MAINTENANCE IN IMPORT MANAGEMENT

(Guide No. 17)

ITC

INTERNATIONAL TRADE CENTRE UNCTAD/GATT

Geneva

1989

Abstract for trade information services

1989

05.05.02
MAI

International Trade Centre UNCTAD/GATT
MAINTENANCE IN IMPORT MANAGEMENT
Geneva 1989. v, 71 p. (SIOT Guide No. 17)

Textbook on planning and organization of **maintenance** of imported equipment and machinery, within the context of **import management** - discusses fundamental aspects of maintenance, preventive maintenance programmes; project management; cost and management of spare parts; responsibilities of the importer; procedures, standardization, specifications; price revision formulas; and gives a case study.

English (Free to organizations in developing countries)

Palais des Nations, 1211 Geneva 10, Switzerland

The preparation and publication of this guide was financed by the Government of Sweden as part of the programme for import operations and techniques.

ITC/078/F2/89-V

Contents

Page

ANNEXES

A. Introduction

The supply management function includes the actions of purchasing, logistics and materials management. Maintenance constitutes an important facet of this activity, in the importation of equipment and machinery for agriculture, industry, transportation and other services.

This guide will cover the imports of spare parts and the necessary services to keep in good operating conditions the equipment on hand or to be useful for managers responsible for the procurement function in either the public or private sectors. Tied in with the maintenance function are not only the contract preparation and its negotiation, but also all the preliminary stages of the contract until its realisation at any point in time.

Developing countries are often faced with problems in procuring spare parts and in organising maintenance services. Their growth depends largely on these imports. To their particular difficulties of choosing a technology or of selecting a supplier, the high costs of transport and routing must be added, in addition to the numerous problems of delays due to import and financing procedures. Because of shortages of foreign currency, importers are sometimes forced to buy equipment without looking into the required maintenance.

This situation can be the cause of stopped production plants, of fleets of largely inoperative vehicles, and of deteriorating buildings.

B. Context

The imports of capital goods and equipment can promote the development process of a country. They help in bringing in new industries and keeping them in operating conditions with services. Cities badly need these sewage systems, electrical networks, etc.

The overcrowding of cities and substantial urbanisation are creating additional needs, particularly in housing, transport, telecommunications and others. In rural regions, farming equipment is often badly needed to increase productivity. Moreover, agricultural products have to be brought to the consumers' regions and, where these exist, to food processing industries.

The growing number of new needs are causing an enormous increase in capital goods and equipment imports. The massive and accelerated import of these goods, without consideration for their maintenance, to keep them in good operating conditions, can cause a country to run into an enormous external debt while producing a doubtful added value. Without a strict maintenance programme, the economy of a country can be adversely hit: to have to pay off external debts without the benefit of operational equipment because of missing spare parts or the lack of training services is an abnormal condition in a sound economy. This is more obvious when the equipment is essential to the welfare of the population or necessary for exports, a vital source of revenue needed to return the loan.

Maintenance is not a constraint by essence. On the contrary, it is a state of mind which leads to improved living conditions. In this respect, all economic sectors are concerned, within homes to protect family properties as well as within industry, agriculture, tourism, transportation, etc.

The level of maintenance generally indicates a given stage of development. In the context of developing countries, where resources in foreign currency are sometimes limited, maintenance must be an essential, constant and collective concern.

To operate effectively and efficiently, an importer from a developing country must:

- Clearly define the needs of the end user or consumer;
- Know his supply markets as well as possible;

- Improve his time management;

- Check his suppliers' technical competence;

- Reduce costs, not only at the time of the import but also during the whole of the productive life of the goods;

- Plan all of the required maintenance stages;

- Make sure that the ability exists to keep purchased items in good operating conditions.

To own equipment and not be able to keep it operational is worse than not having it. If it is impossible to be assured of the availability of the needed services and spare parts, it is preferable not to purchase the equipment at all. It is extremely dangerous to buy equipment under loans with the expectation of paying back these loans through the wealth created by the equipment without the assurance of having a good maintenance system in place.

C. Objectives and Content of this Guide

The basic objective of this guide is to demonstrate the necessity to plan and prepare for all aspects pertaining to maintenance at the earliest stage of the procurement process. It is then that the importer defines the needs and also defines not only the total value of the investment but also the maintenance costs for the life cycle of the equipment. Following this evaluation, the importer from a developing country is then in a much more favourable situation to select the most appropriate technology, that which best suits the identified needs; he can, thereafter, plan and control his long term costs.

Such a preliminary analysis of any investment project leads the importer to evaluate the upkeep and the maintenance of a given equipment for its projected period of utilisation. With this approach, the importer can evaluate two important components of his procurement total cost, that is, the acquisition costs and the utilisation costs.

During a period of scarcity of foreign currency, the importer of a developing country can be quite interested in reducing his cash outlay at the time of import. This approach can be justified as he is looking for the best offers on the market in order to minimise his acquisition costs at the time of purchase. Yet, the analysis of the upkeep and maintenance costs for the utilisation period of the equipment can be found more important than the original purchase value. It is a well known fact indeed that it can be more costly to keep a car in good operating condition than to buy it; the upkeep for a normal life cycle of 15 years can be higher than the purchasing price.

To arrive at this global approach in the importing of goods which need upkeep and maintenance, this guide will present firstly the fundamentals of maintenance, particularly of preventive and corrective maintenance, as well as those aspects related to quality management and assurance. In the previous example of the motorcar, some parts may be changed as a preventive measure, to avoid failures and ensure the proper safety of passengers, (testing and periodic replacement of brake parts). Other repairs, for example, are of a corrective nature, like the refitting of a damaged or a defective component, (for example, replacement of a broken windshield or the repair of a defective valve). These types of maintenance are related to the basic issues of quality management and quality control, as the importer must make sure that each part used meets the minimum quality requirements and provides passengers with a good level of safety.

In the second place, we will consider the essential question of how to take advantage of standardisation, so as to avoid the unnecessary increase in stocks of spare parts and in the number of suppliers. Standardisation can also help eliminate the problem of falling into a captive market situation following a choice of a technology which is not compatible with international standards. These technological choices can sometimes be covered by national rules or laws to which an importer can refer. National standards offer the

advantage of reflecting particular operating conditions in a given country. A motorcar operating in a desert must present characteristics which are different from those of another vehicle operating in northern and mountainous regions.

A developing country is, by essence, in a stage which requires high investment. Therefore it is not surprising to see how the structure of imports reflect the high percentage of purchases of capital goods and equipment. Thirdly, this guide will offer, some important considerations on project management, as purchases of capital goods and equipment often form part of broader projects. In this section, the guide will refer, for example, to a case concerning the construction of a hydro-electric dam. The roles and the responsibilities of a consulting engineer, the preliminary phases of a project, the evaluation of the dam life cycle, the selection of suppliers and the interface with the buyer's technological partners will all form part of the subject, as these issues are all directly relevant to maintenance.

The guide will be paying particular attention to the control of maintenance costs, which should be known even before preparing the import order. Therefore, in the fourth place, the guide will present approaches for better evaluation and control of these costs by the importer. The proposed method of evaluation takes into consideration the basic elements of maintenance and the total procurement cost approach as presented also in ITC's guide number nine, (Bid Evaluation), and number eleven, (Price Monitoring in Import).

The preliminary aspects of contract preparation are therefore of major importance in the context of capital goods imports. In the fifth place, to substantiate this assertion, this guide will touch upon the question of supply market research and reviews with people concerned before and at the time of tendering. Before the invitation to bid is made for the purchase of a fleet of vehicles, the importer becomes more familiar with the supply market.

