Chapter D

Maintenance of refuse collection vehicles

Adrian Coad and others

It is a scene that is found all over the world. The Municipal garage is almost full with all kinds of unserviceable vehicles - some modern and sophisticated, whilst others are ancient and battered; some need only minor attention whilst others are lacking their motors, rear axles or major body parts. Many of the vehicles have been there for months, some for years..
What are the different views of this situation?
The ***politicians*** *are unhappy because they are getting complaints that the refuse collection service is irregular and inadequate.*
The ***senior administrators*** *have the feeling that the engineers and mechanics do not really know their job or are not trying hard enough to keep all the vehicles going.*
The ***transport engineer*** *believes that the problems are not caused by him*

- *He wants to dispose of aged, unserviceable vehicles that are so old that spare parts for them are no longer available; these old trucks are taking up precious space, but the administrative procedures are so long and difficult that he does not have the time to do all this extra work to get rid of them.*
- *The modern, sophisticated vehicles are proving unsuited to the conditions they have to work in. He knew that there would be problems and would have advised against the purchase of the vehicles, but no-one asked for his opinion when the vehicles were ordered.*
- *He would like to make faster progress in the repair of vehicles, but he is hampered by the restrictions imposed by the trade unions on the working practices of his men, he spends too long filling in reports and records, and administrative arrangements leave him very little freedom to purchase the parts he needs and to send some vehicles to outside contractors for specialised repair and maintenance work.*
- *Often, when the transport engineer wants to take a vehicle into the garage for important maintenance, he is not able to get it because the operations department needs it urgently. The result is that the vehicle is not properly maintained and so it develops major faults.*
- *Some of the drivers abuse their vehicles and refuse to drive them as they should. They continue to drive their vehicles when they have developed serious mechanical faults, instead of stopping and contacting the garage. They do not report defects until serious damage has been done. The Conservancy department, which is responsible for the drivers, does nothing to rebuke or inform the drivers.*

What can be done?

D-1 INTRODUCTION

It is commonly acknowledged that a large proportion of many municipal budgets is spent on solid waste management, and a high proportion of the allocation to this field is spent on collection - usually considerably more than on disposal. The weak link in the chain, as far as collection is concerned, is often the vehicles. It is not uncommon for collection operations to be hampered by the lack of serviceable vehicles or by the inadequate performance of the vehicles. Maintenance is the key.

Refuse collection services must be reliable. If not, complaints and piles of uncollected waste accumulate at a disconcerting rate. Sometimes the failure of the service is due to labour disputes, but often it is the failure of the vehicles - a failure of maintenance.

It is easy to blame the engineer in charge of vehicles when there is a shortage of vehicles. Often it is not his fault that so many of his vehicles are unserviceable.. Unfortunately, the management environment is often constructed so that the maintenance engineer, who knows most about the problems, is not in a position to draw the attention of his seniors to the problems of vehicle maintenance because he fears that he will be accused of being unable to do his job. So no-one hears his insights, and he struggles on in silence to overcome difficulties (that could often have been avoided if others had listened to him), working long hours, receiving many complaints, and rarely being thanked for his strenuous behind-the-scenes efforts.

D-1.1 Is maintenance neglected?

Varying degrees of importance are attached to maintenance in different places, so it is not possible to generalise on the extent to which maintenance is neglected. There is no doubt that considerable thought and resources have been devoted to developing maintenance capabilities in Mumbai, and much can be learned from a study of the practices and systems in use in the Municipal workshops and garages in that city. Much of the rest of this chapter is devoted to learning from Mumbai's engineers. However, before the case of Mumbai is studied in detail, some general points will be made - some of these points could be used as a checklist.

1. *Are maintenance engineers involved* in the specification and selection of new vehicles? The experience and attention to detail of maintenance engineers can lead to vital insights when vehicles are being chosen. An experienced maintenance engineer can often predict with great accuracy what the weak points of a particular vehicle type will prove to be. Unfortunately it is common that no-one asks for his opinion when vehicles are being chosen, and when the vehicles have been purchased he is unable to draw his superiors' attention to the problems for fear of being criticised for being unable to do his job properly.
2. *Are operation and maintenance costs considered* when tenders are being evaluated? It seems common practice to consider only the purchase price of the vehicles. It would be much more reasonable to consider the operation and maintenance costs in addition to the capital costs, either as an annual cost for each year during the expected life of the vehicle, or as a present cost (i.e. the sum that must be set aside at the beginning to meet all purchase and operating costs throughout the life of the vehicle). Regrettably, in the current situation, it is difficult to obtain operating and maintenance costs from other organisations because engineers may fear the hostility of the supplying company if they release unfavourable figures. The other difficulty is that accounting procedures and records may not be organised in such a way that operating and maintenance costs for a particular vehicle can be abstracted. A later section in this chapter will discuss record keeping.
3. *Are sufficient resources allocated* to maintenance operations? Resources include manpower (especially skilled craftsmen and mechanics, and engineers), investment in buildings and machinery, and recurrent allocations for the purchase of spare parts and payment of outside contractors. The aim should be to minimise the total costs of the waste collection service, and this may sometimes require increasing the resources allocated to maintenance so that less capital expenditure (such as the purchasing of new vehicles) is required to maintain the desired level of service. (For example, a low allocation for maintenance may result in vehicle availabilities of only 50% - that is, an average of only 50% of the vehicles being available for duty on any particular day. Spending more on maintenance might lead to a higher availability figure of, say, 80%, so that more of the existing fleet are operational and therefore it is not necessary to purchase so many new vehicles.)

4. *Are administrative procedures appropriate*? It is necessary to have administrative procedures that prevent or discourage theft of tools and spare parts and that prevent unwise purchases and misuse of funds. These systems need to be evaluated from time to time to determine whether they are operating effectively without hindering the execution of maintenance work. There are stories from a variety of countries concerning bureaucratic practices that at least treble the time taken to do a certain maintenance task, and it seems to be common that bureaucratic delays result in the acquisition of spare parts from overseas taking four to six months. There was a case where the repair manuals for vehicles were kept at the head office rather than in the workshop, so that ordering a new spare part became a lengthy and disruptive operation - because there was no manual to indicate the number of a part that was required to execute a repair, it would often be necessary to take a second vehicle off the road, identical to the one under repair, and remove the corresponding part from the operational vehicle to show the parts supplier what precise component was necessary. Such practices are obviously counterproductive. Managers should be motivated to improve efficiency and to be willing to change practices.
5. *Does the management culture value maintenance*? Conventional university courses place little emphasis on maintenance, so engineers and managers may have little knowledge of maintenance issues unless they have made a special effort to learn from their colleagues or attend special courses. In solid waste management maintenance is a vital issue. Record keeping is an essential part of maintenance management, but mechanics tire of filling in forms unless they are convinced that the forms serve a useful function. Mechanics and engineers are more likely to be ready to fill in forms correctly and write thorough reports if they are aware that managers read them and act upon them. Senior managers should be aware of this need and ensure that their subordinates know that the reports they write are valued and used.

D-1.2 The two types of maintenance

(This section includes contributions from A. K. Sarkar.)

There are two ways of carrying out maintenance on vehicles and mechanical plant; they are known as *breakdown maintenance* and *preventive (*or *planned) maintenance*.

Breakdown maintenance involves taking no action till the machine fails to operate; it is only repaired after it has broken down. Preventive maintenance involves repairing the machine and replacing components before there is a failure, so that breakdowns become very rare.

There are situations in which breakdown maintenance is appropriate. Such situations are when a breakdown does not have any serious consequences, such as when there are many spare machines and only the component that has failed is affected. A simple example would be the failure of a light bulb in a room where there are many light bulbs so that the loss of illumination from one does not cause any inconvenience. There are many more situations where breakdown maintenance is being practised, but often this is by default, because of a failure of management. The practice of breakdown maintenance in the wrong situation can lead to unreliable services, extra expenditure and unnecessary emotional and physical stress for maintenance staff.

Preventive maintenance involves repair or replacement before failure occurs. As a result of such timely interventions machines are kept in good condition so that breakdowns are rare, services are seldom interrupted, maintenance work can be scheduled, and expenditure is less because less overtime is paid and repairs are made before defective components cause damage to other parts of the machine. Preventive maintenance also aims to reduce wear and tear, to cut down oil and fuel consumption, to minimise pollution, to extend the service life of the equipment and to promote reliability and safety of operation

An obvious example where preventive maintenance is essential is the engines of a passenger aeroplane. The consequences of failure are so serious that every reasonable precaution must be taken to avoid breakdown. The failure of a small component in an engine could lead to much more serious damage of other components - if the failed part breaks off other components or fractures a fuel line. Airlines strive to maintain regular schedules, and so want to schedule their maintenance work as much as possible. Airlines must be financially competitive, and so seek to reduce maintenance costs. For all these reasons it is essential that thorough preventive maintenance procedures be applied to aero engine maintenance. (In contrast with the engines, some airlines seem

to operate a policy of breakdown maintenance for their in-flight entertainment systems, not making any checks or repairs until a fault is reported and the aircraft is grounded for other reasons.)

An essential element of any preventive maintenance programme is lubrication. Without an adequate supply of oil with the correct properties, sliding parts wear more rapidly, and may overheat and seize. A lubricant serves the following purposes:

- It minimises friction
- It acts as a coolant
- It carries away metallic particles resulting from wear
- It reduces corrosion
- It minimises the formation of acids and foam.

To achieve these goals a lubricant should

- be very clean
- contain no solid particles
- be free of water
- contain no acids or alkalis
- have a definite viscosity, stability and pour point.

All lubricants lose these required properties with time, the period depending on the application in which they are used, and so they need to be changed at the appropriate intervals.

Preventive maintenance work may be carried out based on either condition monitoring or replacement schedules. Sometimes the wear on a component is gradual, and regular testing can indicate when breakdown is approaching. In such cases replacement or repair can be based on a measurement of wear or deterioration, and a regular schedule of condition monitoring is required. In other cases deterioration may be unpredictable (being either difficult or uneconomic to measure or coming without warning) and in such cases components should be replaced according to a schedule based on elapsed time or the degree of utilisation of the machine (such as kilometres travelled or hours of operation).

The degree to which preventive maintenance is practised varies according to need and cost. There is a continuum between breakdown and preventive maintenance and the appropriate point between these two must be chosen according to the consequences of failure.

The consequences of failure of refuse collection vehicles are serious. If a truck breaks down the regular collection service is interrupted, causing piles of wastes to accumulate and complaints from the public. The collection crews are idle if their vehicle is inoperative. Mechanics do not like working with vehicles that are loaded with decomposing garbage. Many types of refuse collection vehicles are sophisticated and expensive. The costs of maintaining refuse collection fleets are very high. For these reasons it is clearly appropriate to operate systems of preventive maintenance for refuse collection trucks.

The two types of maintenance can be characterised as shown in table D.1 below.

Table D.1 The characteristics of breakdown and preventive maintenance

Breakdown maintenance	Preventive maintenance
Easy to carry out	Needs corporate planning
Needs no planning	Needs trained staff
Low reliability	Needs regular monitoring
Overall more costly	Needs backup material
	High reliability
	Overall less costly

Preventive maintenance needs corporate planning to set up the schedules and to foster the culture of preventive maintenance - of operating according to records and plans and maintaining vehicles at prescribed intervals rather than when they appear defective.

Training is essential so that staff at all levels understand the reasons behind the practice of preventive maintenance. Mechanics who have spent most of their working lives responding to breakdowns may require intensive training and monitoring before they change their methods of working.

Monitoring of the system is vital, especially in the early stages. The need to monitor staff practices has already been mentioned, but there is also the need to review schedules and recommendations to ensure that they are appropriate to the vehicles in the actual working conditions. Schedules may need to be revised in the light of experience, if, for example breakdowns are still occurring when manufacturer's schedules are being adhered to. A key feature of preventive maintenance is the usage of reports and records to determine action.

The backup material that is required includes manufacturer's manuals and service modules and systems for reporting. There are computer software packages that are used to organise preventive maintenance for large vehicle fleets, but the same work can be done manually in an effective way.

There are three tiers of maintenance work -

(i) daily maintenance, which is normally performed by the driver,
(ii) scheduled maintenance, which is normally based on the kilometres run, and
(iii) annual maintenance, which may be the preparation for an annual roadworthiness test or in response to changing seasonal conditions.

Daily checks involve a visual check of the body, checking coolant and lubricant levels, and verifying that the tyre pressures and brakes are satisfactory. Scheduled maintenance involves a large number of tasks; these are described in a later section and in appendix DD-2.3. Seasonal maintenance may involve painting exposed steel with anti-corrosive paint and checking windscreen wipers before the wet season, cleaning the radiator inside and out before the hot season, or ensuring a sufficient concentration of antifreeze before subzero temperatures are expected.

Good, reliable record-keeping is an essential feature of any good preventive maintenance scheme. A key component of the records should be the *Equipment History form*, one of which is kept for every item of machinery (in this case for every vehicle). It details the specification of the equipment and all the maintenance work that has been done on the vehicle. The costs of all maintenance work, both spare parts and labour costs, should be recorded on this form. This information enables the effectiveness of the maintenance schedule and the maintenance work to be evaluated, allows checking that the vehicle has been serviced when it should have been, and enables computation of the true cost of running the vehicle - information that is very important when decisions are being made about the purchase of more vehicles of the same type. If maintenance costs for similar vehicles are very different, the reason may be the way in which the drivers treat their vehicles, and the driver whose vehicle needs more repairs may need retraining or disciplining. The introduction of such a system of record keeping may seem like an impossible task, and it will need considerable effort and perseverance to get it started, but once the system is working it becomes a comfortable routine to keep the records up to date. Information about Equipment History forms that are used in Mumbai is shown in Appendix DD-3.3.

The concept of preventive maintenance needs the support of the highest levels of management because there is often tension between the vehicle repair department and the user departments. The users may want vehicles on a day when they have been set aside for routine maintenance work. If the maintenance department is over-ruled and the vehicles go out for duty, it may prove impossible to service them at the required intervals so that the vehicles are operated until they break down and expensive repairs are required.

One of the major challenges to the engineer who runs a preventive maintenance scheme is the motivation of his workforce. How can he motivate them to perform every task seriously, and to complete the records accurately and in full? Training is the foundation - each employee must understand how to do his work effectively and why his role is important. Supervision and spot-checks (checking that levels are correct, parts replaced and components cleaned after a service is said to have been completed) are part of the answer. Building responsibility is another vital step. Mechanics can be made to feel more responsible by requiring them to write their names and signatures clearly on the report forms that describe the work they claim to have done. Another approach is to divide a large workforce into small teams, each responsible for particular vehicles, and to emphasise the link between the work done by the maintenance crew and the condition and serviceability of the small

number of vehicles that they are directly responsible for. Publishing monthly the availability figures for each team's vehicles could help to develop team spirit and a positive sense of competition between the teams.

D-2 MANAGING VEHICLE MAINTENANCE IN MUMBAI

The rest of this chapter is mostly concerned with the practice of vehicle maintenance in Mumbai. There is much to learn from the way maintenance is managed in that city. The system of record keeping is well developed, and the tables of information in the rest of this chapter and in the appendices can be regarded both as examples of data collection practice and as sources of information.

D-2.1 Maintenance infrastructure in Mumbai

Based on information collected by Mrs P Singh, Mr P Pahade and Mr V S Rao

For the purposes of solid waste management, Greater Mumbai was divided into two zones - City and Suburbs. Within the Solid Waste Management Department there was one central vehicle workshop in each zone - the *Unit Workshop* in the City and Santa Cruz in the Suburbs. Most major repairs were carried out at these workshops, and the central stores for spare parts are kept here. In addition there were garages where serviceable vehicles were kept and both major and minor maintenance was carried out. In the suburbs these garages were at Bandra, Malad, Borivali, Kurla, Chembur and Pantnagar.

