

Chapter 17

Logistic Support

Abstract The aim of this chapter is to describe the factors involved in supporting physical assets from the point of introduction into service, over their lifetime through to disposal. These factors also influence the initial choice of equipment. *Outcomes* In this chapter you will learn that many problems in physical asset management can be reduced by considering the supportability of equipment at the acquisition stage. You will learn about the factors that need to be taken into account in planning equipment support, and will be provided with check lists to assist this type of planning.

17.1 Introduction¹

Physical assets require the support of people, services, and resources of many types, including operators, maintainers, repair facilities, consumables, spare parts, documentation, and training. To ensure that these supports are provided and budgeted for, several types of analysis are needed. The following techniques are applicable:

- Logistic Support Analysis—the detailed analysis of support requirements.
- Level of Repair Analysis—is concerned with deciding where particular types of repair will be carried out, for example, what will be done by local technicians, what by central workshops, and so on.
- Integrated Logistic Support—is a system for ensuring that, once we have decided on our logistic support concept, all aspects necessary to implement it are identified and implemented.
- Through Life Support—is a concept which emphasizes the need for logistic support to extend over the whole life of the equipment. This consideration is important where contracts for support are to be let.
- Supplier Viewpoint—Under this heading we consider the issue of logistic support from the point of view of a manufacturer or supplier, for whom both commitments and business opportunities exist.

¹ ISO 55000 Clause 2.4.2 “Asset management is based on a set of fundamentals” at (b) “This includes ... (3) the integration of asset management processes with ...logistics...”.

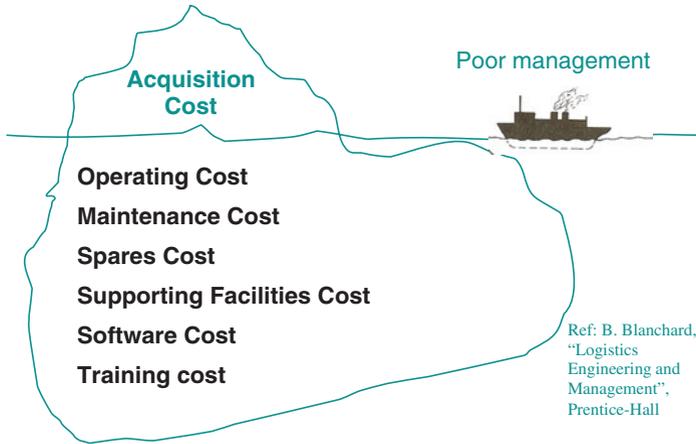


Fig. 17.1 Ice Berg diagram

The aims of these techniques are to:

- Form a basis for planning and budgeting for the logistic support of equipment from acquisition through operation to disposal—through life support;
- Take account of costs over the life cycle of equipment, and not just focus on minimizing acquisition cost.

In the case of common user equipment, purchased and used in an urban or industrial environment with many surrounding support services, the techniques outlined in this chapter are relatively easy to apply. This does not mean that the principles involved can be ignored or that it is impossible to go wrong. However, the available support of equipment distributors, manufacturers, and specialized maintenance organizations can greatly reduce the extent to which asset owners need to deal with the details of logistic support. By contrast, if we are to operate away from a supportive environment, great care must be taken to ensure that the essential logistic support elements are in place.

Figure 17.1, the Ice Berg diagram, based on the original by Ben Blanchard,² illustrates graphically the dangers of failure to recognize the activities and costs involved in logistic and through life support of physical assets.

17.2 Logistic Support Analysis (LSA)

Logistic support analysis is the determination of the equipment, people, and facilities required to support a given capability throughout its life. Logistic support analysis is designed to determine the “what, how, and where” of the provision of support

² Blanchard, Benjamin S, “Logistics Engineering and Management”, 4th ed, Prentice-Hall International.

resources and services for physical equipment. It is carried out in the early decision making phase of an acquisition plan. The aim of LSA is to ensure that our assets can be logistically supported in a practical and cost-effective way, and to define how this can be done. The analysis may influence the choice of the equipment itself, and will influence the nature and structure of our supporting services. LSA is concerned with:

- assessing the net maintenance and logistics load created by the asset,
- setting the maintenance and repair policies at a strategic level,
- establishing the extent and location of maintenance, repair, and overhaul facilities. This may involve decisions to outsource some or all of these tasks,
- costing for the above.