The procurement function has evolved from an administrative and bureaucratic function to a managerial one. The guide will thus refer, in the sixth place, to the rules and the responsibilities of the importer of a developing country, whether from the public or private sector. At this stage, the guide will pay particular attention to the contractual clauses so as to grasp those aspects concerning maintenance and the responsibilities of the importer.

The great distance of the suppliers, the delays in delivery and financing procedures force the importer in a developing country to carefully plan for his needs. It is well understood that in cases of emergency, some quick decisions on imports of spare parts will have to be made in order to protect capital goods or to prevent production stoppages. In view of this, the guide will touch upon the import procedures to ensure that maintenance-related goods are imported economically.

As a last topic, this guide will propose several examples of price revision formula which provide for long term agreements with suppliers. Besides presenting the most common formula, some examples will be given concerning goods which are made of raw materials traded on commodity markets. In the example of the power station and its distribution network, the price of imported cable will be directly related to the price of copper, which varies on the commodity exchange market in accordance with supply and demand.

Chapter 1

FUNDAMENTAL ASPECTS OF MAINTENANCE

A. Definitions

No function is likely to have a greater impact on the overall cost of imported equipment than maintenance. Yet, good maintenance management has often been an elusive objective with maintenance effectiveness conditioning operational performance.

Facilities and equipment are becoming increasingly sophisticated and complex in both new automated equipment and in equipment of old design which has been modernised.

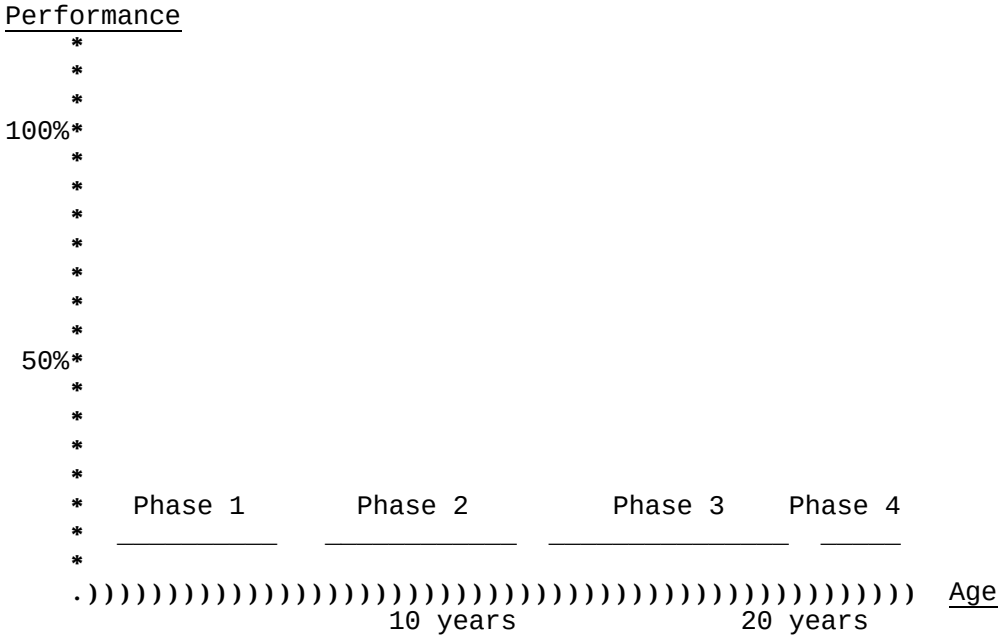
Today's equipment is highly capital-intensive and contains complex parts which require greater reliability. The cost of equipment failure and downtime necessitates that prevention and prediction dominate the maintenance activity;

this is why the maintenance function is stepping in, more and more, at the beginning of the supply process.

Every machine has a life cycle which follows a similar trend, going through the following phases:

The first period consists of the conception, development and construction of the equipment; the second is called the start up and testing phase, involving training and learning; the third period is the productive one where efficiency reaches its maximum is stable for a relatively long period depending on the quality of the maintenance programme; the fourth and last period of the curve shows a rapid decrease of efficiency leading to obsolescence and/or de-commissioning or retiring of the equipment.

LIFE CYCLE CHART:



Several factors will obviously affect the life of the productive third period. Here are some important ones: the quality of design, the material used and the construction process or technology. It is important to make sure that the equipment meets all the normal requirements of expected quality.

The other factors affecting the productive life of equipment are the way this equipment is used throughout its useful life period, as also the type of maintenance given to the machine during that time.

The maintenance factor is of capital importance. Assuming that there is no maintenance at all, the useful life of the equipment will be reduced drastically. On the other hand, excessive maintenance will make the equipment last beyond the expected time for which it has been designed, perhaps leading to inefficiency as compared to newer technologies. It can be concluded from this that maintenance must be organised and well managed. Concern for maintenance effectiveness is compounded in light of the great technological advances reached within the last decades.

As it is in other phases of management, maintenance must be defined and measured. The word "maintenance" can be defined as the sum of surveillance

measures and actions which keep equipment or facilities in good operating condition. It is a means of achieving greater use of equipment for greater benefit.

B. Usefulness

The maintenance and servicing of equipment is generally of two types: preventive and corrective. The latter will be reviewed first.

Corrective maintenance is that which is required to repair or replace component parts following a failure of some kind and to return the equipment or system to operational status. This restoration of the facility includes the cost of manpower required to do the work and the materials needed for the repairs. Such a failure can happen at any time during the life cycle. When it happens, the goal is to minimise the time of repair and to get the most out of the repair resources available, i.e., personnel, facilities, tools, tests and handling equipment.

Anyone who has been in charge of some type of equipment has been faced, one day or another, with certain unforeseen failures. Corrective maintenance involves the question of repairing the failure as soon as possible, at the lowest possible cost with the available resources. Its management is generally limited to a system of work orders which include the required labour and spare parts (at both estimated and actual costs), as well as the type of work done. A sample maintenance work order is shown on page 7.

This form, once filled, is put away in the concerned equipment file and will eventually be used to draw the proper conclusions on the profitability of the equipment in question.

It is essential, additionally, that the importing organisation's stock control system should record the outflow of spares referring to the maintenance work order number (and thus to the equipment being maintained) in order to serve as basis for future planning of requirements of spare parts in connection with the equipment in operation.

Sample Maintenance Work Order

Date requested: Time requested: Dept. no: Location: Number:

Priority: Urgent Machine availability

Important Time: Shift: Date:

Preventive

Type of machine:

Nature of problem:

Tradesmen requested: Requested by:

Tradesmen assigned:

Millwright	Machinist
Pipe fitter	Welder
Electrician	Toolmaker

Date started	Time started	Date completed	Time completed

Work performed

Actual costs: Approval date:

Labour: Signature:

Material:

This guide will not deal in any additional details with the subject of corrective maintenance. It will rather, present at length, preventive maintenance methods and techniques which are more complex to set up. In any case, a preventive maintenance programme takes the corrective maintenance. It is well proven that prevention tends to eliminate corrective maintenance, and is less costly. As the saying goes: "prevention is better than cure".

The higher cost of corrective maintenance relates to equipment failures, which may have an enormous impact over a large group of people. Following the technological advancement of the past decades in meteorology, in industrial equipment knowledge, in various techniques such as X-Ray photography, thermography, supersonic sounding, vibration analysis, etc., materials or equipment can be inspected even in operation, thus leading to the prevention of failures.