The Transport Section of the Solid Waste Management Department was responsible for the maintenance of vehicles that were used for solid waste management, and also for vehicles that were used for the following departments: Roads, Health, Hospitals, Schools, Markets, Licences and Encroachment, Pest Control, Wards, and Accounts. This wide variety of functions called for a wide range of vehicle types, including VIP cars, minibuses, ambulances, tankers, breakdown trucks and many others. The range of vehicles used for solid waste collection included at least three types of compactor truck, open tipper trucks (or dumpers), conventional trucks, tractors (some with a container at the rear), JCBs, and jeeps. It was estimated that about 27% of the vehicles were connected with solid waste collection.

An Executive Engineer (Transport) was based at each workshop and responsible for each zone. He was assisted by four Assistant Engineers (who were responsible for two or three garages each). For each garage there was normally a Sub Engineer in charge, and he was assisted by Junior Engineers.

At the central workshop there were three major functions - administration (including preparing budgets, accounting and billing), central stores and vehicle maintenance. Major repairs, including replacement and reconditioning of units (motors, gearboxes, starters, dynamos, clutch pressure plates, water pumps etc.) were carried out at the central workshops, though the following specific tasks were sent out to subcontractors:

- repairs of diesel injector pumps
- repairs of hydraulic systems of compactor trucks
- tyre retreading, and
- minor machining.

Apart from the administrative side and the engineers already mentioned, the staffing at the Santa Cruz workshop was as follows:

- two sub-engineers, one responsible for maintenance and one for stores
- three junior engineers
- two clerks
- one technical assistant
- one foreman,
- one technical time keeper,
- three shop recorders,
- four store assistants, and
- 123 craftsmen and labourers.

The ratio of maintenance staff to vehicles at Santa Cruz was 1.3 : 1 - this is a norm agreed between the MCGM and the unions and includes para-technical staff such as time-keepers, shop recorders, store assistants etc. It must be remembered that most of the vehicles were much simpler than refuse compactors, so this ratio might need to be higher if only refuse trucks were being maintained. The number of staff employed was high compared to numbers employed in some other countries, but a detailed study of staff working patterns would be needed to determine whether the workshop was actually overmanned. Similarly, the balance between skilled and unskilled staff is another factor that is to be considered.

The stores section at the central workshops was responsible for procuring almost all the spares and consumables needed for vehicle maintenance (except mild steel plate, uniforms, bleaching powder and cotton waste). Items were classified into schedules according to the type of supplier (vehicle manufacturer, component manufacturer, authorised dealers etc.) and according to class based on value. Terms and conditions were negotiated with these suppliers to be valid for two years to avoid the time-wasting procedure of tendering for every purchase. Reordering of spares was carried out when the stock levels fell to a four month supply, with the aim of holding at least two months' stock at any time. The operation of any stores department can be monitored by ascertaining the number of requests for parts that have been satisfactorily met within a given time interval. Surveys of this type conducted on a regular basis indicate whether the stores are operating in a satisfactory way, and if the operation is deemed to be unsatisfactory, the reasons should be investigated. Possible causes may be a deterioration in the performance of suppliers (which would call for a revision of the reorder levels) or insufficient powers for the engineer in charge. Delays in the supply of spare parts result in expensive vehicles being unproductive for unnecessarily long periods of time, and perhaps a failure to provide a service, a crew being idle and precious workshop space being occupied; considerations of the costs of delays should be used to justify investigations and expenditure related to spares procurement. A survey on the supply of spare parts for one month in 1993 is presented in Appendix DD-2.1

One of the suburban garages - Bandra - and one of the city garages - Prabhadevi - were studied in more detail. Much of the vehicle data used in this report comes from these two garages; the authors have been favourably impressed by the standard of record-keeping at Bandra and Prabhadevi and are very grateful for the help provided by the staff there. Table D.2 below shows the vehicles that were kept at Bandra and their status on one particular day in 1993.

Table D.2 Vehicles at Bandra garage and their status on 27 November 1993

Type of vehicle	Number	Status				
		Proposed for scrap	Annual test	Long laid up	Running repair	Available
Refuse (open)	5	5				
Refuse compactor	21	-	2	-	4	15
Mechanical sweeper	2	-	1	1	-	-
JCB	2	-	-	-	1	1
JCB dumper (open tipper)	11	1	-	1	-	9
Dog van	1	-	-	-	-	1
Ambulance	20	4	4	-	1	11
Hearse	4	-	1	-	-	3
Pest control vehicle	1	1	-	-	-	-
Dy Chief Accountant's van	5	-	-	-	-	5
Garage duty	1	-	-	-	1	-
Breakdown truck	2	1	-	-	-	1
TOTAL	75	12	8	2	7	46

Key

Proposed for scrap:	No longer regarded as serviceable; permission to scrap is awaited
Annual test	Vehicles are required to pass a condition and roadworthiness test each year, also known as "Police Passing" and RTO test
Long laid up	The vehicle is considered repairable, but it has been out of service for at least two months
Running repair	Undergoing or awaiting repairs
Available	Ready for service

At Bandra garage there were 65 employees connected with maintenance and 124 involved in operation - drivers and assistants who accompanied drivers in refuse compactor trucks. Details of the maintenance staffing are provided in appendix DD-2.2. Servicing and routine maintenance was carried out at the garages, and some of the work in preparation for the annual test (depending on workloads at garages and the central workshop). At the time of the study in 1993 most of the compactor trucks were still in their warranty period so the manufacturer was responsible for repairs for the new vehicles. The manufacturer had set up a team that was working at Bandra to undertake repairs to the bodies of the new compactor vehicles. They also helped with repairs to the hydraulics of older compactor trucks. Their presence at the garage gave the permanent employees the opportunity of observing how repairs were handled (provided that their own work was not so much that they had no time to observe the manufacturer's mechanics at work).

D-2.2 Preventive maintenance systems in Mumbai

(Most of the information in this section and in Appendix DD-2.3 has been provided by Mr V K Rao, MCGM, and the editor is very grateful for his contribution and involvement.)

Preventive maintenance in the Solid Waste Management Department of the MCGM was based on a programme regular servicing or "docking" for the refuse collection trucks. There were five levels of servicing operation for refuse collection trucks:

N	Normal servicing	every 1 000 km or monthly
A	'A' Docking	every 4 000 km
B	'B' Docking	every 8 000 km
C	'C' Docking	every 16 000 km
D	'D' Docking	every 32 000 km

The schedule for servicing was therefore decided according to the reading of the kilometre gauge (odometer) of the vehicle. For more sophisticated and larger types of machinery (such as a bulldozer) it is customary to measure usage by means of an hour meter, which records the time that the motor is actually running, rather than the distance it has travelled. However, since refuse trucks are built onto normal truck chassis, the only available method of measurement of usage is the odometer. The distances covered by a vehicle in a day vary greatly within the city - trucks bringing waste from the city centre may cover twice the distance each day that is covered by a vehicle operating close to the disposal site, so it is not feasible to base the maintenance schedules on calendar time (rather than distance covered). The intervals between servicing or maintenance for heavy municipal vehicles in Mumbai have been set as shown in table D.3

Table D.3 Frequencies of different types of service

Reading of odometer (km)	Type of service or docking
1 000	N
2 000	N
3 000	N
4 000	A
5 000 etc.	N
8 000	B
9 000 etc.	N
12 000	A
13 000 etc.	N

Reading of odometer (km)	Type of service or docking
16 000	C
17 000 etc.	N
20 000	A
21 000 etc.	N
24 000	B
25 000 etc.	N
28 000	A
29 000 etc.	N
32 000	D

[This raises the issue of whether the kilometre gauges are reliable. In some cities the workshop staff will say that it is not possible to keep these gauges operational, and so a system like this can only be operated by estimating the distances that the vehicles have covered - a task that adds a considerable degree of paperwork and introduces uncertainty. Some drivers might feel that it is in their interest to

have inoperative odometers in their vehicles since that would make it more difficult to account for the usage of fuel, enabling them to sell some of their fuel without detection. Other drivers might be glad of the opportunity of travelling further than they are authorised. In other cities the management might make it a matter of priority that odometers should be kept operational at all times so that maintenance can be organised as described above, pilferage of fuel can be discouraged and the general condition of the vehicles can be monitored more precisely.]

Lists of instructions called Docking Schedules have been prepared to guide the fitters as to what should be done for each vehicle at each docking. They have been reproduced in Appendix DD-2.3. They show that components are to be replaced at certain specified intervals. These replacements were not at the discretion of the fitter, but should always be done at the time indicated. When a vehicle was expected in for a docking the necessary parts were prepared on a tray and checked by a sub-engineer. At the end of the service, all the old items that had been replaced by the new parts were to be returned on the tray to be checked and then destroyed. This degree of checking and security is essential because there is a strong temptation for mechanics to keep the new parts and sell them, leaving the old worn-out parts in the vehicles, or perhaps the used components might be cleaned and sold as new components.

Exchange units were normally replaced at predetermined intervals according to the docking schedules. For example, dynamos were replaced every 8 000 km, and clutch plates every 16 000 km. Engines were replaced every 128 000 km. (A history form was kept for each engine, recording which vehicle it was taken from, at which garage, and by whom, and showing into which vehicle it was subsequently fitted etc.) The units that were removed were reconditioned in the workshop and kept ready for fitting into another vehicle when an exchange was necessary. In this way units could be reconditioned when the fitters had time, and in clean and convenient conditions. If this unit replacement system were not used, major vehicle parts would need to be repaired in a hurry while the vehicle was kept idle in the garage. This system can only be economically applied if there is a degree of standardisation, so that components from each vehicle can be used in a number of others.

Standardisation on a few types of vehicle is important for a number of other reasons also. It reduces the number of spare parts that must be held in the stores, and it enables the mechanics to be very familiar with the small range of different types of machine so that they can perform the maintenance work efficiently. Standardisation on just one vehicle type is rarely possible in a large city because there is usually a variety of situations that must be served so that several different types of vehicle are required. A typical constraint is the width or road surface of the access route; in some situations narrow trucks are needed to reach certain parts of a city. Sometimes standardisation is prevented by the method of selection of the vehicles - if they are selected solely on the basis of the lowest tender or as a result of trade agreements, the transport engineer is not in a position to standardise his fleet as he would like to.

Determination of the intervals at which items should be changed (that is, preparation of the docking schedules) depends on the experience of the engineer. The starting point may often be the recommendations of the manufacturers; but this may need to be modified. A very good example is given by the frequency of changing engine oil. The chassis manufacturers of a particular compactor vehicle used in Mumbai recommended that the oil should be changed every 16 000 km. Engineers in charge of the vehicles monitored the condition of the oil and noticed that it reached the state when it needed to be changed sooner than it should have. They realised that this was because the engine of a compactor truck works hard when the vehicle is stationary - compacting and unloading the refuse - and so the distance covered alone is not an accurate indication of the amount of work done by the engine and transmission. (The manufacturers of the engine had set the distance that an ordinary truck could run, without thinking of the extra work done by a refuse compactor when it is stationary.) In Mumbai it has been decided to change the engine oil at intervals of 8 000 km. Intervals between oil changes depend on the specification of the oil that is used; it may be cost-effective to use a more expensive oil if the required intervals between changes are longer.

There was a similar approach in Calcutta, as described by A. K. Sarkar. Two coefficients were used; one relating to the conditions under which the vehicle was operating, and the other being concerned with the type of body. For example, a chassis manufacturer might recommend a frequency for oil change of 8 000 km, but this would be for a long-distance transport vehicle operating on paved roads and usually running in top gear. However, for a vehicle that is operating at low speeds on bad roads

and dusty conditions, this interval should be reduced by the coefficient 0.6. If the standard chassis is fitted with a specialised body that includes hydraulic systems, the interval between oil changes should be reduced by a further coefficient, for example 0.8 for a tipper truck or dumper-placer truck. So, for this example, the interval between oil changes for a tipper truck collecting solid waste should be :

8 000 x 0.6 x 0.8 = 3 840 ~ 4 000 km.

Similarly, the manufacturer may recommend that an oil filter be serviced every 1 000 km. If, however, a vehicle is working at low speeds and in dusty conditions, the interval between servicing should be reduced by the coefficient 0.6 to 600 km. If the vehicle also has hydraulic equipment that causes the engine to operate when the vehicle is not moving, the interval should be reduced by a further 0.8 to 480 (or 500) km.

Maintenance records should also be used to determine the frequency at which parts should be replaced or overhauled. If breakdowns still occur as a result of failures of parts that are exchanged or repaired in the preventive maintenance schedules, it is likely that it would be appropriate to increase the frequency at which these parts should be replaced. It is recommended to use a report form that is to be filled in whenever a vehicle breaks down; the breakdown is classified into one of three groups:

a) due to a fault in the last servicing or docking
b) non-avoidable, or
c) accidental.

If the breakdown is thought to be as a result of poor servicing (category [a]), the name of the fitter who carried out the last servicing should be written on the breakdown form. A regular inspection of these breakdown forms would enable the engineer to form an opinion as to whether the frequency of servicing of a particular part of the vehicle has been sufficient. The form is reproduced in Appendix DD-2.4. These forms might also indicate if the routine maintenance is being done correctly, if the results were collated in such a way that any trends or high frequencies of particular faults could be discerned.

Another key element of preventive maintenance is the scheduling of the maintenance work so that the work for the mechanics is evenly spread throughout the year. This requires good judgement from the transport engineer to know how long different tasks will take, to know when vehicles can be spared, and to continue to make allowances for unforeseen breakdowns and complications. Appendix DD-2.5 shows a table used to forecast when each vehicle will need to be called in for its next docking.

Tyres can be an expensive item in the maintenance of refuse trucks because of the high risk of punctures when driving over refuse, and the risk of rubbing the tyres against kerb stones. The maintenance of tyres has been discussed in some detail in Appendix DD-3.2.

New vehicles were allowed to run for two years before the first annual RTO roadworthiness test must be taken. If a number of new vehicles arrive at the same time it will be necessary to test most of them at staggered intervals early (i.e. before the two years has passed) so that it is not necessary to take all the new vehicles out of service at the same time

D-3 MAINTENANCE RECORDS

D-3.1 Recording systems

As has already been mentioned, record keeping is an essential prerequisite of preventive maintenance. The records should be in a form so that the required information is easily abstracted. Record-keeping is not an end in itself; all records should be evaluated from time to time in an effort to reduce unnecessary form-filling and report writing. The amount of time that craftsmen spend on record keeping should be kept to the necessary minimum.

At Bandra garage in 1993 it was noted that there were 36 registers used to record a variety of operational and maintenance data. Their titles were as follows: (Items marked * are discussed later in this chapter or in the appendices.) The titles of the registers are listed in table D.4 below

Table D.4 List of titles of maintenance registers

1. Staff muster	19. Tyre register* - see Appendix DD-3.1, 2
2. Driving licences	20. Tyre repair register* - see Appendix DD-3.1, 2
3. Addresses	21. Tool register
4. Spot muster	22. Inward and outward register
5. Overtime statement	23. Dead stock register
6. Overtime register	24. Plant and machinery register
7. Daily diaries	25. Despatch slip register
8. Additional work allotment	26. Cannibalising register
9. Job allocation	27. Store receipt register
10. Vehicle allocation / vehicle manufacturer	28. Store issue register
11. Breakdown register	29. Store ledger
12. Sickness register (vehicle defects) * see D-3.2	30. Gate pass register
13. Log sheet	31. Spare parts register
14. Fuel and trip register** - see Appendix DD-3.1	32. Stores indent
15. Daily utilisation report	33. Material requisition notes
16. Oil register	34. Servicing schedule
17. Oil consumption register* - see Appendix DD-3.1	35. Police passing dates schedule
18. Battery register	36. Maintain module

D-3.2 Data on vehicle defects

Before discussing data on vehicle defects it is appropriate to discuss the main types of vehicle that are referred to in this section. Two basic types are considered - compactor trucks and *dumper placers* - known outside India as skip lift or container hoist trucks.

At the time of the study there were two types of refuse compactor vehicle in common use. The older vehicles were the Airtech Schörling 4R type which have been described in a previous report (*Observations of solid waste management in Bombay 1992* by Scheu and Coad) and which are conventional ram-operated rear-loading compactors.