Logistic support analysis starts by identifying the type and quantity of assets involved, the utilization rate, and service level required. For example, with a vehicle fleet this will mean identifying the vehicle types, quantities, availabilities, and average kilometers run per year. At this stage we will also identify any special environmental or operational factors that affect our analysis. This can include climatic factors such as heat, cold, dust, or corrosive environments and operational factors such as equipment loading and planned equipment availability. In addition, we consider the extent to which new equipment will replace existing equipment, and the impact that this will have on the net requirement for logistic support.

17.2.1 Logistic Support Basic Data

In order to carry out LSA, basic data regarding the equipment to be supported must be established. This includes:

- Asset type
- Asset quantity
- Utilization rate or “rate of effort”
- Planned equipment availability
- Period of support or overall operation duration
- Specific environmental or operational factors
- Nature and quantity of equipment to be retired and the effect of this on support requirements.

17.2.2 Logistic Support Detailed Factors

LSA continues with an analysis of the logistics of operational support, including the provision, transport, and storage of consumables. This can be summarized as follows:

- Consumables by type
- Consumption rate
- Transportation

- Access
- Storage
- Shelf life of consumables
- Waste disposal

We then turn to a consideration of operation, maintenance, repair, and overhaul. Factors include the life of the prime equipment, the major assemblies or subsidiary items involved, the provision of maintenance facilities and of spare parts. Key points are summarized as follows:

- Planned life of main equipment
- LSA mission duration (e.g, provisioning of spares for first 3 years)
- Equipment criticality, reliability, and availability targets
- Test and evaluation criteria and standards
- Extent of in-house and/or outsourced support
- Major assemblies types and life
- Repair/Replace policy
- Spares and Rotables requirements
- Level of repair policy
- Maintenance facilities
- Maintenance labor requirements
- Support and test equipment
- Operator training and training facilities
- Maintainer training and training facilities.

17.3 Level of Repair Analysis (LORA)³

Level of Repair Analysis is concerned with determining maintenance policy. This will involve repair or replace policy and where various maintenance activities are to be carried out, so that appropriate staff and facilities can be provided.

Technical and economic considerations are used to determine whether an item should be repaired or replaced upon its failure, and in the case of repairs, to determine at which location the repair will be carried out.

For example, an electricity transmission company was planning the acquisition of a new radio communication system for use by field repair teams. Following a LORA, the maintenance policy adopted was that only first line repairs would be carried out by the company. These consisted of performance checks, setting adjustments, and complete unit or subunit replacements. No second or third line work was to be carried out by the company. A support contract was made with the supplier to accept any items requiring deeper maintenance and to provide refurbished or new replacement items within an agreed turnaround timeframe.

³ Level of repair analysis US-MIL-STD-1390D.

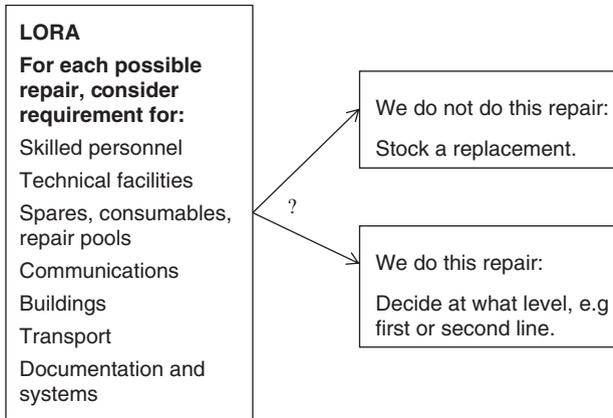


Fig. 17.2 Level of repair analysis

In general, LORA is used to determine at what level of the organization maintenance work will be carried out for each preventive maintenance activity and in response to each failure mode. Figure 17.2 illustrates the type of factors involved in a level of repair decision.