Preventive maintenance is a system of repairing equipment, machinery or facilities at predetermined intervals to prevent costly downtime or failures, or to retard wearout and deterioration. It is the lubrication, the cleaning, the adjusting and the replacement of minor parts which keeps a piece of equipment above some predetermined state of performance.

Preventive maintenance is also an engineered effort to optimise the equipment cost. As we have seen, the equipment cost is a function of four factors: purchase cost, equipment life or durability, operating cost and maintenance cost. Preventive maintenance can reduce equipment cost by reducing maintenance cost and increasing equipment life. The contribution of equipment to overall efficiency is primarily the result of equipment performance, and preventive maintenance can increase performance by reducing costly interruption of operations. Substituting preventive maintenance for corrective maintenance usually increases equipment availability, resulting in greater output.

Industrial technology presently aims at going beyond both preventive and corrective maintenance. Management is trying to minimise or even eliminate the need for maintenance by improving equipment design. Appraisal of equipment purchases are largely based on the owning and operating costs of its useful life cycle. This appraisal must include downtime losses for maintenance servicing, upkeep and repair.

With increase in integrated continuous manufacturing processes, the mechanical and electronic control equipment must be designed with a high degree of reliability. It must also have an inherent maintainability to permit easy and quick repairs. Reliability and maintainability must be considered before the first design line is drawn, and throughout the stages of equipment development. A major cause for poor reliability is the complexity of a system in trying to improve performance and accuracy. A solution is to reduce the number and complexity of components; another is to operate components below their rated capabilities.

When purchasing equipment, its reliability becomes a very important factor for management, by giving a definite time period between failures. It then becomes possible to plan the various maintenance actions during its life cycle. It also permits to establish the consumption of spare parts and the evaluation of the total cost of maintenance.

Maintainability can be improved at the design stages by applying some basic principles such as the following:

- Quick recognition of malfunctions by self-checking equipment, automatic interruption and visual indicators.

- Quick isolation of malfunctions by automatic indicators and through use of test point inspection windows.

- Inherent reliability: simpler design, self-aligning equipment, standard equipment or parts of proven quality.

- Minimum special training of maintenance stall.

- Easy performance of scheduled preventive maintenance: servicing, materials needed, special tools, frequency of maintenance, adjustment or calibration needed, level of personnel skill required, special monitoring equipment and operating tolerances.

- Safety precautions: workers must be protected against toxic materials, electrical shocks and any other dangerous situation.

C. Planning a Preventive Maintenance Programme

Planning a preventive maintenance programme is essential to its success. A correct balance must be achieved between the cost of preventive maintenance and that of corrective maintenance, aimed at keeping overall costs as low as possible and ensuring effectiveness.

Management continuously seeks to establish good preventive maintenance programmes. There is, however, no predetermined system which would fit all situations. Each facility must have its own system, although some basic principles can be outlined, as follows.

Preventive maintenance is a system which, as any system, requires planning and execution. There is a cost to such a system but experience has proven that it is less costly than downtime. The simplest system provides for a large envelope with the name of the machine on it, into which the maintenance instruction manual of the machine and the machine parts list are placed. Maintenance work orders prepared for every preventive or corrective maintenance job requested for the machine are also placed in the envelope. When the envelope is found to be sufficiently full of such orders, an investigation is started to determine whether or not corrective maintenance orders are excessive. The analysis shows the road to follow.

D. Objectives

Generally speaking, maintenance systems go beyond a simple envelope and a work order, but paper work should be kept to a minimum. More maintenance programmes have broken down from the weight of paper than for any other reason.

Some of the objectives that one might have for such a programme include lowering total maintenance costs by setting the ratio of preventive to corrective maintenance and the reduction of downtime, which has the effect of reducing the total operating cost but not necessarily the total maintenance cost. The collection of records of such costs can supply the proper information for decisions on maintenance alternatives. Other objectives may include, safety for machines such as pressurised vessels, electrical distribution systems, compressed air systems, gas lines and the like. Different objectives may exist for a maintenance system on a production line and for an other on a fleet of trucks. The objectives of each maintenance system should be clearly established to achieve the intended results.

E. Basic Rules Governing Preventive Maintenance Programmes

Step One: Inventory and Selection of Equipment

Following the establishment of objectives comes the selection of the equipment to be included in the maintenance programme.

Several criteria might be of some guidance in making this selection, and can help in deciding the types of maintenance to be carried on individual pieces of equipment.

a) A complete inventory of each piece of equipment in operation must be made to facilitate decisions as to what type of maintenance to be considered.

   An example of an equipment data card is given on page 11.

b) A few major facilities may be initially included in the maintenance programme, and additions to these made once the programme is off the ground.

c) Cost reductions expected through the maintenance programme must be identified, in line with the established objectives, including the relative economics of repeated expenditure on maintenance.

d) The type of system must be decided upon, based on the kind of operation involved, i.e. office, trucking, school, production.

e) The characteristics of the machinery must be taken into account including age, condition and value.

f) The service conditions must be considered, such as: machines operating on a continuous basis versus intermittently and environmental factors, e.i., wet rather than dry, dusty rather than clean, etc,. to determine those conditions requiring a higher lever of maintenance.

g) The critical nature of the machinery must be appraised, including the importance of interruption-free operations. Some failures can cause long stoppages for repair creating a great impact on operations. On the other hand, some short stoppages can be detrimental to quality. There are some problems involved in establishing which are the critical machines. These can be resolved with the assistance of staff from the concerned unit and other specialists within the organisation. Equipment Data Card

P.M. Code no.: Date:
Priority: Location:
Drawing no.: Building:
System: Floor:

Function:
Machine type:
Manufacturer:
Model no.: Serial no.
Special note:

Motor: H.P. Volts: Phase:
Frame: Amps: RPM:
Manufacturer:
Model no.: Serial no.:

Drive type:
Belt: Direct: Gear:
I.F. belt:
Number: Size: MFR.: No.:
I.F. gear:
Description:

Service conditions:

Duty:	Continuous:	Intermittent:
Lighting:	Good:	Bad:
Access:	Good:	Bad:
Humidity:	Damp:	Dry:
Ventilation:	Good:	Bad:

Note:

Use reverse side for any additional marks or sketches showing piping connections to machine including any control devices used.

Spare parts:

Please attach list.

h) The type of maintenance utilised must be established. Decisions must be taken as to the availability of machines for preventive maintenance shutdown, and this brings up scheduling problems. Some maintenance is seasonal and the times and schedules for carrying out such repairs will be dictated by this factor. Consideration should also be given to non-destructive testing on bearings, for instance on motors, etc.

i) Other factors include: the importance of prolonging the life of the equipment: as the equipment becomes obsolete, the benefit for prolonging its life diminishes;

- The frequency of breakdowns and other trouble;

- The danger for personnel in case of failure, as in some cases its importance may outweigh other factors;

- The relative economics of running equipment until it fails or becomes unusable versus carrying out repeated inspections.