The more modern compactors are the Airtech "Multipack" model which is an Indian design which aims to reduce maintenance by minimising the number of hydraulic rams required to perform all operations. By using chains and cables, the pair of large rams on top of the body lift the one cubic metre wheeled containers, compact their contents into the body and also raise the tailgate during emptying. The load is ejected by means of an ejector plate that is operated by two rams operating in tandem. (See figure B-2.1.) There have been some teething problems with this new design which have hopefully now been sorted out. The lifting mechanism at the rear reduced the ground clearance of the body considerably so that on soft ground at disposal sites it sometimes became held by the ground, so that when the vehicle tried to move the *resting rods* that held this equipment in position became bent or broken. The cables that lifted the wheeled containers sometimes became elongated or displaced, affecting the operation. The ejector rams, being offset from the line of action, sometimes became bent. Minor problems, such as the lack of bushes in a lever mounted on a shaft, and the lack of grease nipples in the cable pulleys have hopefully been rectified by now. The seals in the hydraulic rams were also prone to leaking and this suggested that a higher specification for the rams would be appropriate. There were also some chassis problems in the early models received by the MCGM. Multipack trucks are shown in photographs 5 and 6.

Two types of dumper placer were in widespread use in Mumbai, though there were other, smaller models also being used. One was based on an Ashok Leyland chassis and the other on a Tata chassis. One problem with the former type was the hydraulic rams used to stabilise the vehicle when lifting heavy containers - they were simple vertical rams which could be damaged if the driver started his vehicle moving while the ram was down.

The basic source of information on vehicle defects has been the "sickness register" which is kept in a foolscap-size bound notebook. It was completed every day except Sundays, and the entries were summarised daily for compactors and weekly for all vehicles. The basic format that was being used at Mumbai garages is illustrated in table D.5

Table D.5 Sample of vehicle sickness register from Prabhadevi Garage, October 1 1994

Serial number	Vehicle number	Vehicle type	Service	Laid-up since	Remarks
1	1185	AL	Ref	9/8	Hopper beam (Bandra)
2	1081	"	"	5/9	Accident (Waiting for other parts)
3	1069	"	"	"	Automotive (Kurla)
4	1198	"	"	27/9	Packer plate not operating (Bandra)
5	1183	"	"	29/9	B servicing and PTO mod^{n} work
6	1088	"	"	1/10	Air lock
7	1095	"	"	30/9	F/L leaf spring work, other work
8	1199	"	"	30/9	Ejector cylinder bent (B)
9	7996	"	Asp	18/9	RTO passing
10	7994	"	"	25/9	"
11	1131	"	"	21/9	Accident, door lock
12	1110	"	"	1/10	Brakes weak, horn, driver's seat faulty

The last part of the registration number of the vehicle is written in column 2.
The third column may have a description of the vehicle such as "MPRC A/Leyland" (**M**ulti**p**ack **R**efuse **C**ompactor **A**shok Leyland), or, simply as here "AL" for Ashok Leyland.
Column 4 shows the service that the vehicle is put to; "Ref" refers to refuse collection and "Asp" may refer to road repairs.
The next column shows the date when the vehicle was taken off the road. This could be taken from the previous day's entry.
The last column gives the reason for the vehicle being off the road, and in this case also shows where the vehicle has been taken for repair (Bandra or Kurla). Alternatively, some registers have a column headed "Attended by" in which would be written the initials of a mechanic or (for example) "Airtech" - the manufacturer of the compacting bodies who had a base at Bandra.

This register provides a vast amount of data concerning the maintenance of the vehicle fleet, but the register took unnecessary time to complete, and abstracting certain items of information for a long period of time is a lengthy process.

Preparing the table each day and writing in the data took more time than was necessary. If a proforma were prepared in advance some time could be saved, and the repetition of data from one day to the next could be avoided. For example, if a vehicle is off the road for twenty days for the same reason, the same entry is made for the vehicle each day, that is, twenty times.

If information is sought about the performance of maintenance tasks, the occurrence of certain failures, or the duration of specific problems, many pages of the register must be referred to. The method of recording the data shown in table D.6 would reduce some of these problems and provide the data in a much more accessible way. A blank table of the form shown would be started each month. It should have enough columns to accommodate all the refuse collection trucks at a particular garage, and enough rows to allow the entry of data from each day of the month. If a vehicle is used on a particular day the appropriate space should be ticked. If the vehicle is serviceable but not used, the entry should be "Sp" as an abbreviation for "spare". If the vehicle is off the road for other reasons, the reason should be indicated according to the key at the bottom of table D.6. The key separates the defects into basic categories of mechanical problems, concerned with the chassis (supplied by Ashok Leyland usually) and the body (manufactured by Airtech). The other major categories are "S" for preventive maintenance servicing and "P" for preparation for the annual roadworthiness test. Lower case letters are then used to specific mechanical and body problems in more detail according to a code that can be developed to suit common failures and convenient categories. The second and third columns are for daily summaries of the total number of vehicles allocated to the particular garage and the number on-line or spare i.e. the number available. This method of record keeping simplifies the data entry process and enables a supervising engineer to see at a glance how many vehicles have been available, how long any particular vehicle has been laid up, and what types of problem are occurring frequently. Records for several months have been compiled and are presented in slightly different forms in Appendix DD-1.

One obvious way of using the data extracted from the sickness records is to calculate the availabilities of the vehicles - that is, the percentage of the time that the vehicles are available for service. Availability data show the effectiveness of the maintenance operation and also suggest the number of vehicles that should be purchased - if, for example, the availability is 50 % it means that two vehicles should be purchased for every vehicle needed on the road each day. Availabilities would be expected to vary with the type and age of the vehicles. Figure D.1 below shows availability data for compactor trucks for almost two years. It can be seen that the availabilities vary between 53% and 74%. The lower values suggest that there is a need to investigate the most common causes for vehicles being off the road. Bus companies are able to achieve availabilities approaching 90%, but before comparisons are made with refuse truck fleets it must be remembered that buses are much simpler vehicles than rear-loading compactor trucks, and refuse collection trucks are often obliged to run on difficult ground at disposal sites. The graph also shows that for the period February to August the figures for 1993 are lower than for those for 1992. The most obvious explanation for this is that the new compactor trucks which were supplied from February 1993 onwards were not as reliable when they first arrived as the older vehicles they were replacing. (A detailed study of maintenance records would show if this was indeed the case and what the common problems were.)

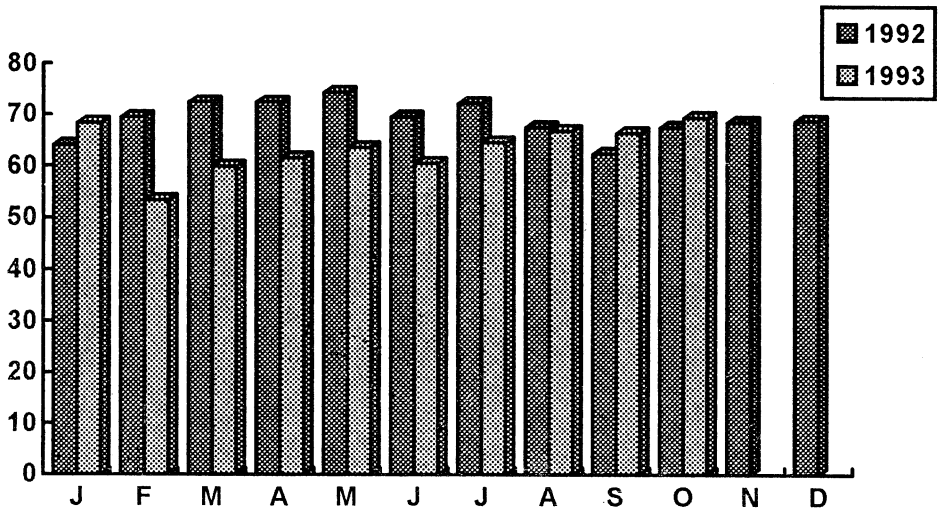

Figure D.1 Monthly availability of refuse compactor trucks for the period January 1992 to October 1993

An inspection of the charts in Appendix DD-1 shows that considerable time is sometimes taken to prepare the trucks for the annual roadworthiness test, and for the test itself. Figure D.2 shows how the time for this work has varied over the period December 1991 to April 1993.

Similarly, it is possible to use information such as that presented in table D.6 to determine the time taken for any repair. If a vehicle is off the road for a long time for the same reason it is likely to be either because of a shortage of skilled fitters to carry out the repair or the lack of the necessary spare parts. The lack of parts may be due to the failure of manufacturers or dealers to have them available, or because of lengthy bureaucratic purchasing procedures. It was reported that, in 1993, sub-engineers and junior engineers had no right to purchase spares from the open market, and assistant engineer had the right to spend only up to Rs 50. - a limit that had been in place for about 30 years. Delays in repairs can be very expensive because an expensive vehicle is lying idle and workshop space is being occupied unproductively. In many cases it might be worthwhile to examine the degree to which repairs are taking more time than they should, and if this appears to be a problem, to identify ways of reducing the periods for which vehicles are off the road. One further reason for delays in

Table D.6 Data from Bandra Garage October 1993

October 1993			Vehicle registration numbers								
Day	Total	O/L+Sp	2469	2470	2471	2472	2473	2474	2475	2476	2477
1	22	12	B u	✓	M h,l	✓	✓	✓	M b,i	✓	✓
2											
3											
4	22	14	B	✓	✓	✓	✓	✓	M	✓	✓
5	22	16	✓	✓	✓	✓	✓	✓	M	✓	✓
6	22	16	✓	✓	✓	M m	✓	✓	M	✓	✓
7	22	15	✓	B o	B u	✓	✓	✓	M	✓	✓
8	22	16	✓	B	✓	Sp	✓	✓	M	✓	B o
9	22	15	✓	B	✓	✓	✓	✓	M	✓	✓
10											
11	22	15	✓	B o	Sp	✓	✓	✓	M	✓	✓
12	22	14	✓	B	✓	✓	✓	✓	M	✓	B p
13	22	14	B o	B o,pc	B o,l	✓	✓	✓	M	✓	B m,p
14	22	15	✓	✓	✓	✓	✓	✓	M	✓	B
15	22	17	✓	✓	B p	S	✓	✓	M	✓	✓
16	22	15	✓	✓	B	S	✓	✓	M	✓	B u,i
17											
18	22	17	✓	✓	B	S	✓	✓	B t	✓	✓
19	22	17	B l,p	✓	B	S	✓	✓	B	✓	✓
20	22	15	M c	✓	B	S	✓	✓	B	✓	✓
21	22	17	✓	✓	B p	S	✓	M c	B	✓	✓
22	22	16	✓	✓	B	✓	✓	M	B	✓	✓
23	22	14	✓	✓	B	M d	✓	M	B	✓	✓
24											
25	22	16	✓	✓	✓	M	B t	M	B	✓	✓
26	22	16	M c	✓	✓	M	✓	✓	B	✓	✓
27	22	16	?	✓	✓	M	✓	✓	B	✓	✓
28	22	16	✓	✓	B p	M	✓	✓	B	✓	✓
29	22	14	✓	✓	B	M	✓	✓	✓	✓	✓
30	22	15	✓	✓	✓	M	✓	✓	✓	✓	B
31											

Note: Servicing for new vehicles is done by supplier (BML)
Observations: Older vehicles kept as spares when sufficient vehicles are available

B Body repairs **M** Mechanical, i.e. chassis **P** Annual Police test **S** Service **Sp** Spares **L** Long laid up (More than 2 months)

The list of lower case characters may be difficult to remember; the author has taken some liberties with spelling and added reminders for his personal use; the reader should consider developing his own system.

a	chassis	j	washing (j cloth)	s	steering sp springs
b	brakes	k	lubrikation system	t	pto
c	clutch cb cab	l	container lift	u	rams - uther (not leaks)
d	differential	m	motor	v	rust (vanishing steel)
e	electrical	n	starting	w	wire rope
f	fuel	o	ram leaks (o rings)	x	ejector plate (exit)
g	gearbox	p	packer plate pc chain	z	tailgate lock (at the end)
h	wheels	q	qontrols		
i	air pipe, system	r	resting rods		

repairs may be the facilities that are available to the mechanics - shortages of tools for certain tasks or inadequate protection from the weather (especially monsoon rains) may be the reason for some repairs taking a long time.

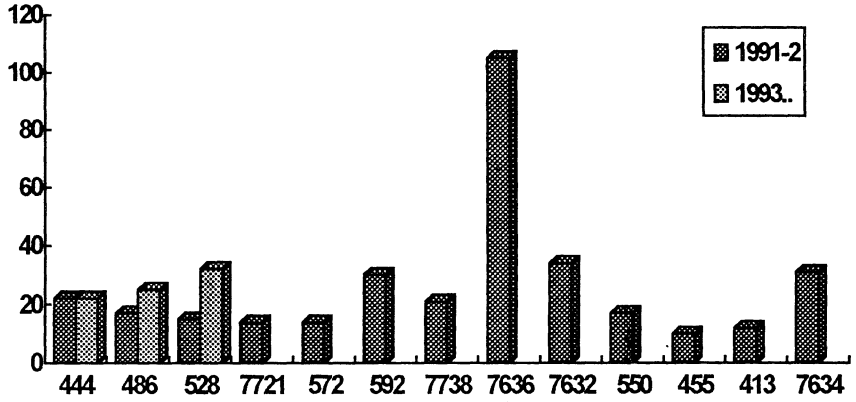

Figure D.2 Time taken for annual roadworthiness test

Compactor trucks for refuse collection have complex hydraulic machinery for lifting, loading, compacting and unloading solid waste. It is to be expected that such machinery will fail from time to time. A review of failures of hydraulic systems in compactor trucks based at Prabhadevi Garage is shown in figure D.3.

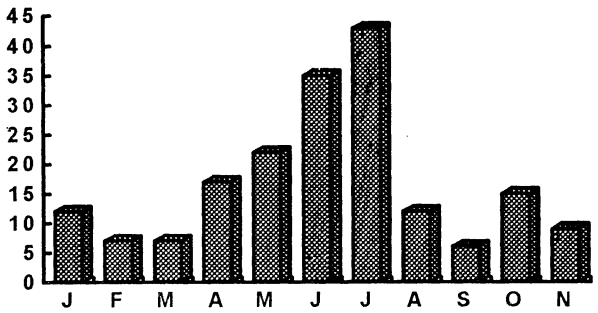

Figure D.3 Hydraulic failures in refuse compactor trucks based at Prabhadevi Garage in 1994
(The value for November is for the month up to the 20th day)

The results show particularly high failures during the monsoon months. This is probably because the density of the waste is much higher when it is wet and so the lifting equipment is overloaded. At Prabhadevi garage a wheeled refuse container has been partly filled with concrete so that the lifting gear can be tested after repairs have been made and before the vehicle is sent out for duty

Another common problem with refuse collection vehicles is the wearing out of clutch plates. This is because these vehicles spend much of their time in slow moving traffic in which there are frequent gear changes, and because driving with a full load on soft ground on refuse disposal sites adds to clutch wear. Figure D.4 shows, for different vehicles, the replacement rates for clutch plates during the period April 1991 to March 1992, and the replacement rates for pressure plates for the period June 1991 to March 1992. The chart shows which vehicles have suffered most clutch wear, and suggests that there might be benefit in providing some training for the drivers of the vehicles with the most clutch wear. The reasons for low wear, particularly for 4143 should be examined - it may have

been because the vehicle was little used during that period because it was kept as a spare or was awaiting repairs for much of the time, or it may have been the result of skilful and careful driving.