Figure 17.3 shows the overall position as we decide what work is to be carried out at each level for the fleet as a whole, and the resources and facilities needed at each level. LORA analysis provides the basis from which we can estimate the type and volume of work which is required at each level of repair. This then determines where we locate resources (e.g., test and repair equipment), and where to stock spare parts. To evaluate an entire system from scratch, including costing all options is a considerable task. In practice, for any particular acquisition we can usually draw on experience from similar or existing equipment, although this does not mean that we should not fully consider the options and how developments of equipment and technology impact on the development of logistic support.

17.3.1 Levels of Repair

The different levels are as follows:

17.3.1.1 Operator Maintenance

Operators should have some responsibility for, and ownership in, the equipment which they operate.

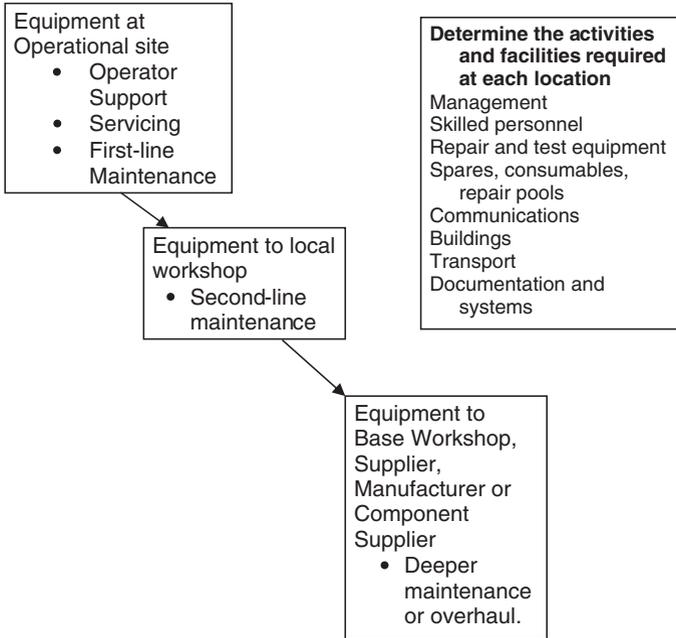


Fig. 17.3 Logistic support and level of repair elements

17.3.1.2 Servicing

Estimate the routine servicing load and provide resources.

17.3.1.3 First Line Maintenance

Plan the range of repairs to be carried out at first line, that is at the user area, with local technical support, diagnosis, and troubleshooting. Estimate the numbers and type of tradespersons to be located with users, and the spares, tooling, documentation, and training required.

17.3.1.4 Second Line Maintenance

This provides workshop facilities in a general location to support major plant, or as a support facility for plant scattered over a geographical area. Consider any particular repairs or system changeovers that will be carried out at this level and determine the corresponding requirement for facilities such as heavy lifting equipment, major welding, machining or chemical treatment, specialized technical skills, repair, testing, and monitoring. A workshop normally acts as a

base for recovery teams, emergency response teams, and field repair teams and for more specialized trades such as instrument, electronic, or communications specialists.

17.3.1.5 Third Line or Base Maintenance

This provides in-depth facilities, e.g., overhauls, and may be provided by a equipment manufacturer, a supplier, or a contractor.

17.3.1.6 Rotables

Rotables are components which are sent away for repair and then returned. Level of repair analysis involves considering whether some components should fall into this category and in making arrangements for the repair process.

17.3.1.7 Example

For a vehicle fleet, the type and quantity of vehicles and the planned utilization will form a basis for estimating the amount of servicing and first and second line repair work which will be required per year. From this data we can decide whether a dedicated vehicle servicing facility is required, whether to provide and staff this in-house at a specific location, or whether to let an outsourcing contract. We can also estimate the requirement for workshop facilities, in-house or outsourced.

17.4 Integrated Logistic Support (ILS)^{4,5}

Integrated Logistic Support is a system for ensuring that all items and services necessary to implement the support of items are identified and arranged for. Integrated Logistic Support is a follow-up to LSA. ILS uses formal check lists as an aid to identifying the items to be supplied and checked as satisfactory before the equipment is formally accepted by the user.

Integrated Logistic Support starts from the list of assets forming the capability, noting the amount of equipment involved, and the utilization rate. For example, with a vehicle fleet this will mean identifying the vehicle types, quantities, and average kilometers run per year. Figure 17.4 indicates the scope of factors covered by ILS.