Step Two: Equipment Performance Data

To prepare and schedule a maintenance job on a piece of equipment, there are several sources of information which might be considered.

a) Equipment manual: this manual is provided by the equipment supplier and is always the best source of information.

b) General literature on the subject such as specialised magazines or books.

c) General practices: often times general practice will dictate the type and frequency of maintenance, such as daily draining of a compressor tank which is a good practice and should be included in a maintenance schedule.

d) Lubricant suppliers' recommendations: this is a very good source of information. Lubricant manufacturers often have expertise and interest in making good use of their products, and can help in the planning of a substantial part of a preventive maintenance programme as to the type of inspection, frequency and type of lubricant to be used.

e) Other buyers of similar equipment, and their experiences with maintenance requirements and costs.

f) Experience and judgement: A maintenance programme should be dynamic, not cast in concrete. The programme should be changing and be revised from time to time to reflect actual needs rather than estimated requirements.

Step Three: How Much Preventive Maintenance

The context of a given system will dictate the sufficiency of preventive maintenance. The consequences of an engine failure are a lot more serious in an aircraft than in a car; the corresponding levels of maintenance will thus be quite different.

Other factors also contribute to decision making, such as the budget allowed for maintenance functions and the cost of inventory of spare parts and other materials.

Step Four: Estimating the Cost of Preventive Maintenance

The cost of preventive maintenance is always dependent on the size of the programme. However, the programme should grow from a relatively simple beginning to attain a level of sophistication determined with practice. The beginning serves as an experimentation period for all personnel involved in the programme, and the cost is then limited to those actually required to operate the programme on either a full or part-time basis.

The costs of materials and spare parts are often rather high. Some of these costs will apply whether or not a good programme exists. An experienced maintenance man identifies the need for stocking spare parts for critical machines and, at the same time, controls these costs. Well looked after, a good programme offsets these costs. It is certainly less costly than no system at all, or a "hit and miss" system.

F. Functions of a Preventive Maintenance Programme

1. A preventive maintenance programme should be organised to reduce and eliminate repetitive or expensive repair work.

2. It should also provide an economically justified programme of lubrication so as to reduce the requirements for mechanical maintenance. Such a programme should provide for:

- Review and establishment of the items to be covered.
- Development and implementation of schedules including standard practices, frequencies, quantities, types of lubricants, and routes to be followed.
- Control of the work done by means of a check list that will assure that the lubrication was carried out and recorded.

- Analysis and control of the quality of the lubricants, (i.e., sampling and testing of all lubricants from transformers, gear boxes and critical gear drives).

- Where feasible, re-design of the lubrication system and installation of an automatic system to minimize manual lubrication.

3. Periodic inspections:

The purpose of regular inspection is to discover and correct unfavorable situations in their developing stages and thus prevent breakdowns. A reduction in the number of stoppages will result in a better machine performance and will reduce maintenance cost by avoiding major damages. Such inspection should be justified for economic reasons and should thus be well planned and organised, covering aspects such as the determination of the type, extent and interval of inspections, the review of check lists or practices and the optimisation of procedures. 4. Operating procedures:

Start-up failures, whether on new facilities or on existing equipment, are legion. In most cases, these failures are due to improper procedures or procedures not properly followed.

In the case of existing equipment, the data system is very important, as described earlier. Proper information should be transmitted to the maintenance operation group.

In the case of new equipment, the supplier is generally the best source of information on operating procedures.

5. Data accumulation and reporting:

Preventive maintenance requires a good system of records and reports. The data system may be manual or computerised. It is usually possible to develop suitable information from either approach.

The input document is obviously basic to any information system, and should provide a complete history of each piece of equipment for review as necessary.

An equipment numbering system is fundamental to the equipment cost records necessary for good control.

Good information permits the identification of recurring and high cost repairs, the adjustment of the frequency of preventive maintenance work, and the review of the job content.

6. Other techniques:

There are other ways to help implement a good programme of preventive maintenance. They involve finer techniques which may be added to the basic system, such as:

- Equipment testing: non-destructive testing;

- Maintenance manuals: procedures and practices;

- Standardisation: tools, materials, spare parts, procurement specifications;

- Design changes: minimize moving parts, better materials, automatic lubrication, sealed units, etc.

- Materials analysis: better materials, salvaged materials;

- Maintenance mechanics and operators training: demonstrations,

films, on-the-job training, courses, etc.

- Warehouse: reduced inventory, spare parts control, improved reliability.

Any good maintenance programme will more than live up to expectations. It will increase availability of process equipment and at the same time reduce total maintenance costs. Efficient maintenance will always provide a high return on investment and help to improve the quality of the final product or service.

Chapter 2

PROJECT MANAGEMENT

Much of the capital goods and equipment imported by developing countries form part of projects with components such as construction, acquisition of equipment, installation and commissioning, etc.

In some cases, such projects are implemented as "turnkey operations" where the main contract is passed on to a supplier who is capable of doing the work as a whole as required in the project. However several other firms and suppliers can be involved in such a project; they become subcontractors of the main contractor. The latter remains responsible for the global realisation of the project and his responsibility can include the supply and maintenance of equipment.

A. Role and Responsibilities of a Consulting Engineer

Before starting a project, preliminary studies must be made. They are often prepared by a consulting engineering firm. Such a study will emphasise the following elements:

1. The practicability of the project taking into consideration the following conditions:

   - Economic
   - Political
   - Social
   - Cultural

2. The possible impact of the project on the environment of the country:

   - Human
   - Ecological

3. The preliminary search for the various technological choices, taking into account:

   - Special needs

   - Similar projects already realised

   - Present technologies available or being developed

   - New technologies not yet proven

4. The preliminary listing of all the stages necessary for the realisation of the project such as:

   - Possible schedule

   - Expected date of termination

5. The preliminary presentation of all the aspects related to the future maintenance of the proposed equipment:

   - Training needs;

- Necessary assistance at time of start-up;

- Level of standardisation of spare parts.

Before writing his preliminary study report, the consulting engineer must work out a complete market research of the products to be purchased and also, if pertinent, of the products to be fabricated with new equipment. The market study should include:

- How decisions are taken on the market;

- Where present and future consumers are located;

- Number of potential consumers for the probable life of the project;

- Financing alternatives for the project;

- What the impact of the project is likely to be on the country's economy.

Whether this is a project involving public utilities (electrical power system, water supply, etc.) or a manufacturing facility, the consulting engineer must extend his study to cover data concerning:

- Possible distribution of the products or services;

- Likely prices for the products and services during the useful life of the equipment;

- Estimate of projected revenues generated by the project.

Whatever the nature of the project, the consulting engineer must present in his preliminary report the total costs and potential gains related to the project. It often happens that consultants only estimate the potential gains without correctly evaluating all the maintenance costs of the project equipment. To achieve its objectives, such a preliminary report must include not only the costs of realising the project but also all the future operation costs, which must imply the costs of maintenance. The latter could probably be the most important cost to consider.

Concerning a developing country, the preliminary report must embrace a sound study of all the procurement sources for raw materials and spare parts. At this stage, one should identify technological partners and potential suppliers before the project starts. This prevision helps to discover eventual captive market conditions and will also determine and account for the cost of the maintenance. The importer gets a better understanding of the agreements which can be negotiated with suppliers of raw materials or the suppliers of spare parts, if his estimates of costs include a price revision formula.

A preliminary research report usually also includes the selection of a site for the project. This site selection will bear an important impact on the estimated costs for the realisation of the project, and even on the operational costs later on as it will affect the maintenance costs. For instance, when working on a preliminary study for the construction of a railway, it would be normal to forecast the site of the maintenance shops and spare parts stores, keeping in mind the maximum reduction of the possible costs. Other local factors can also affect the maintenance costs: type of soil, proximity of required services (water supply, electrical network, distribution network, harbour, airport, etc.). It is, therefore, at the very beginning, at the stage of the preliminary studies, that the maintenance costs can be minimised by the first basic choices which would make the project viable and meet the real needs.