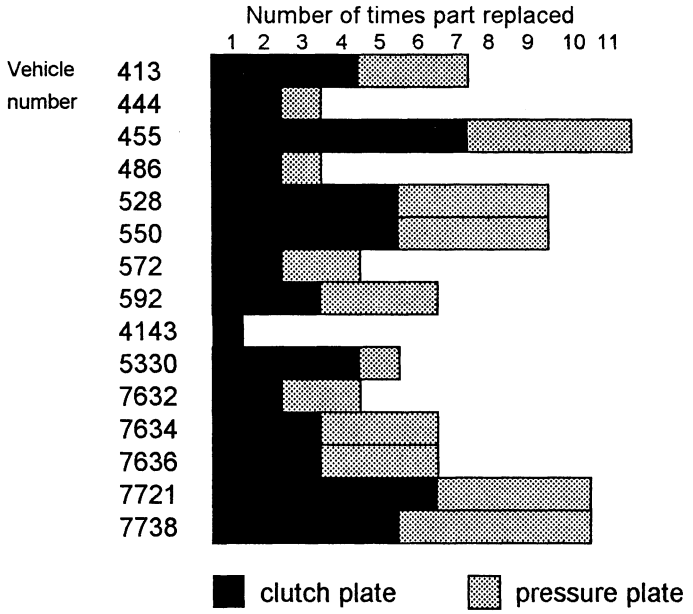

Figure D.4 Replacement rates for clutch parts for various compactor trucks.

A detailed way of calculating the achievement of a garage in the area of maintenance is shown in table D.7, which is taken from the records of Prabhadevi Garage. It analyses the situation in terms of vehicle days - for example the total number of vehicle days in a month is the number of vehicles based at the garage multiplied by the number of days in that month.

Table D.7 Record of operations May-November 1993, Prabhadevi Garage

Row #	Description	May	June	July	Aug	Sept	Oct	Nov
1	Total number of vehicles	22*	28*	28	28	28	28	28
2	Total vehicle days for whole fleet (number of vehicles multiplied by number of days they were at the garage)	586	766	868	868	840	868	840
	Number of vehicle days lost to							
3	body failures	112	181	190	158	185	134	136
4	mechanical (chassis) failures, including servicing and docking	72	163	146	136	143	112	151
5	vehicle not being required (spare)	31	10	45	44	17	10	16
6	vehicle days lost because of accidents	6	26	36	31	30	33	30
7	Total of vehicle days lost [rows (3+4+5+6)]	221	380	417	369	375	329	333
8	Balance of vehicle days [rows (2 - 7)]	365	386	451	499	465	539	507
9	Required vehicle days - i.e. demand	380	390	454	503	493	546	518
10	**Service efficiency [rows (8/9)] percent**	**96**	**99**	**99**	**99**	**94**	**99**	**98**
11	Number of vehicles supplied	13	13	15	17	17	18	18
12	**Fleet efficiency [rows (11/1)] percent**	**59**	**46**	**54**	**61**	**61**	**64**	**64**

Notes Row 1 * varying through the month
Row 7 It appears that the author made an error in transcribing the values for October since the values in rows 3 to 6 do not add to the figure in this row.

This method of analysis gives a useful summary of the service provided by the garage. By including the spare vehicles with the vehicles not available the service efficiency provides a useful indicator of how well the garage has met its obligations over the month. Considerable effort is required to collect all this data from the daily register.

D-4 CONCLUSIONS

- The management of maintenance is a subject that is challenging and important.
- Good preventive maintenance can save money and improve reliability.
- A successful maintenance programme requires teamwork and commitment; from the fitters and drivers who carry out regular inspections and maintenance work and fill in information slips, to the manager who designs and modifies the information management system, monitors the reports regularly and acts upon the information he receives.
- Information costs money. It takes time to fill in forms and update records, so ways should be found of simplifying reporting procedures without losing useful information.
- Information is valuable if it is used to save money and improve efficiency.
- Information is worthless if it neither reviewed nor used. The use of maintenance information can be encouraged by presenting it in a form that is convenient to use.
- The kilometre gauge or odometer is an important tool in maintenance management. Kilometre readings are used in many maintenance records and so a high priority should be placed on keeping the kilometre gauges in trucks in good condition.

D-5 EXERCISES

Review the charts in Appendix DD-1 and answer the following questions:

1. Note the slight differences between the styles of presentation of the different charts and make recommendations as to which features are most useful, and which style is easiest to use and interpret.

2. List the items of information that can be deduced from the charts. Write your answers in the form of questions that can be answered from the charts.
   (For example the charts could be used to answer the question -
   Which is the most common fault occurring in the trucks?)

3. Compare these charts with the daily sickness register method of recording vehicle faults, as illustrated in table D.5.
   a) Discuss the advantages and disadvantages of each system in terms of the time taken to enter the information and the ease with which a manager could extract information.
   b) If charts were used in this way for recording the condition of the fleet, would a daily register still be necessary? If it would, for what purposes would it be used?

4 Compare the availabilities of different types of vehicles. (There are three types of vehicles mentioned in the charts: older compactors, Multipack compactors, and dumper-placers or skip trucks.)
   a) Consider whether there is enough information to draw reliable conclusions about the average availability of each type.
   b) Examine the relationship between vehicle age or make and reliability for dumper-placer trucks.
   c) Consider whether workshop practices and priorities might have an influence on availability figures, giving evidence for your opinions.
   d) Imagine that you were appointed as a manager of one of the garages studied. Develop a strategy for improving availabilities, based on the records that are presented here.
   e) How could information about availabilities be used in the process of selection of the most economical type of vehicle for use in a particular situation?

Review the registers in Appendix DD-1

1. Consider whether it would be helpful to add any further columns to the tables to assist managers in identifying any important information. Do this for two cases:
   (i) where the records are prepared manually
   (ii) where computers are used and the software is being developed especially for this application.

2. Estimate the fuel consumption of the compactor vehicles. Consider whether it is better to use an average of the values that can be calculated rather than to select only two or three of the figures that you can calculate.

Using on the records in Appendix DD-1.3:

1. Estimate the utilisation ratio (number of vehicles in service divided by total number owned) for the different types of vehicles and different months. Comment on the results.
2. Discuss reasons why this ratio may not be the same as availability. (Some of the reasons may apply to only some types of vehicle.)

List of contents Appendices DD

Appendix DD-1.1 Charts of vehicle defects, Bandra Garage, Mumbai Suburbs

DD-1.1.1 February 1993

10 vehicles are required for duty each day

continued on next sheet

Numbers 24xx and 25xx are for new type of compactor (Multipack); others are for previous type (4R)

Feb	Total	2469	2470	2471	2472	2473	2474	2475	2476	2477	2482	2483	2503	2504	2505
1	17	M b													
2	17									M z,n	M n				
3	14									M					
4	23						M			M					
5	19		M ms				B p			M					
6			M				B		M s						
7															
8	21						B			M n	B	M s			
9	24				S		B		S	M	B	M			
10	24				B xu		B	B p		M	M e				
11	23				B			M n	B l	M	M				
12	24	Sp	Sp		B	Sp		M		M	M			Sp	Sp
13	24							M	M g	M	M		M f		Sp
14															
15	24	Sp	Sp					M	M	M	M			Sp	
16	24	S						M	M	M	M				B z
17	24	B z	B l	S			M g	M	M	M	M				
18	23	B					M	M	M	M	M				M m
19	-	-					-	-	-	-	-				-
20	23		M g				B	M			M				
21															
22	23		M					M			M				
23	23		M					M			M				
24	22		M			M n		M			M				
25	22		M			M	M g	B	B z,t		M				
26	22		M			M	M	B p	B		M				
27	22		M				M	B			M		B z		
28	-		-												

Records show 2513 fuelled at Bandra 16th Feb., 2512 17th Feb

Key to lower case letters is on next sheet

B Body repairs **M** Mechanical, i.e. chassis **P** Annual Police test **S** Service **Sp** Spares **L** Long laid up (More than 2 months) **E** Elsewhere (but included in numbers)

Data from Bandra garage February 1993 continued

Feb	413	444	455	486	528	550	572	592	7632	7634	7636	7721	7738	Overall availy
1		P	M c		B p					M n	L		M	76
2		P	M		B						L		M	76
3		P			B			M d			L			77
4		B									L			72
5		B	M f		B p	M t					L			72
6		B	M		B	M					L			69
7														
8		B	M	P	B		B q	B o			L			76
9		B	M	P	B						L			68
10	B p	B	M	P	B			S			L	B z		68
11	B	B		P	B						L	B	B v	67
12	B			P							L	B	B	69
13	B	M h		P					M c		L	B	B	72
14														
15	B	M		P					M		L	B	B	63
16	B	Sp		P			Sp			Sp	L	B	B	63
17				P					Sp	M t	L	B	B	66
18	B p			P					M		L	B	B	66
19	-			-					-		-	-	-	-
20	B	M e		P			M m		M		L	B	B	62
21														
22		M		P					M	Sp	L	B	B	61
23	B p	M		P					M		L	M c	B	66
24	B	M		P					M		L	M		67
25				P							L	M spr		68
26				P						Sp	L	M		68
27	B u			P					B l		L			68
28														

a chassis
b brakes
c clutch
cb cab
d differential
e electrical
f fuel
g gearbox
h wheels
hy hydraulic system
i air pipe, system
j washing (j cloth)
k lubrikation system
l container lift
m motor
n starting
o ram leaks (o rings)
p packer plate
pc packer plate chain
q qontrols
r resting rods
s steering
spr springs
t pto
u rams - uther (not leaks)
v rust (vanishing steel)
w wire rope
x ejector plate (exit)
xu ejector ram
z tailgate (at the end)

B Body repairs **M** Mechanical, i.e. chassis **P** Annual Police test **S** Service **Sp** Spares **L** Long laid up (More than 2 months) **E** Elsewhere (but included in numbers)

DD-1.1.2 Data from Bandra Garage October 1993

			Vehicle registration numbers																			
Oct	Total	O/L+Sp	2469	2470	2471	2472	2473	2474	2475	2476	2477	2482	2483	2503	2504	2505	2584	2585	2586	2721	444	7632	7634	7636
1	22	12	B u	✓	M h,l	✓	✓	✓	M b,i	✓	✓	M s,f	✓	✓	B t	M cb	M c	✓	✓	✓	M b	✓	M spr	L
2																								
3																								
4	22	14	B	✓	✓	✓	✓	✓	M	✓	✓	M	✓	✓	✓	M	✓	✓	✓	✓	M	B p	M	L
5	22	16	✓	✓	✓	✓	✓	✓	M	✓	✓	M	B p	✓	✓	M	✓	✓	Sp	✓	M	✓	Sp	L
6	22	16	✓	✓	✓	M m	✓	✓	M	✓	✓	✓	✓	✓	✓	B o	S	✓	✓	✓	M	✓	Sp	L
7	22	15	✓	B o	B u	✓	✓	✓	M	✓	✓	✓	✓	✓	✓	✓	S	✓	✓	B z	M	✓	✓	L
8	22	16	✓	B	✓	Sp	✓	✓	M	✓	B o	✓	✓	✓	✓	✓	S	✓	✓	✓	M	✓	✓	M
9	22	15	✓	B	✓	✓	✓	✓	M	✓	✓	✓	✓	M	✓	✓	S	✓	✓	✓	M	M d	✓	P
10																								
11	22	15	✓	B o	Sp	✓	✓	✓	M	✓	✓	B	✓	✓	M		S	✓	✓	✓	M	✓	✓	P
12	22	14	✓	B	✓	✓	✓	✓	M	✓	B p	✓	M	✓	✓	B l	S	✓	✓	✓	M	✓	✓	P
13	22	14	B o	B o,pc	B o,l	✓	✓	✓	M	✓	B m,p	✓	✓	✓	B o		✓	✓	✓	✓	M	✓	✓	P
14	22	15	✓	✓	✓	✓	✓	✓	M	✓	B	✓	✓	B i	✓	B u	✓	✓	✓	✓	M	✓	B t	P
15	22	17	✓	✓	B p	S	✓	✓	M	✓	✓	✓	✓	✓	✓	B	✓	✓	✓	✓	Sp	Sp	✓	P
16	22	15	✓	✓	B	S	✓	✓	M	✓	B u,i	B o	✓	✓	✓	✓	✓	✓	✓	✓	✓	B p	✓	P
17																								
18	22	17	✓	✓	B	S	✓	✓	B t	✓	✓	✓	✓	✓	✓	✓	✓	✓	B r	✓	✓	Sp	Sp	P
19	22	17	B l,p	✓	B	S	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Sp	Sp	P
20	22	15	M c	✓	B	S	✓	✓	B	✓	✓	✓	✓	✓	M b	✓	✓	✓	✓	✓	B p	Sp	✓	P
21	22	17	✓	✓	B p	S	✓	M c	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Sp	Sp	P
22	22	16	✓	✓	B	✓	✓	M	B	✓	✓	✓	B	✓	M	✓	✓	✓	✓	✓	✓	Sp	✓	P
23	22	14	✓	✓	B	M d	✓	M	B	✓	✓	✓	M m	✓	M	✓	✓	✓	✓	✓	✓	M c	✓	P
24																								
25	22	16	✓	✓	✓	M	B t	M	B	✓	✓	✓	✓	✓	✓	✓	B r	✓	✓	✓	✓	✓	✓	P
26	22	16	M c	✓	✓	M	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	B	✓	B	✓	✓	✓	Sp	P
27	22	16	?	✓	✓	M	✓	✓	B	✓	✓	M i	✓	✓	M c,b	✓	✓	✓	✓	✓	✓	✓	✓	P
28	22	16	✓	✓	B p	M	✓	✓	B	✓	✓	M	✓	✓	M	✓	✓	✓	✓	✓	✓	✓	✓	P
29	22	14	✓	✓	B	M	✓	✓	✓	✓	✓	M	M	✓	✓	B z	✓	✓	✓	✓	✓	B o	B	P
30	22	15	✓	✓	✓	M	✓	✓	✓	✓	B	M	M	✓	✓	✓	✓	✓	✓	✓	✓	B	B	P
31																								

Note: Servicing for new vehicles is done by supplier (BML) Observations: Older vehicles kept as spares when sufficient vehicles are available

KEY

B Body repairs **M** Mechanical, i.e. chassis **P** Annual Police test **S** Service **Sp** Spares **L** Long laid up (More than 2 months)

a	chassis	e	electrical	i	air pipe, system	m	motor	q	qontrols	u	rams - uther (not leaks)	z	tailgate lock (at the end)
b	brakes	f	fuel	j	washing (j cloth)	n	starting	r	resting rods	v	rust (vanishing steel)		
c	clutch cb cab	g	gearbox	k	lubrikation system	o	ram leaks (o rings)	s	steering spr springs	w	wire rope		
d	differential	h	wheels	l	container lift	p	packer plate pc chain	t	pto	x	ejector plate (exit)		

DD-1.1.3 Data from Bandra Garage November 1993,

including summary table according to maintenance categories. The key to the symbols is the same as on the chart for October 1993.