⁴ US MIL-STD-1388-2B Integrated Logistic Support.

⁵ IEC 60300-3-12 Integrated Logistic Support.

Equipment outline description, sketch/Flow chart/Outline drawing.
Equipment acquisition timings and allocation to sites
Installation plan
Configuration List.
Supplier and Contractor Details.
Transport Plan
Site Preparation Plan
Disposal Plan
Operations
Operator Staffing Requirements and Plan
Operating Manual
Operator Training Plan
Operator Training Materials
Consumables Specification and Pricing
Consumables Provisioning Plan
Consumables Storage Plan
Consumables Disposal Plan
Engineering
Technical Documentation and Drawings
Technical Data
Safety Plan
Engineering Support Plan
Engineering Training
Maintenance Support Plan
Maintenance Policies for each Level of Repair:
Operational
Intermediate
Depot
Maintenance Procedures and Workshop Manuals
Repair Plan for Repairables (Rotables, Repair Pool)
Repair / Replace Policy
Maintenance Staffing Plan
Maintenance Training Plan
Support and Test Equipment
List
Provisioning and Installation
Test Specifications
Bill of Materials
Spare Parts Catalogue and Pricing
Spare Parts Provisioning Plan

Fig. 17.4 Integrated logistic support factors

17.5 Logistic Support Plan

The end result of the LSA is a logistic support plan which states how the logistic support elements required by the equipment are to be provided. The plan defines responsibilities for:

- a. testing and evaluation criteria for acceptance;
- b. packaging, handling, storage, and transportation;
- c. transport vehicles, four wheel drives, vans, and trucks;
- d. engineering support;
- e. consumables provision and transportation;
- f. repair, maintenance, and overhaul support;
- g. spare parts provision, storage, and information system;
- h. recovery vehicles and crews;
- i. provision and training of operators and maintainers;
- j. workforce accommodation and recreational facilities;
- k. technical data provision and management;
- l. configuration management;
- m. workshops, site offices, compound, plant yard, and covered storage;
- n. cranes, fork lifts, and handling equipment;
- o. electrical power provisions;
- p. water supply and treatment if necessary;
- q. support facilities and test equipment;
- r. occupational, health, and safety issues;
- s. environmental issues;
- t. waste disposal facilities;
- u. disposal of equipment which is replaced.

17.6 Through Life Support

The through life support of assets is provided by support systems which cover a range of activities including:

- Operations
- Supply
- Maintenance
- Engineering
- Training

An indication of the range of support activities required is given in Fig. 17.5.

17.7 Configuration Management Plan

The configuration of an equipment means the detail of its specification and its key assemblies. In managing deployed assets it will be necessary to keep track of the configuration of the items, as modifications occur, variant models are introduced, or, in the case of fixed plant, new facilities are added and old ones become disused. A viable plan for configuration management should be formed at the logistic support planning stage. More detail of configuration management itself is given in Sect. 11.8.

Operations	Supply	Maintenance	Engineering	Training
Operators	Supply Personnel	Maintenance Personnel	Engineering Personnel	Training Personnel
Operating Facilities	Supply Facilities	Maintenance Facilities	Engineering Facilities	Training Facilities
Operating Support Equipment	Transport, Storage and Handling Equipment	Maintenance Equipment	Engineering Support and Test Equipment	Training Equipment
Operating Documentation	Supply Commodity and Spares Catalogs	Maintenance Manuals	Engineering Drawings and Data	Training Materials
Operations Management	Supply Management	Maintenance Management	Engineering Management	Training Management
Operating Management Information Systems	Supply Management Information Systems	Maintenance Management Information Systems	Engineering Information Systems	Training Information Systems

Fig. 17.5 Through life support systems required

17.8 Through Life Support Contract

Factors to be considered in letting a through life support contract include:

- Maintenance support
- Supply support
- Engineering support
- Labor augmentation for periods of high demand or specific needs
- Cataloging

Performance indicators relating to such a contract include:

- Prime equipment availability
- Rotables availability
- Reliability following repair.