Working on a project without considering the maintenance costs means overlooking reality:

ALL CAPITAL GOODS MUST BE WELL MAINTAINED TO BE KEPT IN GOOD OPERATING CONDITIONS.

The consulting engineer must make estimates of the global costs of a project, often including technological alternatives. Following such estimates, the consulting engineer can recommend a technological choice which would consider all such costs, including the important costs of maintenance.

To complete his estimate the consulting engineer must look into his own files for similar projects, and ask potential suppliers to estimate their own possible costs. By extrapolating his own experience, the engineer can gather all the required data and tabulate all the costs which might be incurred during the utilisation period. This means that the preliminary research will usually show a table of the construction costs and another table showing all the operation costs, including maintenance. After the study of these tables, a sound decision can be made; in fact, some important costs will be taken into account which otherwise might have been left out. The information condensed in the tables takes on a vital importance, particularly if the technological choices are manifold. In some cases, the purchase costs can be low in comparison with the high operating and maintenance costs. In other instances, the purchase costs can be higher as the operating and maintenance costs are low due to the type of technology. The comparative tables show a clearer and more global picture of the various options available on the market.

As the most important objective of the preliminary research is to assist the future owners in their decision to start up a project, the maintenance costs cannot be excluded. The owner's desire is, of course, to have a facility which operates continuously and well.

A well-prepared preliminary research, for example, can avoid the construction of a dam to produce electrical power on a river with too low a volume of water during the dry period. It can also lead to reject a technology in which a supplier monopoly exists on required products or spare parts. It could also help to avoid buying equipment which would become obsolete too early.

MAINTENANCE MUST BE A BASIC PREOCCUPATION OF A CONSULTING ENGINEER AT THE RESEARCH STAGE, SOUND PROJECT MANAGEMENT.

B. Project Formulation

After the approval of the preliminary project, the project formulation phase begins. At this stage, all the data presented in the preliminary report will be reviewed in detail.

Maintenance costs are very important in the majority of projects. There is thus reason to extrapolate the real maintenance costs for the entire useful life of a project. In the example of a hydro-electric dam, a detailed study of maintenance needs must be completed in relation to the various technological choices, and this for each piece of equipment.

Note: All figures shown in the following tables are fictitious and must not be used for comparison purposes.

Example: Turbine no. 1 (in U.S. dollars)

Costs of acquisition:	Choice A	Choice B	Choice C
Purchasing costs	200,000	350,000	700,000
Transport	70,000	30,000	90,000
Total acquisition:	270,000	380,000	790,500
Installation costs:	Choice A	Choice B	Choice C

Infrastructure	320,000	160,000	840,000
Handling	180,000	180,000	70,000
Wiring	220,000	220,000	130,000
Labour	440,000	365,000	210,000
Total installation:	1,160,000	925,000	1,250,000

From the above compilation, a new table can be made, taking into consideration the acquisition and installation expenses. The new tabulation now gives the following results.

SUMMARY TABLE:	Choice A	Choice B	Choice C
Purchasing costs	270,000	380,000	790,500
Installation costs	1,160,000	925,000	1,250,000
Total to date:	1,430,000	1,305,000	2,040,500

The useful life must now be determined for each choice based on previous experience or on the recommendation provided by the respective suppliers.

The following table shows the above total figures broken down into monthly values, taking into account the probable useful life of the equipment under normal maintenance based on manufacturers' recommendations.

	Choice A	Choice B	Choice C
Probable life in months	120	144	180
Estimated monthly purchasing and installation cost (in constant U.S. dollars)	11,917	9,063	11,336

From the analysis of the previous tables, it can be concluded that in looking at acquisition and installation costs, choice B is the most advantageous, at 1,305,000 U.S. dollars, and is still the most interesting for its probable useful life at 9,063 U.S. dollars per month.

These tables, however, do not include the maintenance costs of the turbines. Before making the final decision, it is necessary to evaluate the maintenance costs for each proposal according to the manufacturer's recommendations. For simplification purposes, the spare parts in the next table are shown under one heading for the life of the project.

Their values are given in constant U.S. dollars, at their purchased prices when the table was prepared, over the total useful life of the equipment.

COSTS OF MAINTENANCE:	Choice A	Choice B	Choice C
Spare parts	1,080,000	740,000	560,000
Labour	860,000	1,430,000	740,000
Training of personnel	420,000	240,000	580,000
Total:	2,360,000	2,410,000	1,880,000
Divided by:			
Useful life of turbines (in months)	120	144	180

Monthly cost of maintenance; (in constant U.S. dollars)	19,667	16,736	10,444

From the previous table, a new table can be made up, presenting another image, as a rough draft of the monthly global cost (in constant U.S. dollars)

ROUGH DRAFT OF MONTHLY GLOBAL COST;

	Choice A	Choice B	Choice C
Monthly acquisition and installation costs	11,917	9,063	11,336
Monthly maintenance costs	19,667	16,736	10,444
Total monthly global cost	31,584	25,799	21,780

Now it can be concluded that alternative C becomes the most advantageous choice at 21,780 U.S. dollars per month. Other factors must be considered however, to come up with a find global cost. These are:

- The period during which these maintenance expenses are incurred, taking into account the probable inflation in the suppliers' countries.
- The portion payable in foreign currency and the portion payable in local currency.
- The financing expenses.
- etc.

To build up such tables, the consulting engineer will have prepared a preliminary design which presents the needs of the customer.

When the needs are identified and known, he tabulates all the data received from the potential suppliers. A list of equipment can be finalised only when the work, as a whole, is complete, such as:

- General drawings of the projected installation;
- Specifications of equipment and expected performance;
- Specifications of buildings;
- Design of the logistics process;
- Preparation of bidding documents.

In the example of the hydro-electric dam or in any other large scale project, it is very often practical and advisable to sign an agreement for the responsibility of the whole project with the engineering firm which has prepared a sound preliminary report. When the project is on its way, the same engineer can be given the surveillance of the project, including maintenance, for a given number of years ahead.

Under such circumstances, the responsibilities given to this firm would be well defined in a consulting contract and would include:

- Total supervision and coordination of all works before, during and after the project (methods of payments and time period to be covered).
- Final design of project and technical choices, keeping in mind the global cost of procurement, including maintenance cost.
- Power to obtain the necessary mandates (import permits,

financing, invitation to bid, issuance of subcontracts).

- Responsibility to select the competent personnel needed in all phases of the project.

- Responsibility to prepare a training programme for the workers on the construction site and for those operating the machinery, including all maintenance operations.

- Preparation of all detailed drawings: mechanical, building (foundation, erection, roofs, drainage, etc.) electrical, pipefitting, steel reinforcing, etc.

- Quality control of all works done by employees on the building site or by subcontractors.

- Quality control of all equipment received from suppliers.

- Preparation of a maintenance programme for the useful life period of the project, including:

  - Preventive maintenance

  - Corrective maintenance.

C. Useful Life of Equipment

For a large project such as a hydro-electric dam, there is a clear difference between the utilisation period of the dam itself, say for example fifty years, and the useful life of each sub-assembly or system which forms part of the project. There are thousands of pieces of equipment in a hydro-electric dam; each one, as a unit or sub-assembly, must be looked after according to the programme of preventive and corrective maintenance.

