER COSTS(115):			$ 0.000000	
MAINTENANCE(120):			$ 1.601989	
MANPOWER(121):	$ 0.805823			
DOCUMENT(122):	$ 0.257897			
TEST EQUIPMENT(123):	$ 0.000000			
REP FACILITIES(124):	$ 0.538269			
LOGISTICS(130):			$ 0.751656	
INITIAL SPARES(131):	$ 0.678780			
TRANSPORT(132):	$ 0.014859			
DOCUMENT(133):	$ 0.058017			
ADMINISTRATION(140):			$ 3.832345	
RECURRING(150):				$ 38.251250 M/YEAR
OPERATING(160):			$ 22.059030	
CONSUMABLES(161):	$ 5.771687			
MANPOWER(162):	$ 15.373185			
MAINTENANCE(163):	$ 0.914158			
MAINTENANCE(170):			$ 15.838594	
CONSUMABLES(171):	$ 8.111648			
MANPOWER(172):	$ 6.792247			
SCHED. REPAIR:	$ 0.347261			
PE REPAIR:	$ 2.937851			
1ST REPAIR:	$ 1.862670			
2ND REPAIR:	$ 1.644465			
3RD REPAIR:	$ 0.000000			
MAINTENANCE(173):	$ 0.934699			
LOGISTICS(180):			$ 0.031316	
SPARES REPLACE(181):	$ 0.000000			
TRANSPORT(182):	$ 0.031316			
MANPOWER(183):	$ 0.000000			
ADMINISTRATION(190):			$ 0.322310	

OVERALL PRIME EQUIPMENT OPERATIONAL READINESS IN THE SYSTEM = 0.848188

TABLE D-9

ANNUAL COST SUMMARY

YEAR	ANNUAL COST	CUMULATIVE LCC (PRESENT VALUE)
0	$ 180.621692 M	$ 180.621692 M
1	40.546325	221.168018
2	42.979105	264.147122
3	45.557851	309.704972
4	48.291322	357.996296
5	51.188802	409.185096
6	54.260130	463.445228
7	57.515738	520.960968
8	60.966682	581.927648
9	64.624683	646.552328
10	68.502164	715.054496
11	72.612295	787.666792
12	76.969032	864.635824
13	81.587174	946.223000
14	86.482405	1032.705408
15	91.671349	1124.376752
16	97.171632	1221.548384
17	103.001929	1324.550320
18	109.182045	1433.732368
19	115.732968	1549.465344
20	122.676946	1672.142288