			Vehicle registration numbers																		
Nov	Total	O/L+Sp	2469	2470	2471	2472	2473	2474	2475	2476	2477	2482	2483	2503	2504	2505	2584	2585	2586	2721	7632	7634	7636
1				B p		M					B o	M	M								B o		P
2				B		M		B w				M									B	Sp	P
3				B		M	M g	B				M									B	S	P
4				B		M	S	B				M								B i	B		P
5						M	S	B				M									B		P
6				M a		M	S	B				M	M g							B p	B		P
7																							
8					M t	M		B p				M	M							B	B		P
9					B	M		B				M	M								B	M b	P
10					B	M		B				M									B		P
11				B x	B	M	B l													Sp	S		P
12					B	M	S	Sp						Sp				B w,r		Sp	P	M t	P
13																							
14																							
15																							
16				B x,q	B	M						M c						B			P	M	P
17				B	B	M										Sp					P		P
18				B	B	M		S									M c				P		P
19				B	B	M		S								B t					P		P
20					B	M	M m,s			M g,h											P		P
21																							
22					B	M	M	S						M c		B o	B o				P		P
23					B	M	M	S		M											P	B t	P
24					B		M	S		M						B o					P		P
25					Sp		M	S		M						B					P		P
26							M	S		M	M e					B		B t			P		P
27					M		M	S	Sp						B o,p	Sp		Sp	Sp		P	Sp	P
28																							
29							M	S	B												P	Sp	P
30							M	S		M g	M c		M a								P		P

Summary - number of days lost for each cause 24 days of records

Mechanical	0	1	2	18	10	0	0	6	2	9	5	1	0	0	1	0	0	0		3	0
Bodywork	0	9	12	0	1	8	1	0	1	0	0	0	1	5	1	3	0	3	9	1	0
Servicing	0	0	0	0	4	11	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
P Test, preparation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	24
TOTAL	0	10	14	18	15	19	1	6	3	9	5	1	1	5	2	3	0	3	24	5	24

Appendix DD-1.2 Charts of vehicle defects, Prabhadevi Garage, Mumbai City

DD-1.2.1 September 1994

MAINTENANCE RECORD TATA AND ASHOK LEYLAND DUMPER -PLACERS IN PRABHADEVI GARAGE

					Day in September 1994															
Sr. No.	Make	Reg^{n} No.	Year of purchase	Start of problem	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	A.L.	7958	1991		✓	✓	✓	✓	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	✓	✓	✓	✓	✓
2	A.L.	7960	1991		✓	S_N	✓	✓	✓	✓	✓	✓	✓	✓	✓	S_B	S_BP	S_BP	P	P	P
3	A.L.	7961	1991		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Hr
4	A.L.	7964	1991		✓	✓	✓	✓	✓	✓	✓	Mt	Mt	✓	✓	✓	✓	✓	✓	✓	✓
5	A.L.	8043	1991		✓	✓	S_N	✓	✓	✓	✓	✓	✓	✓	Mm	✓	Mc	Mc	Mc	Mc	Mc
6	A.L.	8044	1991	25/8/94	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Mf	Hh
7	TATA	5733	1986		✓	✓	✓	✓	✓	Mf	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	TATA	5734	1986		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Mt	Mt	Mt	Mt
9	TATA	8848	1988		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	TATA	8890	1988		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	TATA	8891	1988		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	S_C	S_C	S_C	S_C	S_C	S_C
12	TATA	8893	1988	30/8/94	Mc	Mc	Mc	✓	✓	Mf	✓	✓	✓	Ms	✓	✓	✓	✓	✓	Mf	✓
13	TATA	1377	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	Hc	Hc	Hc	Hc	Hc	Hc	Hc	Hc
14	TATA	1378	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
15	TATA	1379	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	TATA	1380	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	TATA	1383	1994		✓	✓	S_NHp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	TATA	1384	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
19	TATA	1392	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20	TATA	1399	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
21	TATA	1402	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
22	TATA	1395	1994		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Hg	✓	✓	✓	✓
23	A.L.	8045	1991		S_N	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of trucks unserviceable					3	3	4	1	2	4	2	3	3	4	4	5	6	6	6	7	7

MAINTENANCE RECORD TATA AND ASHOK LEYLAND DUMPER PLACERS IN PRABHADEVI GARAGE

DD-1.2.1 September 1994 continued

			Day in September 1994														
Sr. No.	Make	Reg^{n} No.	18	19	20	21	22	23	24	25	26	27	28	29	30	Repair finished	Avail^{y} %
1	A.L.	7958	✓	✓	✓	Mf	✓	Mf	✓	✓	✓	✓	✓	✓	✓		67
2	A.L.	7960	P	P	P	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		67
3	A.L.	7961	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Hg	1/10/94	93
4	A.L.	7964	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Mf	Mf	✓		87
5	A.L.	8043	Mc	Mc	Mc	Hg	Hg	Hg	Hg	Hg	Mc	Me	Me	✓	✓		40
6	A.L.	8044	Hg	Hg	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		37
7	TATA	5733	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	S_B	S_B	1/10/94	90
8	TATA	5734	✓	✓	Mt	✓	Md	Md	✓	✓	✓	✓	✓	✓	✓		77
9	TATA	8848	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
10	TATA	8890	✓	✓	✓	✓	✓	✓	Hr	✓	✓	✓	✓	Hl	Hl	6/10/94	90
11	TATA	8891	S_C	S_C	S_C	S_C	S_C	S_C	S_C	✓	✓	✓	Me	✓	✓		53
12	TATA	8893	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		80
13	TATA	1377	Hc	Hc	✓	✓	✓	Hc	Hc	Hc	Hc	Hc	Hc	✓	✓		47
14	TATA	1378	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
15	TATA	1379	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
16	TATA	1380	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
17	TATA	1383	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		97
18	TATA	1384	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
19	TATA	1392	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
20	TATA	1399	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
21	TATA	1402	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		100
22	TATA	1395	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		97
23	A.L.	8045	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Mc	Mc	Mc	6/10/94	87
Trucks unserviceable			5	5	4	3	3	5	4	2	2	2	5	4	4		

KEY

S Service **N/A/B/C**
P Preparation for test
M
- **b** brakes
- **c** cab
- **d** steering
- **e** electrical
- **f** fuel system
- **g** gearbox
- **h** chassis frame
- **m** motor
- **r** radiator
- **s** starter
- **t** clutch
- **u** universal joint
- **x** exhaust

H hydralics
- **c** controls
- **g** PTO
- **h** chains
- **l** leak
- **p** pipes
- **r** ram
- **t** tipping rear hook
- **u** pump

DD-1.2.2 October 1994 MAINTENANCE RECORD FOR 28 MULTIPACK COMPACTORS IN PRABHADEVI GARAGE

The date of registration (column 2) would not normally be included in a maintenance record The Key to the symbols is on the continuation of this table

Day Vehicle	Date of reg^{n}	Start of problem	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	availability percent
1069	19/10/92	5/9/94	M	M	M	A	P	M	P	Mz									50
1076	21/11/92										P	P	P	P	P	P	P	P	50
1078	30/11/92						Msp			Mh			SNH		Sp	Mh			75
1080	15/12/92							MsBo											94
1081	15/12/92	5/9/94	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	0
1085	18/12/92												Bu	Bt					88
1086	18/12/92											Bz						SNBz	88
1087	19/12/92							Msb	Msp		Sp	Mm			Sp			BoMs	75
1088	19/12/92		Mz	Sp							Sp	BvMv							88
1091	28/12/92							SNH	SN	Sp				Msp	Msp		Msp	Sp	69
1092	28/12/92								Mm			Mm		SNH	SN	SNMsp	Msp		63
1093	28/12/92									SN					Sp				94
1094	28/12/92						Sc	Sc	Sc	Sc	Mu								69
1095	28/12/92	30/9/94	Msp	Bz	Bz	M	Bz				SN								63
1096	2/1/93				Bz							SN		Bu			Msp	Mc	69
1098	2/1/93	27/9/94	Bp							Mf			Mm						81
1162	7/4/93															SB	SB	Sp	88
1173	23/4/93						SNH	SNMh	M	SBMsp		Mcb		Mbg	Sp				63
1178	27/4/93								MmSB		Bu				Bu	Bu	Bu		31
1179	27/4/93			Bz	Bz								SNH						81
1180	28/4/93											McbSB	SB	Sp				Md	81
1183	29/4/93	29/9/94	BtSB	BtSB	Bt	Bt		Bt			Bt								63
1185	28/4/93	9/8/94	Bz	Bz	Bz	Bt		Sp		Bu			Sp	Bo	Bo	Bto			50
1198	25/5/93												Sp		Sp				100
1199	26/5/93	30/9/94	Br	Bt,cb	Sc	Sc	Sc										Bw		63
1203	27/5/93																		100
1209	31/5/93						Mb												94
1210	31/5/93				SNH	SN			Mm		Sp			Sp	Sp		Bu	Bu	69

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DD 1.2.2 October 1994 continued MAINTENANCE RECORD COMPACTOR TRUCKS AT PRABHADEVI GARAGE

Day / Vehicl	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Problem continued until	Availy per cent
1069	ByMs									Mf		Mf		Mf			73
1076	P													Sp	Bz		87
1078	P	P	P	P	P	P	P	P	P								40
1080				Md	P	P	P	P	P	P	P	P	S_{NH}		Mbcs		27
1081	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	after 21/11	0
1085					Mn	S_B	By				Bq	Bq	Bq	P	P,Bt		47
1086				S_N													93
1087	S_NBoMs	S_H						Md									80
1088			Mf												Sp		93
1091							Mb								S_N		87
1092			Mf				Mfm	Mm	Mm	MmBt	MmBt	MmBt	MmBt	Mm	Mm	4/11/94	33
1093	Boy																93
1094										S_N							93
1095																	100
1096						Mb											93
1098	Mg	Mfg	Mg	Mg	Bt	BtS_A	Mg										40
1162																	100
1173			Sp							Mc		S_A		Sp			87
1178		Sp															100
1179													Bo				93
1180	Md		Md			S_N											80
1183			S_N				Bo	Bo	Bo	Bo	Bo						60
1185		Bo	Bo	Sp	Sp			Sp	Bq								80
1198		S_N		By					Bw								80
1199		Bo		Mg	Sp	S_N	S_N	Bp					Bw		MgBw	1/11/94	53
1203								McS_C	S_C	McS_C	$MspS_C$	S_C	S_C				60
1209					S_C	S_C	S_C							Bz			73
1210	By			By					S_N			Bqr	Bz	Sp			67

KEY

Capitals

A accident
B body
M mechanical
P Annual police test
S Servicing - **N/A/B/C/H**
Sp spare

Lower case

a chassis
b brakes
c clutch **cb** cab
d differential, rear axle
f fuel
g gearbox
h wheels
m motor
n starter
o hydraulic leak [o-rings]
p packer plate
q hydraulic controls
r general repairs
s steering
t PTO
v electrical
w wire rope
x ejector plate
y hydraulics
z tailgate

Appendix DD-1.3 Vehicles in service, May to October 1994
Ahmedabad Central Workshop

These records show the number of vehicles in service on each day for three months in 1994. May is one of the hottest months, July is during the monsoon, and October has a less extreme climate. Where the data is available, the total number of the particular type of vehicle based at the workshop is shown. The vehicles are operated on a seven days a week basis, with Sunday being the same as any other day. These records do not exactly indicate availabilities, because on some days there may be more vehicles ready for duty than are actually needed and used.

1. JCB - Front loader and backhoe.

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	2	2	2	2	2	2	3	2	3	3	3	3	2	3	2	3
July	2	3	2	3	2	3	4	2	3	1	3	2	3	2	3	2
Oct	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	3	3	3	3	2	2	2	2	2	3	3	3	1	3	3	**2.48**
July	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	**2.71**
Oct	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2	**2.39**

2. JCB tipper - Open tipper truck loaded by JCB

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	8	8	8	8	7	7	10	8	11	12	12	12	8	12	8	12
July	8	8	8	8	8	2	2	2	2	4	4	4	4	4	4	4
Oct	14	12	12	12	12	12	12	12	12	12	12	12	12	12	12	8

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	4	4	4	4	8	8	6	6	6	4	4	4	4	3	3	**7.19**
July	12	4	4	12	4	4	4	8	4	4	4	4	4	3	4	**5**
Oct	8	12	12	8	12	12	12	12	12	4	8	12	12	12	12	**11.3**

3. Large roll-on roll-off [hook lift] trucks Total number - 18

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	11	11	11	10	12	6	6	11	10	6	6	10	8	11	11	11
July	10	11	8	6	10	10	6	10	10	7	6	6	10	10	10	10
Oct	8	8	8	10	10	10	8	10	8	10	8	6	6	10	8	6

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	10	11	12	11	11	10	9	8	11	11	6	10	6	8	10	**9.52**
July	6	10	10	11	11	6	11	10	8	7	11	11	11	10	6	**9.0**
Oct	6	10	8	8	7	6	5	8	7	8	8	8	6	9	10	**7.90**

4. Small roll-on roll-off [hook lift] trucks Total number - 3

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
July	1	1	1	1	1	1	1	1	1	1	2	2	1	2	2	2
Oct	2	2	2	2	2	1	1	1	1	1	1	1	2	1	1	1

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	1	1	3	2	2	3	2	1	1	2	2	2	2	2	2	**1.52**
July	1	1	1	1	1	2	2	1	2	2	2	-	2	2	1	**1.35**
Oct	1	1	1	1	1	2	0	0	1	2	2	2	2	1	2	**1.32**

5. Compactor trucks Total number 6

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	3	3	4	4	3	3	3	3	3	4	4	4	4	4	2	4
July	3	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4
Oct	4	3	4	3	4	3	4	4	4	3	3	4	4	4	4	3

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	4	3	3	3	3	2	3	3	1	3	3	3	3	4	4	**3.23**
July	4	4	4	4	4	4	4	3	4	4	4	4	4	4	3	**3.87**
Oct	4	4	4	4	4	4	4	4	3	4	4	4	3	3	3	**3.68**

6. Large dumper-placer [skip lift] trucks Total number - 3

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	2	2	2	2	1	1	2	2	2	1	1	2	1	2	2	2
July	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Oct	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	2	1	2	2	2	1	1	2	2	2	2	2	2	2	2	**1.74**
July	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	**1.97**
Oct	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**1.97**

7. Small dumper placer [skip lift] trucks Total number - 4

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	0
Oct	2	1	2	2	2	2	2	2	1	1	1	2	2	1	1	1

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**0.03**
July	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	**0.26**
Oct	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**1.78**

8. Refuse rickshaw - three wheeler with tipping box Total number - 24

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	11	13	11	12	11	13	13	12	13	12	12	10	11	12	12	12
July	8	7	8	4	10	6	11	11	11	11	10	10	6	6	7	6
Oct	12	12	12	12	6	6	6	8	8	8	9	7	10	12	11	11

	Day in month															
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Ave**
May	11	11	12	11	6	0	0	5	11	12	12	13	11	13	11	**10.5**
July	7	6	5	5	13	13	13	14	13	13	13	12	12	12	6	**9.32**
Oct	14	12	13	13	10	11	10	10	14	12	11	12	11	11	11	**10.5**

Calendar for 1994 - to indicate whether there is a pattern according to day of the week

	Day in month															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
May	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M
July	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa
Oct	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su

	Day in month														
Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
May	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu
July	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su
Oct	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M

The average numbers shown on the right end of the tables do not necessarily lead to availability data, since a vehicle may be unused on a particular day because of a decision by a supervisor, not just because it is awaiting repair. The results shown here do indicate the degree of utilisation of each type of vehicle, and could be used in estimations of the costs of the different methods.

Appendix DD-2.1 Stores supply survey

This survey was based on data from one garage regarding the ability of central stores to provide the parts requested, for October 1993.

Day in October	Number of items indented at central stores	Number of items that were **not** available at central stores	Percentage of items requested that were supplied
1	7	6	14
4	17	12	29
5	8	5	38
6	8	3	63
7	10	3	70
8	9	6	33
9	10	5	50
11	9	5	44
12	8	5	38
13	7	3	57
14	7	4	43
15	9	9	0
16	10	7	30
18	9	7	22
19	9	6	33
20	7	5	29
21	8	4	50
22	6	4	33
24	10	7	30
25	7	5	29
27	10	5	50
28	10	5	50
29	20	4	80
30	5	3	40
TOTAL	229	131	43

It shows that, over the whole month, the central stores were able to supply the parts requested on only 43% of the occasions that they were requested. The method of recording the data is important here because it may be that when a request is made some, but not all of the requested parts of one particular type can be supplied. The table above is according to type of item (i.e. if five filters were requested but only two supplied, the entry in the table above would show that the order had been supplied). A better method of analysis might be to regard each object as an individual item, whether it is a washer or a large component, so that the "total" row at the bottom of the table shows the number of objects supplied.