The next example for a group of electric motors which activate discharge valves shows how such programmes can be recorded, particularly on computer:

Maintenance costs

Motors (numbers)	Locations (numbers)	Test 1	Test 2	Test 3
SM 326	789654	01.01.01	08.12.34	09.06.67

For the first test, the codes mean:

Employee	Frequency	Duty
01	01	01
Oiler	Monthly	Oiling

For the second test, the codes mean:

Employee	Frequency	Duty
08	12	34
Mechanic	Yearly	Change of bearings

For the third test, the codes mean:

Employee	Frequency	Duty

09	60	67
Electrician	Every 5 years	Motor rewind

Everything that has to be done on each piece of equipment or unit can be computerised. Such programme planning can help in preparing beforehand a work scheme for all maintenance employees and train them properly in their respective functions.

On a large-scale project where maintenance is of vital importance, the maintenance programme can be prepared for the full utilisation period of the project. The programme consists in planning beforehand all the repairs and replacements at a given period. With this programming, the costs of maintenance become known; the spare parts can also be added to the programme and then stocked for use during the planned repair period.

It must be remembered that the useful life of a piece of equipment is subject to several utilisation factors, and particularly to the quality of maintenance. For instance, an electric motor can have a life cycle of twenty years, on continuous duty, as long as preventive maintenance is carried out at regular intervals. The inspection of the shaft can take place at specific intervals to detect any metal cracks. From these inspections, repair maintenance can take place on time and avoid major damage. Preventive maintenance, by means of appropriate surveillance, leads to a good planning of corrective maintenance; the repair takes place before an emergency shutdown. This approach in maintenance will extend the life cycle and, by the same token, maximise the economical performance of the project.

D. Choice of Suppliers

At the beginning of the preparatory phase of a project, the search for and appraisal of suppliers is essential to eventually control costs of a project, especially the maintenance costs. The selection of suppliers will be based on the technology chosen in the preliminary evaluation report.

Assuming that an item is generally purchased only because of its need and usefulness, it is essential that it can be maintained in good operating condition; this assurance becomes a necessity at time of purchasing.

This principle must be applied when selecting the suppliers. Some suppliers will be involved only during the construction part of the project, whereas others will have to supply spare parts and important assistance during the start-up. Some other suppliers will have to supply spare parts for the useful life of the equipment. This fact becomes essential for the practicability and profitability of the project. Special attention must be paid to those suppliers who, in this case, offer technologies which apply to recognised international standards, thus avoiding a possible captive market situation or major difficulties in obtaining spare parts should the supplier go out of business.

It is difficult to contemplate a large-scale project without a maintenance programme. The acquisition of new technologies implies the training of the responsible maintenance personnel on site. Knowing this reality, suppliers who offer sound assistance in personnel training will stand a better chance to be selected.

The ideal supplier is capable of offering not only a piece of equipment but also a certain stability on the market; in addition, he is in a position to offer a valid guarantee, training, spare parts and after-sales services. Such a supplier can sign long-term agreements covering the above. As regards supply of spare parts, a good supplier should provide the following:

- An agreement which allows the purchaser to buy his spare parts for a period of several years under a price envision formula, mutually agreed upon at the time of negotiations for the purchase of the main equipment.

- A comprehensive list of all sub-contractors who manufacture any equipment components or spare parts.

- The ability to supply spares and services in case of emergency.

- A good knowledge of the concerned markets, with the ability to organise a local or regional after-sales service taking into account cultural and technological differences.

Generally, the selected supplier should:

- Be well qualified to produce, deliver and install the products, equipment and quality services required to meet the identified needs.

- Have a great respect for delivery schedules and a good knowledge of all the constraints which are specific to the developing countries he is supplying.

- Have a positive state of mind and pride in participating in the development of a country.

When purchasing equipment, it is preferable, in general, to negotiate directly with the manufacturer as long as he offers essential services such as: transportation, insurance, training, spare parts, guarantee, after-sales service and others. The importer is interested in obtaining the goods at the right time at the right place, in the exact quantity, of the required quality, and with no problem in the property transfer. When the manufacturer offers these requirements, then there is no need to use any other distribution network.

Some manufacturers, however, limit their activity to the design and production of equipment and leave the distribution system as they offer, in partnership with the manufacturers, the essential services required by the importer. Some of these firms have both a service and a wholesale organisation and can supply both spare parts and all after-sales services. This type of organisation is of great assistance to the manufacturer in organising better after-sales services, especially for remote markets.

What must be looked for in the selection of suppliers is the number and the quality of services offered by the supplier. In this respect, a wholesaler can serve a market to the satisfaction of the clients as he is providing services that the manufacturer would not be in a position to offer. In addition, from regional warehouses, the wholesaler can sometimes contribute to inventory reduction of spare parts; thus, he is giving some assurance as to a good service after the equipment is purchased by the importer.

The wholesaler must be differentiated from an agent. The wholesaler usually keeps an inventory of spare parts besides selling equipment and related services. The agent does not keep any inventory but takes orders from several customers and then buys from the manufacturer offering the best conditions. The agent however is sometimes very helpful to the importer as he can generally come up with the best prices. By the nature of his activities, however, the agent is interested in making deals on a short term basis; the extent of his services very often will be limited, and sometimes reduced to nothing when it touches maintenance and the procurement of spare parts.

The nature of maintenance depends on the type of equipment, and some parts may have to be replaced at regular intervals. In the case of an automobile, for example, oil has to be changed regularly. However, other parts, such as a rearview mirror or a door latch, are designed to last throughout the useful life of the car. Their replacement becomes part of corrective maintenance following a failure, very seldom as a result of normal wear. These parts, which are of corrective maintenance nature, are more difficult to define as far as inventory quantities are concerned. An importer would feel relaxed if a dependable wholesaler were to accept a long term agreement on stocking such spare parts at a prefixed price.

It would be interesting if the various associations of purchasers involved in the buying of similar equipment were to suggest to governments of neighbouring countries the creation of a central warehouse. For instance, the governments of three neighbouring countries using similar equipment in power stations could agree on a regional inventory of spare parts if a central store were created, whether public or private.

It is very important to know who are all the manufacturer's subcontractors, where spare parts are concerned. A great number of manufacturers only design and assemble components, leaving by preference the production of these parts to subcontractors. An importer who purchases an assembly would find it very useful to know all the subcontractors in order to assure a permanent supply of parts over a period of years. Even if a manufacturer is bound by an agreement, the importer would find it advisable to know all the subcontractors who could assure the supply of parts if the principal manufacturer were to cease operating, or even if he were to discontinue the type or model of equipment already supplied. It is when a supplier is selected that an importer has the opportunity to know the producers, the subcontractors, in other words all the intervening parties as well as the nature of their involvement in the manufacturing process.

An importer generally prepares comparative tables after opening the bids of prospective suppliers. As far as maintenance is concerned, it is also advisable to tabulate all the services proposed by each supplier on a comparative basis, as shown on page 25.

Comparative Table of Proposed Services for Imported Goods:

Services	Firm A	Firm B
Guarantee	x	
Training	x	x
Transport		x
Customs Clearance		x
Inventory	x	x
Price Revision Formula	x	
Emergency Repair Service		x
Knowledge of Social Conditions	x	
Business Information	x	x
Telex	x	x
Data Processing	x	x
Financing	x	
Quality Control		x
Number of Employees	24	16
Number of Years In Operation	8	33
Proximity	YES	NO
Containerisation	NO	YES

Maintenance Programme	YES	YES

Such a table would bring out the various services proposed by the suppliers.