17.9 Logistic Support Example

A logistic support example is shown in Fig. 17.6. This relates to the acquisition of a considerable number of large earth moving machines for a remote site.

Five percent of the acquisition budget was committed for the purchase of spare parts. This was intended to cover the first 3 years of operation.

At the point of introduction into service, supporting documentation was delivered concurrently, along with familiarization and training courses for operators and maintainers.

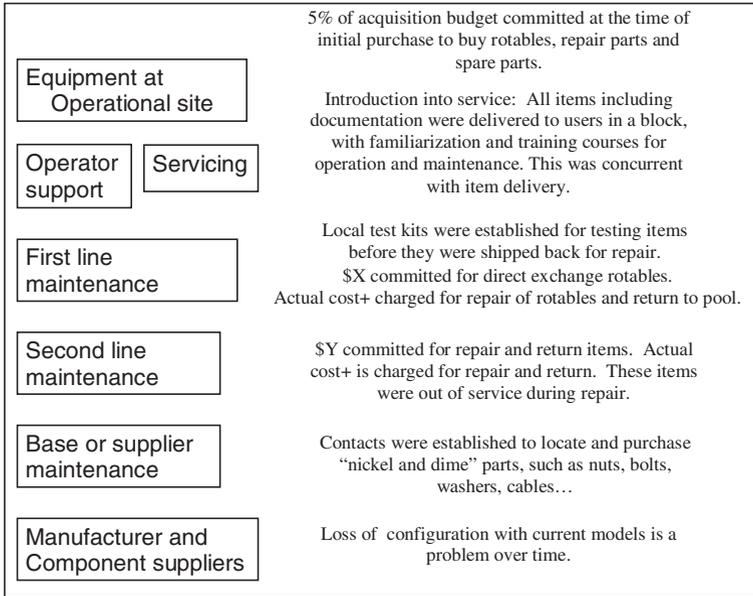


Fig. 17.6 Logistic support example

At first line repair, test kits were supplied to provide a range of tests for items which needed to be checked before possibly being shipped back for deeper repair. Budget (\$X) was set aside for rotables which were to be exchanged and shipped back to either second line or the supplier.

At second line repair, a similar arrangement was made, with allocated budget (\$Y), allowed for repair and return of items requiring repair at the supplier's facilities.

Numerous cheap but essential items (nickel and dime parts) were seen as a problem as it was important not to use inferior substitutes. Contacts were established to obtain these from reputable sources.

Configuration management was put in place, but it was recognized that loss of configuration in relation to current models would be a problem over time. This would ultimately be solved by replacement of the fleet.

17.10 Supplier or Contractor Viewpoint

Suppliers and contractors involved in the original equipment provision are usually involved in subsequent logistic support. There will be a requirement for the supplier to provide user documentation and information relating to equipment operation, including safety issues, and this is often augmented by a performance

warranty. Maintenance recommendations, workshop manuals, and spare parts catalogs are also developed and provided by the original equipment manufacturer (OEM) or supplier.

From the supplier or contractor's viewpoint, the provision of logistic support beyond the basic minimum is an additional business opportunity, although care must be taken to ensure that costs are covered and an adequate profit is generated. The provision of logistic support by a supplier can also be a plus in securing the original sale. However, users must be aware that suppliers can only provide support to the extent that it is good business to do so. It is common for users to underestimate the cost of providing support, and thus to have unrealistic expectations of support provisions. If on-going support is to be provided by a manufacturer, they need to consider the cost of maintaining production processes for original equipment and components to which they are committing, and to identify the people and facilities needed to maintain support, in terms of skill sets, numbers, training requirements, and training facilities.

Services that may be provided on a contract basis include:

- a. consumables provision, transportation, and storage;
- b. spare parts provision and stock holding;
- c. support for introduction into service;
- d. repair, maintenance, and overhaul support;
- e. training of operators and maintainers;
- f. training of operator and maintainer trainers;
- g. technical data management;
- h. configuration management;
- i. support facilities and test equipment;
- j. disposal process.

As a supplier, it is important to adequately cost the provision of such services and to assess the physical and cost requirements over the life cycle of the equipment which is supported. Activity-based costing can be important in this application. Do not try to subsidize the logistic support contract from the initial sale contract. Consideration will need to be given to the provision of the skills required for the tasks to be undertaken, and to being able to retain these skills out into the future. A common approach is to establish separate distributor and support businesses which need to be viable in their own right.