Appendix DD-2.2 Maintenance staff at Bandra garage

Name of gang	Number of gangs	Makeup of gang	Total manpower
Service	1	1 fitter 1 labourer 1 oiler and greaser 2 washermen	5
Welding	2	2 welders 1 labourer	6
Carpentry	1	1 carpenter 1 labourer	2
Tyres	1	1 tyreman 1 tyre pressure man 2 labourers	4
Painting	1	1 painter 1 labourer	2
Electrician	2	1 electrician 2 labourers	6
Breakdown	2	2 fitters 6 labourers	16
Repair gangs	7	mechanics fitters labourers	24

Appendix DD-2.3 Servicing and docking schedules

MUNICIPAL CORPORATION OF GREATER BOMBAY
TRANSPORT BRANCH

MONTHLY MAINTENANCE SCHEDULE

GARAGE: . . . . . Date . . . . . .

Veh. Reg. No.: . . . . . .

Note: 1) Figures in brackets indicate number of greasing points.
2) The vehicle should be thoroughly washed and cleaned before servicing work is taken in hand.
3) A road test should be performed after the servicing is over and report duly filled in here.
4) Strike off whichever is not applicable and put a tick mark on the work done.

Sr No.	Description	Report
1.	Change oil in sump. Drain off while still hot. Use SAE 30 oil.	Changed/Not changed .....litres
2.	Check oil level in injection pump and governor housing, top up if necessary	Checked/Not checked Topped up with .....litres
3.	Check oil level in gearbox. Top up if necessary. Use SAE 90.	Checked/Not checked Topped up with .....litres
4.	Lubricate with oil can	
	i) controls to injection pump	Lubricated/Not lubricated
	ii) linkages of foot and hand brakes	Lubricated/Not lubricated
	iii) felt pads of clutch release bearing sleeve (some drops only)	Lubricated/Not lubricated
	iv) clutch linkages	Lubricated/Not lubricated
	v) door hinges, outer door handles, door latches, dovetails/strike plates	Lubricated/Not lubricated
5.	Grease with grease gun	Whether greased or not
	i) accelerator pedal bushing (1)	Yes/No/Obstruction
	ii) clutch pedal bushing (1)	Yes/No/Obstruction
	iii) brake pedal bushing (1)	Yes/No/Obstruction
	iv) propeller shaft U joints (3)	Yes/No/Obstruction
	v) propeller shaft centre bearing (1)	Yes/No/Obstruction
	vi) propeller shaft sliding yoke (1)	Yes/No/Obstruction
	vii) king pins (4)	Yes/No/Obstruction
	viii) tie rod ends (2)	Yes/No/Obstruction
	ix) drag link ends (2)	Yes/No/Obstruction
	x) front spring pins (6)	Yes/No/Obstruction
	xi) rear spring pins (6)	Yes/No/Obstruction
	xii) apply grease on helper spring brackets (4)	Yes/No/Obstruction
	xiii) hand brake level mounting bracket (1)	Yes/No/Obstruction
	xiv) intermediate level shaft (2)	Yes/No/Obstruction
	xv) upper ball socket (for	Yes/No/Obstruction
	xvi) swivel pin of tipping for rear (2) tipper)	Yes/No/Obstruction
6.	Check oil level in rear axle, top up, if necessary, with GP90 oil.	Checked/Not checked . Topped up with .....litres
7.	Lubricating water pump with bearing grease	Lubricated/Not lubricated
8.	Clean engine oil filter. Fill up filter with app. 0.5 litre oil	Cleaned/Not attended filled ..... litre oil
9.	Clean the prefilter at fuel pump	Cleaned/Not attended
10.	Check brake fluid level in master cylinder. Top up if necessary	Checked/Not checked Topped up with ..... litres

Sr No.	Description	Report
11.	Check and tighten if necessary	
	i) U bolts of front and rear springs	OK/Tightened/Not attended
	ii) Bolts of spring pin-lock plates	Checked and tightened/Not attended
	iii) Wheel nuts	Checked and tightened/Not attended
	iv) Mounting bolts of steering gear assembly	Checked and tightened/Not attended
12.	Drain off condensed water from air tank	Drained/Not attended
13.	Clean oil bath air filter and fill up to correct level with SAE-30 oil	Cleaned/Not attended Filled .....litres
14.	Check chassis frame for cracks	OK/Attended/Not attended
15.	Check and attend	
	i) battery mountings	OK/Attended/Not attended
	ii) head lights	OK/Attended/Not attended
	iii) parking lights	OK/Attended/Not attended
	iv) stop lights	OK/Attended/Not attended
	v) blinkers	OK/Attended/Not attended
	vi) brake lights	OK/Attended/Not attended
	vii) wiper machine	OK/Attended/Not attended
	viii) electric horn/bell	OK/Attended/Not attended
	ix) dipper	OK/Attended/Not attended
16.	Clean battery terminal. Tighten and smear Vaseline/petroleum jelly	OK/Attended/Not attended
	Examine Battery No.	

Cell	1	2	3	4	5	6
Sp. Gr.						
Voltage						

Check electrolyte level and top up with distilled water	OK/Checked/Not checked Topped up ..... litres
17. Check level of hydraulic fluid in tipper tank and top up.	Checked/Not checked Topped up ..... litres
18. Check fan belt tension and adjust	OK/Attended/Not attended

Names
Fitter I .....
Auto Wireman .....
Greaser .....
Labourer .....

The above work was carried out under my supervision

signed .....
Foreman

MUNICIPAL CORPORATION OF GREATER BOMBAY

DOCKING SCHEDULE "A" (4000 km) FOR HEAVY VEHICLES

Veh. No. ..... Date .....
KM Reading ..... Fitter's name .....

Sr. No.	Details of Work	Report
1.	Check gear oil level; top up if necessary	Attended .....litres / Not attended
2.	Check differential oil level; top up if necessary	Attended .....litres / Not attended
3.	Check steering oil level, top up if necessary	Attended .....litres / Not attended
4.	Check brake oil level in master cylinder; top up if necessary	Attended .....litres / Not attended
5.	Lubricate spring of clutch release bearing	Attended / Not attended
6.	Check and lubricate accelerator spring	Attended / Not attended
7.	Remove fuel tank strainer, clean and refit	Attended / Not attended
8.	Remove dirt/dust from primary and secondary filters	Attended / Not attended
9.	Remove water separator, clean it, replace gasket and refit	Attended / Not attended
10.	Check central bolts of all suspension springs (except Leyland vehicles)	Attended / Not attended / OK
11.	Check bolt and lock pin of shackle bracket and tighten if necessary	Attended / Not attended / OK
12.	Check steering free play and adjust	Attended / Not attended / OK
13.	Clean slack adjuster and grease it	Attended / Not attended
14.	Check sound of compressor	Attended / OK / Not OK
15.	Check for leakage in compressor lubrication connections and correct if necessary	Attended / OK / Not OK
16.	Check compressor inlet hose; replace if necessary	Attended / Not attended OK/ Replaced
17.	Check and tighten compressor mounting nuts and bolts	Attended / Not attended
18.	Paint/touch up the body wherever necessary	Attended / Not attended / OK
19.	Remove water from air filter of brake system	Attended / Not attended
20.	Check the condition of seats and repair if necessary	Attended / Not attended / OK

signed .....
fitter

The above works have been carried out satisfactorily directly under my supervision.
Remarks on the vehicle:

signed .....
Asstt. foreman / foreman

I have checked the following points from the above works:

1) Free play of steering
2) Condition of seats
3)
4)

signed .....
Sub-engineer

MUNICIPAL CORPORATION OF GREATER BOMBAY
EX. ENG TRANSPORT - CITY

Docking Schedule "B" (8000 km) for heavy vehicles

Veh. No. ..... Date .....
KM reading ..... Fitter's Name .....

Sr. No.	Details of work	Report
1.	Remove oil pan and clean it	Attended / Not attended
2.	Clean oil sump strainer	Attended / Not attended
3.	Replace starter with O.H. (overhauled) unit	Attended / Not attended
4.	Refit the oil pan with new	Attended / Not attended
5.	Replace dynamo with O.H. unit	Attended / Not attended
6.	Check the coupling of fuel injection pump for play	OK/Not OK/Replaced
7.	Remove and clean fuel line from fuel tank to feed pump and refit with new banjo washers	Attended / Not attended
8.	Remove and clean fuel line from feed pump to filter and refit with new banjo washers	Attended / Not attended
9.	Remove and clean fuel line from filter to injection pump and refit with new banjo washers	Attended / Not attended
10.	Check and tighten delivery valve holders at fuel injection pump	Attended / Not attended
11.	Check and tighten overflow lines joints	Attended / Not attended
12.	Check and tighten brake fluid line joints (Not for A/L [Ashok Leyland])	Attended / Not attended
13.	Check the metal brake fluid lines for wear and repair if necessary	Attended/Not attended OK/repaired
14.	Check and tighten bleeding nipples	Attended / Not attended
15.	Check and tighten wheel cylinder mounting bolts	Attended / Not attended
16.	Check and adjust brakes	OK/Adjusted/Not attended
17.	Check and adjust hand brake	Attended / Not attended
18.	Check and replace if necessary the engine foundation	OK/Adjusted/Not attended
19.	Check tie rod ends	OK/Not OK/Not attended
20.	Check, record and adjust tappet clearance if necessary	

cylinder	I		II		III	
valve	In	Out	In	Out	In	Out
Original						
Adjusted						
cylinder	IV		V		VI	
valve	In	Out	In	Out	In	Out
Original						
Adjusted						

21.	Check and tighten the heat exchanger bolts (TATA/TMB)	Attended / Not attended
22.	Replace tappet cover packing	Attended / Not attended
23.	Clean radiator fins with compressed air (Blow from engine side)	Attended / Not attended
24.	Check the tightness of driving head nuts and axle shaft nuts	Attended / Not attended
25.	Check the tightness of front and rear spring brackets	Attended / Not attended
26.	Check and tighten spring claiming bolts	Attended / Not attended
27.	Check and tighten shock absorber mounting bracket bolts	Attended / Not attended
28.	Clean compressor fins from oil sludge and dust	Attended / Not attended
29.	Check the vent hole in the top cover for unloader valve is not blocked	Attended / Not attended

Sr. No.	Details of work	Report
30.	Check the travel of push rod and ensure that it is at its minimum	Attended / Not attended
31.	Lubricate the four grease points of slack adjuster	Attended / Not attended
32.	Check the electrical connection and correct operation of brake light switch	Attended / Not attended
33.	Check all brake hoses for any leakage	Attended / Not attended
34.	Check for any damage to steel air pipe, replace if any	Attended / Not attended
35.	Check the rubber gaiter is in good condition for hand control valve, graduated HCV. Operate the lever and check proper functioning	Attended / Not attended
36.	Check the pneumatic wind off connector is in good condition (only for fail safe system).	Attended / Not attended
37.	Check the rubber gaiter for quadruple system protection valve (Dualline system).	Attended / Not attended
38.	For dual brake valve, lift the boot from mounting plate and apply few drops of engine oil between mounting plate and plunger	Attended / Not attended

Fitter Signature

The above work was carried out satisfactorily directly under my supervision.
I have checked the following points:

1) Bolts of oil pump strainer
2) Adjusted tappet clearances
3) Adjusted push rod travel of brake chamber

Asst. Foreman/Foreman

Sub-Engineer (

REMARKS:

MUNICIPAL CORPORATION OF GREATER BOMBAY
(TRANSPORT BRANCH, CITY)

DOCKING SCHEDULE "C" (16000 KM FOR HEAVY VEHICLES)

VEHICLE NO. ..... DATE .....

FITTER'S NAME .....

KM READING .....

Sr. No.	Details of work	Report
1.	Change engine oil, Drain off while it is hot (only for milky grade superior quality heavy duty engine oil) (All vehicles except for compactors and dumper placers.)	Attended / Not attended
2.	Change oil in gear box. Drain off while it is hot; clean the drain plug.	Attended / Not attended
3.	Change the oil in the differential. Drain off while it is hot.	Attended / Not attended
4.	remove and clean injectors, check injector pressure, record, and refit injectors	

Cylinder No.	I	II	III	IV	V	VI
Pressure						

5.	Replace the primary fuel filter element	Replaced / Not replaced
6.	Remove injector pipes, clean all pipes by blowing compressed air through them.	Attended / Not attended
7.	Remove and clean overflow lines and refit with new banjo washers	
8.	Replace clutch plate with serviced one.	Replaced / Not replaced
9.	Replace clutch release bearing	Replaced / Not replaced
10.	Replace the locking wire of the clutch fork	Replaced / Not replaced
11.	Replace oiled felt strips in the clutch bearing sleeve	Replaced / Not replaced
12.	Replace pressure plate assembly with serviced one	
13.	Check and tighten back plate nuts and bolts (brake system)	Attended / Not attended
14.	Check brake linings, change if necessary	Attended / Not attended
15.	Lubricate brake shoe return spring with few drops of oil	Attended / Not attended
16.	Replace shock absorber rubber bushes	Replaced / Not replaced
17.	Replace radiator foundation	Replaced / Not replaced
18.	Repack wheel bearings front and rear with heavy duty bearing grease	Attended / Not attended
19.	Replace oil seals of front and rear hub	Replaced / Not replaced
20.	Replace bearing (wheel bearing) lock of bearing adjusting nut	Replaced / Not replaced
21. i)	Add washing soda to radiator water, run the engine for 10 minutes, drain the water from block and radiator.	Attended / Not attended
ii)	Refill fresh water into radiator, run the engine for 10 minutes , drain the water from block and radiator	Attended / Not attended
iii)	Refill the radiator with fresh water	Attended / Not attended
22.	Replace all radiator hoses and their clips	Attended / Not attended
23.	Replace the fan belt	Replaced / Not replaced
24.	Lubricate speedometer cable and refit	Attended / Not attended
25.	Adjust head light focusing	Attended / Not attended

Sr. No.	Details of work	Report
26.	Replace vehicle number plate	Replaced / Not replaced
27.	Attend the body building work if necessary	Attended / Not attended
	HYDRAULIC BRAKES SYSTEM	
1.	Remove master cylinder, dismantle it with care, clean the parts, assemble with a new kit, refit on vehicle	Attended / Not attended
2.	Replace w.c. (wheel cylinder) kit front	Replaced / Not replaced
3.	Replace w.c. (wheel cylinder) kit rear	Replaced / Not replaced
4.	Remove and clean brake oil container and refit	Attended / Not attended
	PNEUMATIC SYSTEM	
1.	Check the compressor head securing bolt, cover bolt and mounting bolts for correct tightness.	Attended / Not attended
2.	Check for leak through oil seal of compressor and change it if necessary.	Attended / Not attended
3.	Check whether worm shaft locks for all slack adjusters are functioning properly.	Attended / Not attended

ASSTT. FOREMAN

I have personally checked the following points and with observations as mentioned below:

(i) Removed (old) clutch plate .....
.....

(ii) The wearing of brake liners .....
.....

(iii) All the parts mentioned in this form have been replaced and the following (old) parts can be reused in case of an emergency:

(a)
(b)
(c)

SUB-ENGINEER.....
(GARAGE)

[Extra servicing for compactor trucks]

MUNICIPAL CORPORATION OF GREATER BOMBAY
TRANSPORT (CITY) BRANCH

1000 KM / 50 Hours / 150 Hours
HYDRAULIC SERVICING AND MAINTENANCE SCHEDULE

			REMARKS
1.	Remove, clean and refit the filter	Attended / Not attended	
2.	Check PTO mounting bolts, tighten if loose	Attended / Not attended	
3.	Lubrication of tailgate hinges	Attended / Not attended	
4.	Greasing of all pivot pins		
	i) Packer cylinder mounting pins	Attended / Not attended	
	ii) Push out (ejector) cylinder mounting pins	Attended / Not attended	
5.	Check the cylinder mounting pin lock bolts	Attended / Not attended	
6.	Check the slider pin locks	Attended / Not attended	
7.	Check cylinder eye bolts	Attended / Not attended	
8.	Check the tilting rope holding pins	Attended / Not attended	
9.	Check rope holding pins and knuckle joints	Attended / Not attended	
10.	Greasing of container arm hinge pin and tailgate hinge pin	Attended / Not attended	
11.	Check free movement of manual hopper	Attended / Not attended	
12.	Check the looseness of all hydraulic connections/hoses etc.	Attended / Not attended	
13.	Checking and resetting hydraulic pressure if necessary	Attended / Not attended	
14.	Check and replace suction hose pipe if necessary	Attended / Not attended	
15.	Lubrication of all hydraulic operating levers	Attended / Not attended	
16.	Lubrication of sliding channels	Attended / Not attended	
17.	Check hydraulic tank filler and its seal	Attended / Not attended	
18.	Filter hydraulic oil in every "B" servicing	Attended / Not attended	

MUNICIPAL CORPORATION OF GREATER BOMBAY
TRANSPORT (CITY) BRANCH

16000 KM / 500 HOURS HYDRAULIC SERVICING AND MAINTENANCE SCHEDULE

			REMARKS
1.	Replace all filters	Attended / Not attended	
2.	Drain and refill hydraulic oil	Attended / Not attended	
3.	Open all the cylinders and replace seals	Attended / Not attended	
4.	Dismantle control valves DV?RV and replace "O" rings if necessary	Attended / Not attended	
5.	In addition attend 1000km/50hr/150hr schedule		

Appendix DD-2.4 Breakdown Report form

MUNICIPAL CORPORATION OF GREATER BOMBAY
TRANSPORT BRANCH

BREAK DOWN REPORT

J.E. Garage .....