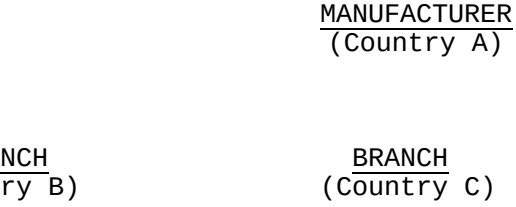
The existence of distribution networks is justified in the marketing process of products and equipment. A distribution network is meant to be an intermediate body which looks after the supply of goods to the consumer or user including several services such as after-sales services, stock holdings guarantee service, financing and a locally-based support to users. Some companies concerned with after-sales service offer maintenance services including spare parts, training and emergency repair service. Equipment is sometimes sold with a complete maintenance programme already prepared for the life of the product. In this case, spare parts can form part of a full guarantee from the original manufacturer.

When selecting suppliers, it is a must to look for suppliers who are capable of providing the parts and the necessary services in order to maintain the equipment in good operating conditions during its estimated useful life.

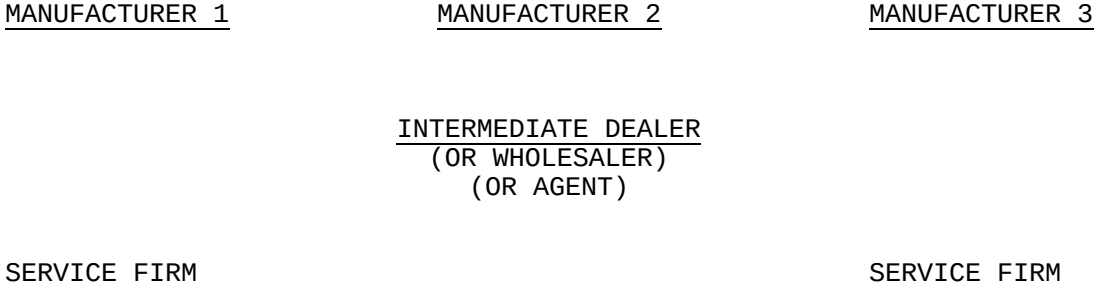
A serious importer will protect himself through an agreement with the supplier for the purpose of assuring a continuous supply. This assurance, however, leaves the buyer open to the opportunity to buy the spare parts elsewhere if competitors offer lower prices in the future.

Several types of distribution systems exist. It is by knowledge and experience in the market that it becomes possible to understand the roles and responsibilities of the intervening agencies involved in providing the necessary services for the maintenance of particular equipment.

The first type of distribution system consists of manufacturers opening their own service branches in developing countries. All undertakings under this model will belong to the same owner, as follows;



The second type includes several manufacturers who are represented by an intermediate broker who mainly looks after contracts. This broker may, in turn, have retailers or service firms capable of providing after-sales services.



USELESS AGENTS MUST BE ELIMINATED; LOOK FOR THOSE OFFERING A SERVICE WHICH REALLY HELPS A CUSTOMER IN HIS MAINTENANCE RESPONSIBILITIES.

E. Dealings with a Technological Partner

For a project involving a new technology, it might be advisable for a buyer with no experience in the field to pick a commercial partner capable of transferring the technology in addition to providing assistance during the first years of the project. This assistance can go from management to the maintenance of all new installations and new equipment.

The technological partner can be a supplier; in this case, a contract is written to cover the cost of these services. The end of the contract becomes the end of the partnership.

Many firms, mainly in the industrial sector, often prefer other agreements aimed at a broadened partnership. This can mean, for example, co-ownership of the new facilities for a predetermined period. This approach favours the sharing of risks, whether in marketing or in operations.

In putting such a plan into execution, the commercial partner can be given different tasks such as:

- Transfer of technology and of related know-how;
- Preparation of the operating manuals;
- Programme planning for preventive and corrective maintenance;
- Training of the required maintenance personnel;
- Emergency repair service in case of failure; and
- Training of operating personnel for the operation start-up.

These partnership agreements are made easier when political, economical, social and cultural conditions are favourable. Chambers of Commerce and Departments of Trade can have an important influence in promoting such partnerships, whether North-South or South-South.

Chapter 3

COSTS AND MANAGEMENT OF SPARE PARTS

A. Evaluation Method

Before producing a piece of equipment, the importer is interested in knowing with accuracy the possible cost of maintenance for the useful life of the project or equipment. To do so, he must have on hand the necessary information which would be used to determine a method of cost evaluation.

Most of the information can be provided by the suppliers and can be checked with other customers using similar equipment. To obtain all the details, the importer must be persistent in his communications with potential suppliers prior to the invitation to bid, particularly when this includes a maintenance programme.

1. Useful life

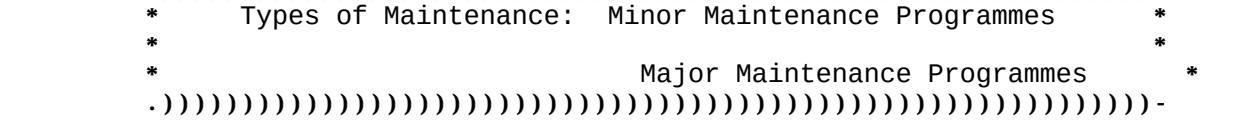
It is essential to know the useful life of a piece of equipment, that is, the number of years the equipment can last under normal use and with a predetermined level of maintenance. This last point becomes essential as the life of the equipment will be affected by the level and quality of maintenance during the period of utilisation.

As soon as this information is available and checked from statements provided by other users, all the information related to maintenance should be added, such as that concerning spare parts.

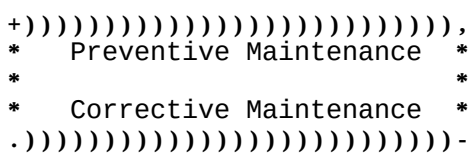
2. Spare parts requirements

The list of spare parts suggested by the equipment manufacturer is usually available at the time of purchase, as the supplier is interested in selling spare parts along with the equipment. Here, the responsibility of the importer consists in determining with the supplier the extent of usefulness of these spare parts. In this regard, it is recommended to tabulate all the spare part items in relation to their importance to the maintenance programme.

Because of their importance and to easily understand how the maintenance stock is managed, we will again touch upon the maintenance concepts already discussed in chapter one.



The selection of spare parts is made easier by subdividing, perhaps arbitrarily, each of these two types of maintenance into:



a) Minor and major preventive maintenance

To illustrate this, we will take the example of a motor-coach, or bus. In this case, the oil draining, the changing of various filters and belts, the greasing, etc., are all part of a minor preventive maintenance programme. The importer has no choice: he must know the frequency of the various maintenance jobs and keep a continuous stock of spare parts and materials needed to keep this vehicle in good operating condition.

In the same example, the importer must take into consideration the normal wear of some mechanical parts after a given period of time.

For safety purposes, the following replacements must be considered: brake blocks, exhaust pipes and mufflers, tires, etc. These actions are part of a major preventive maintenance programme.

Without preventive maintenance, there is every chance that the equipment (in this case the bus) will become useless in a short period of time. Here again the spare parts must be in stock at the right time, as

part of an established preventive maintenance programme. It is a well known fact that, after having covered so many kilometres, this maintenance becomes a necessity; it must also be repeated at longer intervals.

b) Minor and major corrective maintenance

The inventory of spare parts for minor corrective maintenance consists in keeping parts which should normally last the life of the equipment. Some of these parts, however, must be replaced under uncontrollable circumstances. A windshield, for example, should normally last the life of a coach, but during normal operation it can be damaged by accident. This becomes the reason for its unforeseen replacement. Therefore, the importer must keep a minimum inventory of spare parts to be able to replace those which are damaged. Other examples could be: driving mirror, radiator, rear window, etc.