Key elements of logistic support provision are the same in principle as for the user, but the support may extend across a range of users, so the types and numbers of items must be assessed accordingly. Thus we need to consider the following aspects across the range of items supported.

- The types of item for which maintenance is to be supplied;
- The numbers of items of each type;
- The level of utilization;
- Operating environment and any special factors arising from this.

Identify the maintenance level to be covered such as;

- workshop inspection and repairs,
- deeper maintenance,
- overhauls,
- rotables and related repair pools,
- repair/replace policy and related equipment replacement pools.

Plan numbers of trainees for operations, maintenance, and trainers; prepare training facilities; provide an online spares catalog and cost the service provision.

Consider the cost and practicality of maintaining the resources and skill sets necessary to provide the intended support services over the contract period. The equipment supported and the range of technical facilities required in your business will change over time and personnel will retire or move on. Do not under estimate the cost of support provision for aging assets. Consider disposal of consumables, used and unused spares and equipment. Consider the cost of contract preparation, negotiation, and on-going management.

17.11 Cunning at the Castle

Scene: An Ante-Chamber in the Palace

Enter Roderick, an asset manager and Cuthbert, a political strategist.

R: Look here Cuthbert, this plan of King Henry's is crazy. He wants to take the army to France and conquer it!

C: What's wrong with that?

R: The French will knock the stuffing out of our lot, that's what

C: Surely not—what about Agincourt and the gallant English archers?

R: Don't forget the Welsh—but either way the archers are no more. They were disbanded after Formigny

C: Formy—what?

R: Never mind—it's French. It won't feature in English history because we lost. The point is that the French have cannons that outrange our archers by a mile and can crumble a castle like chips. We've got no chance against them until our boys down at the Arsenal develop some new skills

C: So we need a strategy

R: It's more serious than that, Cuthbert, we need to do something. Get thinking

C: *thinks*.....Maybe we could make the French expedition more of a fashion show. The French are cool dudes and if we work it so that Henry goes "all-clinking in gold like a heathen god," to coin a phrase—but just wants to gallop around flashing the Spurs—then they might buy it

R: Good one Cuthbert. The French first team is off in Italy as it happens; its game on at Milan. So we'll go for your plan. Vive le spin

A week later

- C: The French trip is under control, but it's the Scots that I'm worried about. They're getting up a mighty head of steam with King Jimmy and the Bishop telling them they can beat hell out of us and grab England now Henry is over in France. Get your thinking cap on to that one
- R: Nothing that some creative asset management can't handle; we'll send Henry's troops only the old gear, bows and arrows, swords and heavy armor, and keep the newer stuff here
- C: Good, but who's going to run the show against the Scots?
- R: Easy—Queen Katherine. She may not be good at producing sons but she sure can run a war
- C: She can't lead the army though—and don't tell me about Joan of Arc
- R: No, but she's smart enough to put Tommy Norfolk in charge. We'll draft requisitions for the supporting logistics, and bring in plenty of those soccer hooligans from up North

Some months later in a back room of the Palace

- R: Nice one Cuthbert!
- C: Nice one Roderick!

They drink

- R: Henry flashed his Hampton in Flanders and good old Norfolk gave Scotland a flogging at Flodden
- C: Just shows what you can do when political strategy and asset management work together
- R: But methinks we should retire posthaste. Henry is at the gate.

17.12 Exercises

17.12.1 Self-Assessment Questions

1. What is LSA and when is it carried out?
2. What data are required for LSA?
3. What is LORA?
4. What levels of repair are normally considered in LORA?
5. What is ILS?
6. Identify five types of activity where a supplier or contractor might typically offer a logistic support contract

17.12.2 Logistic Support Analysis—Tooth Brush

The Antarctic Corporation (AC) is sending a party of 100 persons to a remote Antarctic site for 1 year.

Carry out a LSA for three toothbrush options:

- Manual
- Electric battery discardable
- Electric battery rechargeable.

17.12.3 Racing Cycle Team

You are the logistic support manager for a cycle racing team. Outline in dot point form the logistic support requirements and plan for the team.