Name of garage ..... REPORT FROM TRAFFIC SECTION

Vehicle No. ..... Date .....

KM reading ..... Type .....

Last S & D type N A B C D Date ..... KM reading .....

Time of breakdown ..... Breakdown register serial number .....

Place of breakdown .....

Nature of defects (as reported by driver) .....

.....

.....

signed .....

Junior Engineer

To Executive Engineer (Transport) REPORT FROM MAINTENANCE SECTION

Name of fitter attending .....

Time: From ..... To .....

Report of fitter .....

.....

Sub-engineer's findings:

.....

.....

Classification (A), (B) or (C)

A) Due to fault in last S & D

B) Non avoidable

C) Accidental

Details of artisans who attended last Name: .....

S & D if the classification is (A) Designation: .....

Junior Engineer's signature ..... Assistant Engineer's signature .....

Final report by Sub-Engineer (Maintenance)

.....

.....

Appendix DD-2.5 Table for scheduling preventive maintenance

Servicing and Docking Programme for the next month _September_ to be framed on the 25th of the current month and submitted on 26th in three copies.

Yes/No/Obstruction

								Programme of next month			
Sr No.	Vehicle No.	Opening reading of the current month	Closing reading of the 24th of current month	Expected running of the current month [(4-3)x5/4]	Opening reading of the next month [3+5]	Closing reading of the next month	Projected servicing or docking schedule	1st week 1-7	2nd week 8-15	3rd week 15-23	4th week 24-30
1	2	3	4	5	6	7	8	9	10	11	12
1	ABC 123	17953	18608	819	18772	19591	N, week 2		N		
2	DEF 456	21707	22650	1179	22886	24065	B, week 4				B

The programme for the next month may need some adjustment after it has been determined in a preliminary way by the method shown here so that the workload is evenly distributed through the month. This calls for the judgement of the maintenance engineer who knows how long each service or docking is likely to take.
If the distance covered by particular vehicle in a month has been unusually low because it has been in the workshop for repairs or for preparation for the annual test, it will be necessary to increase the figure shown in column 5.

Appendix DD-3.1 Examples of registers

July 1994 Prabhadevi Garage 1. Kilometre readings

Ser.	Vehicle	July 1994																
No.	No.	1	2	3			21	22	23	24	25	26	27	28	29	30	31	TOTAL
1	1069	27282	27452	27533			28685	28899	A 899	28821	28943	29064	29113	29198	29290	29407	25450	2208
7	1086	34035	34035	34035			34035	34035	34035	34035	34035	34035	34035	34035	34035	34035	34035	0
18	1173	21564	21784	21822			21992	23109	23203	23247	23330	23384	23521	23593	23737	23828	23871	2307

Note: Servicing is shown, for example 1069 had an "A" service on 23 July when the odometer reading was recorded as 28899. (Probably misread, it is more likely to have been 28799, judging from the other readings and the fact that the third row 8 advances at or before 99.)

July 1994 Prabhadevi Garage 2. Fuel consumption

Ser.	Vehicle	July 1994															
No.	No.	1	2	3	4		22	23	24	25	26	27	28	29	30	31	TOTAL
1	1069		120		100				110		130		85			130	1105
7	1086																0
18	1173	125			105		115				120				120		960

July 1994 Prabhadevi Garage 3. Engine oil consumption

Ser.	Vehicle	July 1994																						
No.	No.	1	2	3	4	5	6	7	8	9	10	11		21	22	23	24	25	26	27	28	29	30	31	TOTAL
1	1069															3									6
7	1086																					3			3
18	1173		3			2		3														2			10

July 1994 Prabhadevi Garage 4. Gear oil consumption

Ser.	Vehicle	July 1994																							
No.	No.	1	2	3	4	5	6	7	8	9	10	11	12	13		23	24	25	26	27	28	29	30	31	TOTAL
1	1069																								
7	1086																								
16	1098													-/10					3						13
17	1162						3						2/5												10
18	1173																								

Note: Gear oil use is recorded as x/y, where x is the oil used for the gear box and y is the oil used for the differential; the same grade is used for both. For example, on 13 July no oil was put into the gearbox of 1098, but 10 litres were put into the differential.

July 1994 Prabhadevi Garage 5. Ram [hydraulic] oil consumption

Ser.	Vehicle	July 1994																						
No.	No.	1	2	3	4	5	6	7	8	9	10	11		21	22	23	24	25	26	27	28	29	30	31	TOTAL
1	1069								40											45					85
7	1086															15									15
18	1173							15						10		30									55

October 1994 Prabhadevi Garage 6. Kilometre readings

Ser.	Vehicle	October 1994																	
No.	No.	1	2	3		10		21	22	23	24	25	26	27	28	29	30	31	TOTAL
1	1069	32104	32104	32119		32270		32270	32270	32270	32349	32427	32427	32460	32470	32544	32544	32615	511
7	1086	34035	34161	34212		34761		35576	35661	35747	35790	35867	35950	36030	36114	36197	36281	36367	2332
18	1173	27601	27773	27870		28174		28948	29040	29097	29097	29097	29099	29142	A-148	29275	29311	29545	1944

October 1994 Prabhadevi Garage 7. Fuel consumption

Ser.	Vehicle	October 1994																
No.	No.	1	2	3	4		22	23	24	25	26	27	28	29	30	31	TOTAL
1	1069						125			125				100			860
7	1086	110			100					110			80			95	830
18	1173		125		115		123			25			130				838

TYRE HISTORY REGISTER

TYRE N°. I2579PR89 . MAKE DUNLOP DATE OF PURCHASE 20.3.90 RECEIVED FROM A.E. (Tr) .

GATE PASS N° ._ Above tyre received along with vehicle No MH01 H 7716 on 20.3.90

Vehicle No.	Fitted on	Km reading	Removed on	Km reading	Total run	Details of repairs				Total cost	B.R.T. No. and date	Signature shop recorder
						Gate pass & indent No.	Name of the firm	Delivery note No.	Repair details			
MH01 H 7716	Original	0	3.6.90	02107	2107	77945 20.6.90	M/s Tyreline	3228 20.6.90	cut	10		
MH01 H 7768	28.6.90	5363	17.6.91	25039	19676	38632 18.6.91	"	1509 18.6.91	"	10		
MH01 H 7698	18.6.91	06919	23.6.91	07284	365	38636 24.6.91	"	1523 24.6.91	"	10		
MH01 H 7768	30.6.91	08843	5.4.92	21615	12772	38685 7.4.92	M/s Unisol Tyres	405 21.4.92	resole	850		
MH01 H 7779	22.4.92	28601	5.6.92	31870	3269	38688 22.4.92	M/s Tyreline	1004 22.4.92	cut	10		
MH01 H 7814	7.6.92	24986	25.7.92	27987	2992	38699 6.6.92	"	1097 6.6.92	"	10		
MMK 7762	27.7.92	71089	16.8.92	72473	1409	33815 17.8.92	M/s Unisole	539 28.8.92	resole	1375		
MH01 H 7698	29.9.92	33124	19.12.92	40848	7729	76234 15.6.94	"	1296 11.7.94	resole	1220		
MH01 H 7688	22.12.92	61697	9.4.93	67274	5577	62458 15.8.94	M/s Tyreline	40 15.8.94	cut	10		
MH01 H 1092	14.4.93	6712	4.6.94	32923	26211							
1185	12.7.94	15671	14.8.94	15671	2560							
MH01 H 1093	16.8.94	36463	14.10.94	42203	5740							
TOTALS					90407					Rs3505		

Km run to first resole 34920; then to second 7670; to third 7729; run on last resole 40088km

Tyre rejected due to tread damage under order form No. 9503 of 15.11.94 M/s Kumar Ent. S.E.Tr A.E.Tr III Ex Eng. Tr (City)

page DD-26

Appendix DD-3.2 Tyre records and ways to increase tyre life

Introduction

by A K Sarkar

Every year a large amount of money is spent on the procurement of tyres and tubes for solid waste vehicles. The tyre section is often the most neglected part of any garage or workshop. Records may not be maintained properly, sometimes no records are kept and the section is controlled by unqualified staff.

The prices of tyres are increasing day by day, and as the solid waste vehicles are to dump the refuse at disposal grounds which are full of scrap metal, nails, broken glass etc., there are chances of punctures and damage to the tyres. So, attention should be given to getting the optimum life from each tyre and thereby satisfactory service from each refuse vehicle.

Tyres for Solid Waste Vehicles

There are many tyres available in the market. These tyres are specified in the following ways:

1. Size - 900 x 20; 1000 x 12, 825 x 20 etc
2. Material used - Nylon, Rayon
3. Ply ratings - 12, 14, 16 ply
4. Pattern - General, Mining etc

As most of the solid waste vehicles have gross weights of 12 to 19 tonnes, 900 x 20 and 1000 x 20 sizes will be suitable with 16 ply ratings.

In Prabhadevi Garage, Mumbai, for its Multipack compactors, 1000 x 20; 16 PL tyres are used. Tyre manufacturers' recommendations in respect of the tyre pressure and load on each tyre are below:

Tyre Size	Ply Rating	Tyre Pressure psi	Load on Each Tyre, Kg
900 x 20	12	85	2540
900 x 20	14	95	2730
1000 x 20	14	90	2955
1000 x 20	16	100	3170

Rayon tyres are suitable for small distances and for resoling, but the price difference between rayon and nylon is negligible and as there is only one manufacturer now making rayon tyres in India, it is better to go for nylon tyres. Mining type tyres may be used at the rear because of their gripping capacity, especially during the monsoon season.

Problem of Tyres in Solid Waste

The main enemies of tyres of refuse vehicles are nails, glass, metal scraps, pieces of cups and plates, sharp edges of stones etc. Sometimes tyres are scrapped after only 5000 to 10000 kilometres because of heavy damage caused by these materials. The average life of the 1000 x 20 tyres of Prabhadevi Garage is 60 000 km, which is excellent for refuse vehicles.

In the monsoon the number of punctures increases significantly compared to other seasons because of the slushy condition of disposal grounds. Statistics available from Prabhadevi garage, Mumbai are shown in figure DD-3.1.

Tyre Records

All records regarding tyres are being kept in three registers in Prabhadevi Garage. These records help in planning, for future purchasing, stocking etc. These records also indicate the reasons for tyre failures and any bad decisions, and thus indirectly increase tyre life. They also help to stop pilferage of good tyres.

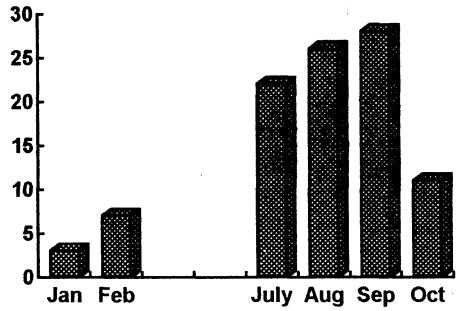

Figure DD-3.1 Variation of punctures with season
(The monsoon in Mumbai is between June and September.)

The following three registers are maintained in Prabhadevi Garage:

1) Tyre pressure register
2) Tyre movement register
3) Tyre history register

Tyre Pressure Register

Tyre pressure must be checked before releasing the vehicle for duty. The tyre pressure register is a very simple register and is maintained by the staff of the tyre section. Pressure is measured before the vehicle leaves the garage, and if necessary the tyre is inflated to the pressure recommended by the tyre manufacturer.

Low tyre pressure damages the side walls and the two ends of the tyre rolling surface. High pressure causes wear at the middle of the tyre surface. Both low and high pressure damage the tyre and reduce tyre life significantly. (Tyre life can be reduced by 30% if the tyres are underinflated by 15%.) Overinflation can also increase the incidence of wheel spin on soft wastes, leading to more punctures because the spinning wheels cut down through the waste until they reach something hard, which may also be sharp. The Prabhadevi Garage experienced tyre bursts due to uneven tyre pressure of the rear wheels. It has been reported in Britain that there is sometimes a tendency for tyres of the same size to be always inflated to the same pressure; the optimum pressure depends on the loading on a wheel (different between front and rear wheels) and should always be to the manufacturer's recommendation.

The recording of tyre pressures in this way adds significantly to the work of checking the tyres, but, if diligently monitored, shows the condition of the tyres (including the existence of slow punctures) and may prevent vehicles requiring a change of tyre in the middle of a shift. The example of a register shown below is for the rear tyres only; whilst serious underinflation is less obvious in a tyre that is paired with another on the rear axle, it is also useful to monitor the pressure in the front tyres on a regular basis.

Example of Tyre Pressure Register (20.8.94)

	Tyre pressure found/after inflation; psi			
Vehicle No	Rear right outer tyre	Rear right inner tyre	Rear left outer tyre	Rear left inner tyre
1198	80/80	40/80	80/80	80/80
1098	50/80	80/80	80/80	80/80
9067	80/80	65/80	65/80	80/80

Tyre Movement Register

This is an important register. It may form a part of the tyre history register. If regularly monitored it may help to stop pilferage of tyres by drivers.

Example of Tyre Movement Register

Date	Veh No	Tyre No	Tyre Size	Where Fitted	Removed from Where
02/03/94	5890	JK4926	1000 x 20	RRO	-
10/03/94	6712	DUN 426	1000 x 20	-	RRO

Note: "RRO" stands for *rear right outer*

Tyre History Register
This is the main register, showing tyre life, repairs to tyres by outside agencies, expenditure for each tyre, defects of the tyre and its movement from one vehicle to another.

It helps in the planning of the yearly procurement of tyres. For example, the Prabhadevi Garage has only 203 tyres (1000 x 20) including 20% spare tyres for its 28 Multipack compactors. The Garage can buy tyres only against scrapped tyres as noted in the register and duly signed by officials. This also restricts the over purchase of tyres.

An example of a Tyre History Register is shown on page DD-3.3

There is no schedule of servicing of tyres because greasing or tightening of nuts and bolts etc. are not required. However, some visual inspection and proper inflation of tyres are essential to obtain optimum life from each tyre. Sharp materials should be removed from tread pattern and between the rear tyres before they can cause damage to the rolling surface and side walls of the tyres.

The following checks are essential
1) Cuts on side wall
2) Cuts on surface
3) Nails inside tyre
4) Distance plate to check the gap between wheel rims.

If there is any cut, tyre should be repaired immediately and not continue to be used for work because this will reduce the tyre life further.

The tyre surface should be checked visually and if it is also found from the tyre history register that it has covered its normal life it should be sent for resoling (retreading) to extend its life. However, it should not be resoled on more than one occasion.

Conclusion
The tyre movement register and the tyre history register are very important and should be maintained strictly and precisely. This will reduce expenditure and improve the serviceability of the tyres and the refuse vehicle.

Appendix DD-3.3 Equipment history record

Two examples of vehicle history records were studied. One was used for compactor trucks at Prabhadevi and the other for road rollers.