17.12.4 Level of Repair Analysis Exercise

An upstream gas supplier operates a large number of wells at scattered, unmanned sites. There is an automatic radio communication system from the sites to a central control room. The organization needs to decide its “Level of Repair Analysis” policy for the communication system.

Analysis shows the following failure modes:

- Battery flat
- Transmitter failed due to electronic fault
- Broken knobs, leads, and connectors
- Extensive physical damage

What Level of Repair policy do you recommend?

17.13 Exercise Solutions

17.13.1 Self-Assessment Questions Solutions

1. *What is LSA and when is it carried out?*
 - a. Logistic support analysis is the determination of the equipment, people, and facilities required to support a given capability throughout its life. Logistic support analysis is designed to determine the “what, how, and where” of the provision of support resources and services for physical equipment. It is carried out in the decision making phase in which we decide the broad parameters of the provision of logistic support for our equipment.

2. *Identify four items of data that are required for LSA.*

Any four of:

- a. Asset type
- b. Asset quantity
- c. Utilization rate or “rate of effort”
- d. Planned equipment availability
- e. Period of support or overall operation duration
- f. Specific environmental or operational factors
- g. Nature and quantity of equipment to be retired and the effect of this on support requirements.

3. *What is LORA?*

- a. Level of Repair Analysis is concerned with determining where various maintenance activities are to be carried out, so that appropriate staff and facilities can be provided. Level of Repair Analysis is used to determine at what level maintenance will be carried out for each planned activity and for each failure mode.

4. *What levels of repair are normally considered in LORA?*

- a. Operator
- b. Servicing (routine)
- c. First line
- d. Second line (workshop)
- e. Third line (base repair, overhaul, or outsourced).

5. *What is ILS?*

- a. Integrated Logistic Support is a system for ensuring that, once we have decided on our logistic support concept, all aspects necessary to implement it are identified and arranged for.

6. *Identify five types activity where a supplier or contractor might typically offer a logistic support contract.*

Any five of:

- a. consumables provision, transportation, and storage;
- b. spare parts provision and stock holding;
- c. support for introduction into service;
- d. repair, maintenance, and overhaul support;
- e. training of operators and maintainers;
- f. training of operator and maintainer trainers;
- g. technical data management;
- h. configuration management;
- i. support facilities and test equipment;
- j. disposal process.

17.13.2 Logistic Support Analysis—Tooth Brush Solution

The Antarctic Corporation (AC) is sending a party of 100 persons to a remote Antarctic site for 1 year (Fleet size = 100; Mission duration = 1 year; Climatic factor).

Carry out a LSA for two toothbrush options:

- Manual
- Electric

Manual Brush life 3 months estimated. Estimated consumption 400 including initial issue. Contingency allowance 10 %. Asset management policy: Replace on request, notify users if consumption excessive.

ILS Plan Purchase 440 brushes and plastic container for storage.

Electric Components: Batteries \times 2 per brush, battery life 2 months (climate factor); brush body life 12 months; brush head life 3 months; battery case end cap life 12 months. Asset management policy: replace components on request; hold some complete brushes to cover possible losses.

ILS Plan Purchase 120 complete brushes; 1,100 batteries; insulated, waterproof container for batteries; allocate battery storage space in protected area; 10 brush bodies; 330 brush heads; 10 end caps; plastic container for storage. Rechargeable battery model dismissed as impractical for this location. Might also consider, toothpaste, disposal of items.

17.13.3 Cycle Team Logistic Support Exercise Solution

Routine maintenance checks for lubrication, brakes, gears, alignment, geometry, and balance

- Spare bicycles
- Spare parts
- Tools
- Skilled mechanics with strong expertise and sense of commitment
- Transport
- Communication system operation and maintenance
- Health and medical support.

17.13.4 Level of Repair Analysis Exercise

Site inspectors to handle battery changing and replacement of broken knobs, leads, and connectors.

Electronic faults to be handled by installing a replacement transmitter and returning the faulty one to the supplier, to be replaced by a reconditioned transmitter to the store.

Items with extensive physical damage to be replaced and the damaged item disposed of thoughtfully.