Vehicle history books used at Prabhadevi garage were notebooks 14cm by 17cm, and included the following information and table for writing in details about maintenance work:

Vehicle No.	MH01 H 1069
Vehicle type	CS 1611
Engine No.	
Chassis No.	DIB 025
Wheelbase	CS 166"
Service	Refuse

Job date	Km reading	System attended and job carried out	Fitter	Issue slip no.	Parts replaced	Signature

The form that was being used for road rollers can be taken as an example of what a comprehensive equipment history record should comprise. The record is 31 pages long, so, instead of reproducing the record in full, its contents will be described in general terms. Each type of vehicle has its own specific requirements for such a history document, so the type of information asked for and the space allocated to each type of information should vary according to the type of equipment and duty.

Considerable thought should be given to the preparation of the history document. Requests for information that can easily be found elsewhere should be avoided, as should information that is not likely to be put to an important use. The space allowed for each entry should be sufficient, suggesting that a proposed format should first be used on an experimental basis so that the space needed for each entry is reasonable. If the document is to be used regularly and last as long as the vehicle, it should be strong enough to survive regular use, with good quality paper and binding. Clerks and mechanics are more likely to look after a document that has an expensive appearance. The paper should be ruled so that entries can be made neatly and without using too much space.

The first page describes the type of vehicle, gives its number and the garage at which it is based. A list of contents then follows since the document is so large.

Page two is concerned with recording details of occasions when the record has been checked or when references have been taken from it. It has two columns, each with space to write the date, the person checking, the part of the record checked or referred to, and any remarks or instructions.

The third page is known as the *equipment record*, and gives many details about the machinery:

A Purchase details:

- Sanction number and date
- Authority
- Amount sanctioned
- Name and description of equipment
- Manufacturer's name and address
- Year of manufacture
- From where it was purchased

- Estimated life
- Date of receipt
- Garage where kept initially
- Expiry date of warranty
- Operation manual number and location
- Service catalogue number
- Identification number

B Technical and operational specifications

- Manufacturer's classification
- Service needed
- Special operation and maintenance instructions
- Details of major units, accessories and assemblies

C Maintenance standard specifications - manufacturer's recommendations

- Preventive maintenance tasks and frequencies - checks, adjustments, lubrication, replacements, overhauling of units; specification of parts and lubricants.

The fourth page is known as the *transfer record*, and it allows recording of the date when the machine is transferred to a new location, the name of the new location, and the reason for transfer.

Page five is concerned with the *Engine overhauling schedule and attendance report*. Since it is likely that engines will be exchanged at least once during the lifetime of the vehicle, the record notes the engine number, type, date of installation, date of overhaul, compression pressures and main dimensions of each engine.

Pages six to ten require information about units, assembly and system overhauling or replacement. For each of the following units or items there are ten spaces for writing down when the components were overhauled:
Cylinder head assembly, fuel injectors, fuel injection pump, fuel filter, oil filter,
clutch plates, clutch assembly, radiator, water pump, gear box, differential, steering assembly,
and brake assembly,
A compactor truck would have a number of other components that would need regular servicing. It would be useful to indicate the type of problem that cause these components to be replaced, or whether they are replaced according to the preventive maintenance schedule, but there is the danger of requiring too much clerical work, so if the information is available somewhere, it might be better to cross reference that information rather than writing the same information twice (in two different types of record). Equipment history records are useful for determining the total costs associated with each item of plant, so it would be a useful compromise to write here the total cost of repairs and maintenance (parts and labour).

The eleventh page is entitled *battery record*. This provides space for writing the specification of battery required and details of replacements - the dates on which replacements were made, the make of each battery used, the reasons for the replacements and the condition of the replacement batteries (specific gravity, voltage and levels).

The next two pages are called the *operational record*, and there is a large amount of information that could be recorded here. One must consider the purposes that the information would be put to, and whether the information is readily available in another document. If the information system were computerised, it would be useful to have the following information in an operational record:

- hours utilised
- number of trips made,
- weight of refuse collected,
- cost of service (based on internal charging system rates),
- value of work done,
- fuel consumed
- engine oil consumed
- hydraulic oil consumed
- other fluids consumed
- total cost of fuel and oils consumed.

Such information could be kept on a monthly basis throughout the life of the vehicle, and would furnish useful management information about the condition, relative costs and economic life of each vehicle.

The next two pages are devoted to the Preventive maintenance schedule and attendance record. Again a great deal of information could be entered into such a record, but in the absence of a computerised system the best approach might be to record the date, odometer (km gauge) reading, type of service (if appropriate) and location where each maintenance task is carried out. This information would allow more detailed information to be found easily from other records.

A more detailed record of the maintenance work is to be written on the following five pages. This information should be kept somewhere, but it may be that the equipment history record is not the most convenient place. The information requested is

- the type of work - breakdown repair, preventive maintenance (type of service or docking), overhaul, unit replacement etc.,
- the date on which the work is completed,
- the job number,
- the tasks performed,
- the down time (in days)
- the agency undertaking the work - if a municipal workshop or garage, the man-hours spent on the work, if outside, the charge for the work,
- the spares and materials used, and their costs, if used internally.

A further ten pages are left blank for the addition of miscellaneous notes. Experience might show that it is a better use of paper and the document as a whole if more space is given to the specific types of entry mentioned above, and less to random or unstructured comments

Finally, there is a page concerned with the *scrapping* of the equipment. This begins by asking for the reasons for wanting to scrap the equipment or vehicle. It then solicits details of the proposal to scrap the vehicle - date and authority. The date of inspection by the scrap committee, the members of the committee and comments by the committee are requested next. Next come the date the tender is invited, the sanction number and date, the authority responsible, the buyer and the selling price. There is also space for an inventory of any spares or materials sold with the scrapped vehicle. Finally, there are the signatures of the people responsible for this transaction.

From acquisition, through operations and maintenance, and finally to scrapping, this is the complete history of one vehicle or machine.

Appendix DD-3.4 List of vehicle defects

This list was compiled from records as a management monitoring exercise to investigate the problems that affected the refuse compactor trucks. The right hand column has been added to the original record to give an understanding of the time lost because of these defects.

MUNICIPAL CORPORATION OF GREATER MUMBAI
(TRANSPORT BRANCH)

LIST OF THE VEHICLES WITH THE DEFECTS IN DETAIL

Sr. No.	Vehicle No.	Failure From	Period To	Nature of Failures	Days off road
1.	MH01-H-1069	5.4.1993		Tailgate not operating	
	- " -	14.5.93	15.5.93	Ram pipe broken	1
2.	MH01-H-1706	13.4.93	15.4.93	Ram oil leakage	2
	- " -	4.5.93	4.5.93	Tailgate hook broken	1
	- " -	5.5.93	11.5.93	Tailgate lifting mechanism hydraulic servicing	6
	- " -	20.5.93	20.5.93	Container lock	1
	- " -	31.5.93	31.5.93	Tailgate not operating	1
	- " -	2.6.93	3.6.93	Hydraulic work	1
	- " -	4.6.93	5.6.93	Intermediate lock	1
	- " -	15.6.93	16.6.93	Hydraulic servicing	1
	- " -	23.6.93	26.6.93	Intermediate lock. Tailgate lock opens while loading	3
	- " -	10.7.93	10.7.93	Hopper rod bent	1
3.	MH01-H-1078	12.4.93	13.4.93	Hydraulic Servicing	1
	- " -	23.4.93	23.4.93	Tailgate lock	1
	- " -	8.5.93	11.5.93	Tailgate lock	3
	- " -	15.5.93	15.5.93	Tailgate chain broken	1
	- " -	17.5.93	17.5.93	Pipe broken	1
	- " -	21.5.93	22.5.93	Tailgate opens while operating	1
	- " -	25.6.93	25.6.93	Tailgate chain broken	1
	- " -	2.7.93	3.7.93	Tailgate opens while operating	1
4.	MH01-H-1080	5.4.93	6.4.93	Carrier plate not working	1
	- " -	21.5.93	22.5.93	Tailgate lock. Tailgate opens	1
	- " -	24.5.93	26.5.93	Hydraulics not working	2
	- " -	14.6.93	15.6.93	- " -	1
	- " -	18.6.93	19.6.93	- " -	1
	- " -	10.7.93	10.7.93	Tailgate lock opens	1
	- " -	21.7.93		Ejector cylinder bent	
5.	MH01-H-1081	7.4.93	8.4.93	Hydraulic servicing	1
	- " -	23.5.93	25.6.93	- " -	2
	- " -	7.7.93	7.7.93	PTO lever. Cylinder leakage	1
6.	MH01-H-1085	15.5.93	19.5.93	Container rope broken	4
	- " -	18.6.93	19.6.93	Both container lifting arms broken	1
	- " -	28.6.93	29.6.93	Container arm LHS broken	1
7.	MH01-H-1086	17.5.93	19.5.93	Hopper plate broken	2
	- " -	20.5.93	20.5.93	PTO pump work	1
	- " -	21.5.93	25.5.93	- " -	4
	- " -	3.6.93	5.6.93	- " -	2
	- " -	17.6.93	18.6.93	Container lock	1
	- " -	25.6.93	26.6.93	Hydraulic servicing	1
	- " -	13.7.93		- " -	

Sr. No.	Vehicle No.	Failure From	Period To	Nature of Failures	Days off road
8.	MH01-H-1087	21.6.93	21.6.93	Tailgate pin	1
9.	MH01-H-1088	17.5.93	24.5.93	Hopper lifting platform bent	7
	- " -	22.6.93	24.6.93	Ejector cylinder bent	2
	- " -	13.7.93	15.7.93	Hydraulic servicing	2
10.	MH01-H-1091	31.5.93	2.6.93	- " -	2
11.	MH01-H-1092	17.5.93	17.5.93	Hydraulic work	1
	- " -	14.6.93	14.6.93	Hydraulic servicing	1
	- " -	16.6.93	21.6.93	Ram oil leakage. Hopper arm rod bent	5
12.	MH01-H-1093	21.6.93	24.6.93	Tailgate lock.	3
	- " -	26.6.93	28.6.93	PTO not working	2
	- " -	7.7.93	7.7.93	Hopper not coming down	1
13.	MH01-H-1094	19.5.93	20.5.93	Tailgate chain broken	1
14.	MH01-H-1095	15.4.93	17.4.93	Hydraulic servicing	2
	- " -	12.5.93	14.5.93	- " -	2
	- " -	19.5.93	24.5.93	Hydraulic work	5
	- " -	19.6.93	19.6.93	Both packer cylinders not working	1
	- " -	3.7.93	3.7.93	Ram oil leakage	1
	- " -	7.7.93	9.7.93	Hopper not working	2
15.	MH01-H-1096	15.4.93	17.4.93	Hydraulic servicing	2
	- " -	2.6.93	3.6.93	Ram oil leakage. Hydraulic servicing	1
	- " -	11.6.93	14.6.93	Ram oil leakage	3
	- " -	26.6.93	28.6.93	Hopper rod bent	2
	- " -	29.6.93	2.7.93	Hopper rod bent. Tailgate lock. Ram oil leakage.	3
	- " -	7.7.93	8.7.93	Intermediate lock bent	1
	- " -	17.7.93	21.7.93	Hydraulic servicing	4
16.	MH01-H-1098	29.5.93	31.5.93	Intermediate lock	2
	- " -	16.6.93	17.6.93	Hydraulic servicing	1
	- " -	16.7.93	17.7.93	Tailgate chain broken	1
17.	MH01-H-1098	19.4.93	22.4.93	Hydraulic servicing	3
	- " -	4.5.93	5.5.93	Hopper pin broken	1
	- " -	24.4.93		Packer cylinder not working	
	- " -	21.6.93	21.6.93	Hydraulic servicing. Container plate bent	1
	- " -	24.6.93	24.6.93	Tailgate lock opens	1
	- " -	29.6.93	29.6.93	Hopper bent	1
	- " -	12.7.93	12.7.93	Hydraulic servicing	1
18.	MH01-H-1178	11.5.93	12.5.93	Hydraulic servicing	1
	- " -	17.5.93	17.5.93	Tailgate chain	1
	- " -	29.5.93	2.6.93	Container arm not proper	4
	- " -	4.6.93	5.6.93	Rear hopper rod bent. Hydraulic servicing	1
	- " -	14.6.93	14.6.93	Tailgate lock opens. Hopper not coming down	1
	- " -	17.6.93	17.6.93	Tailgate opens	1
	- " -	28.6.93	28.6.93	Hopper rod bent (vehicle sent twice during the same period)	1
	- " -	21.7.93	21.7.93	Hopper rod bent (vehicle sent twice during the same period). Ejector cylinder piston not closing	1
		22.7.93	22.7.93	Hopper not coming down	1
19.	MH01-H-1173	25.5.93	27.5.93	PTO not working	2
	- " -	11.6.93	12.6.93	Tailgate opens	1
	- " -	14.6.93	21.6.93	Hopper bent	7
	- " -	30.6.93	3.7.93	Ejector cylinder not closing	3
	- " -	8.7.93	11.7.93	Ejector cylinder bent	3
	- " -	21.7.93	21.7.93	Hopper rod bent	1

Sr. No.	Vehicle No.	Failure From	Period To	Nature of Failures	Days off road
20.	MH01-H-1183	20.5.93	20.5.93	Tilting rope pin broken	1
	- " -	29.5.93	31.5.93	Hopper rope broken	2
	- " -	2.6.93	4.6.93	Ejector cylinder bent	2
	- " -	6.7.93	6.7.93	Tailgate opens while loading	1
	- " -	8.7.93	9.7.93	Hopper lock bent. Hydraulic servicing	1
	- " -	12.7.93	17.7.93	Hydraulics not working	5
	- " -	21.7.93	21.7.93	Loaded container not lifting	1
21.	MH01-H-1179	28.5.93	28.5.93	Tailgate chain broken	1
	- " -	14.6.93	16.6.93	Hopper rod broken	2
	- " -	6.7.93	12.7.93	Tailgate opens. Hydraulic servicing	6
	- " -	15.7.93	15.7.93	Hopper rod both side bent	1
	- " -	16.7.93	17.7.93	- " -	1
22.	MH01-H-1180	17.6.93	18.6.93	Tailgate opens	1
	- " -	8.7.93	8.7.93	Container arm and hopper rod bent	1
	- " -	13.7.93	14.7.93	Hopper rod bent	1
23.	MH01-H-1198	9.6.93	10.6.93	Hydraulics not operating	1
	- " -	12.6.93	12.6.93	- " -	1
	- " -	15.6.93	16.6.93	Tailgate chain broken	1
	- " -	16.6.93	16.6.93	Tailgate lock broken	1
	- " -	22.6.93	23.6.93	Ejector cylinder piston bent	1
	- " -	2.7.93	8.7.93	Ejector not closing and hydraulic servicing	6
24.	MH01-H-1203	11.6.93	11.6.93	Hydraulic work	1
	- " -	14.6.93	16.6.93	PTO gear not working	2
	- " -	29.6.93	29.6.93	Hopper rod bent	2
	- " -	8.7.93	8.7.93	Hydraulic servicing	1
25.	MH01-H-1209	24.6.93	25.6.93	Hydraulic servicing	1
	- " -	21.7.93		Hopper mounting beam work. Major work on both sides Hopper rod bent	
26.	MH01-H-1199	28.6.93	30.6.93	Hopper rod bent	2
	- " -	14.7.93	15.7.93	Container arm bent	1
27.	MH01-H-1162	19.6.93	24.6.93	Ejector cylinder piston bent	5
	- " -	30.6.93	3.7.93	- " -	3
	- " -	15.7.93	17.7.93	Packer plate not working	2
	- " -	28.6.93	28.6.93	Hopper rod bent	1
	- " -	21.7.93		Ejector cylinder not closing	
28.	MH01-H-1210	24.6.93	30.6.93	Ejector cylinder piston bent	6
	- " -	12.7.93	12.7.93	Hydraulic servicing	1