Finally, because of obsolescence or long use, maintenance consists in making a piece of equipment as good as new. In such a case, for example, an engine or a gearbox may have to be replace. This is an example of major corrective maintenance. Here again, the importer must have spare parts in stock to be able to undertake these repairs. Quantities can be minimal as this situation generally arises only after a long period of usage. For the same reasons, deliveries from suppliers can be spread out over a longer period, as well as payments.

With a good knowledge of all the spare parts requirements, the importer can calculate the potential cost of maintenance and fix the inventory levels of spares to be kept, particularly if a fleet of coaches has to be maintained.

The question of interchangeability of spare parts is becoming more and more an important issue at the time of equipment selection if the costs of inventory and of repairs are to be minimized.

EXAMPLE

Following is a short list of spare parts for a motor coach proposed by the supplier. For each one, the frequency of replacement in kilometres is given; the number of potential replacements can now be calculated, taking into account the expected useful life as being 500,000 kilometres.

	Spare Parts	Frequency of Replacement (in kilometres)	Number of Replacements
A)	Oil	20,000	25
	Filters	25,000	20
	Belts	50,000	10
B)	Brake Blocks	80,000	6.25
	Exhaust System	100,000	5
	Tires	70,000	7.14
C)	Windshield	500,000	1
D)	Engine	500,000	1
	Differential	500,000	1

Transmission	500,000	1

Such a table helps to prepare a policy for the management of stocks. It is obvious that, at the time of purchase, an inventory of spare parts of the first two categories (A & B) must be built; these comprise the minor and major preventive maintenance programmes. For the other two categories involving minor and major corrective maintenance items, (C & D), a minimal quantity of parts must be ordered for inventory only to keep the vehicle fleet in safe operating conditions. The above example, although abbreviated, seems clear. It is worth knowing, however, that at the time of purchasing more complex production equipment, some importers do not make these specific differences and end up in having a high inventory of spare parts in the fourth category (goods sold at high cost by supplier). Yet, due to insufficient foreign exchange, there may be insufficient spare parts in stock for the minor repairs. The cost of inventory is high in this case, although what is readily needed is not available.

When such a table is known, it is possible to combine the spare parts and labour costs. The following table is an illustration of how the above information can be rewritten and compiled. For the purpose of simplification, all costs related to labour training have been excluded, as well as those concerning the erection of maintenance shops and the special equipment and tools needed to maintain a vehicle fleet.

Probable cost (abbreviated) of Maintenance

Parts	Quantity	Total Purchase Value (in US dollars)	Labour (in local currency)
Oil	25	750	120,000
Filters	20	300	40,000
Belts	10	400	20,000
Brake Stock	6.25	625	450,000
Exhaust Pipes	5	375	310,000
Tires	7.14	572	190,000
Windshield	1	675	90,000
Engine	1	5,150	875,000
Differential	1	3,430	324,000
Transmission	1	1,750	445,000
Total:		x	y

The sums of x and y equal the probable direct cost of maintenance. It should be noted that all the figures shown in the above table are fictitious and must not be used for comparative purposes in actual situations.

With such a tabulation for each of the quotations received, we can come up with the following table showing the global cost of each offer (based on actual item costs at the time of equipment purchase):

	Supplier A	Supplier B	Supplier C
Equipment	E1	E2	E3
Spare Parts	P1	P2	P3
Labour	L1	L2	L3

Other costs of maintenance can be added on such a table:

After-sales Service	S1	S2	S3
Training	T1	T2	T3

etc.

The above example does not cover for any variation in exchange rates during the service period, nor does it take into consideration the updated value of the spare parts at the actual time of purchase.

B. Procurement Global Cost

In the previous tables, we have taken into account the costs of purchasing and utilisation (maintenance). These costs can be further detailed by including operating costs such as the cost of fuel used or, in the case of production equipment, the cost of electrical power, gas, etc.

The following table presents a summary of all costs which should be considered by the importer at the time of equipment purchase, taking into account the factors of price, quantity, quality and time in the import process.

Price	Quantity	Quality	Time
Purchasing Costs	Holding Costs	Operation and Maintenance Costs	Costs due to Environment
Price of equipment	Inventory capital costs	Personnel (operators by maintenance staff)	Market conditions, (ie., price volatility)
A supplier financing conditions and terms of payment	Other holding costs (storage space, labour & handling equipment, etc.)	Performance (ie.,output in relation to consumption of inputs, ie., energy)	Exchange rates
Labour and other costs relating to installation and commissioning of equipment		Durability	Inflation
Price of technological transfer		Quality assurance (supplier & buyer)	Interest rates
Price of spare parts (initial delivery)		Standardisation (particularly of spares)	
		Maintenance (spare parts, frequency, supplier maintenance contract cost, etc.)	
		After sales service	
		Training of personnel	
		Supplier guarantee/warranty	
		Tools and other maintenance facilities	

When the information on all these costs is compiled, the importer must determine which is the option which offers the lowest global cost of acquisition taking into consideration all of the elements given above, including all costs relating to maintenance.

Chapter 4

RESPONSIBILITIES OF THE IMPORTER

A. Pre-contractual Responsibilities

The importance of preparing clear and precise terms of reference for the import contract, including the equipment specifications and other documents, cannot be over emphasized. If the description of the equipment, the required after-sales services and the maintenance needs are clearly defined in invitations to tender, potential suppliers will have a better chance to meet these requirements by including, as part of their bids, offers for long term agreements covering spare parts and after-sales services.

The emphasis in the bidding invitation should be on **what the equipment is meant to do**, (i.e., performance-oriented specifications), rather than to provide merely a restrictive reference to a specific make or model of equipment.

It is often better, when preparing the tender documents, to include all the clauses which will apply to the actual contract when the equipment is purchased. The basic principle of such inclusions consists in preparing a draft of the contract, as the basis for writing the tender documents. In this way, suppliers know exactly which are the terms of reference, and also have an idea of the general conditions to be met.

There are five major responsibilities for an importer at the pre-contractual period. These are as follow:

1. To prepare the assignment and terms of reference;

2. To prepare the cost estimate (the budget);

3. To search for potential suppliers;

4. To determine which will be the bid evaluation process;

5. To prepare the bidding documents.

When preparing the cost estimate, the importer should include the expected cost of maintenance to the cost of the equipment. Thus, the persons making the decisions will have a better idea of all the costs involved. This is essential for financing and cost control.

These key decision-makers should be aware of the importance of proper maintenance. Its importance on the budget is such that no importation should be authorized unless a comprehensive analysis of the bids is made which includes a comparative table of all the various purchasing and maintenance costs for the useful life of the equipment or the capital goods concerned.

Searching for potential suppliers is one of the most important responsibilities of the importer. In selecting potential suppliers for invitations to tender, the importer is already making an important decision which will be reflected at the time of bid evaluation. Proper information is required to keep him aware of what is happening in the market and where are the most efficient technologies and best possible offers. He should also take care of any import restrictions imposed by his own country. Sometimes, developing countries buy capital goods and equipment under foreign government aid programmes, and must import from predetermined sources.

The first step should consist of a general survey of international market activities. Market information is essential and, as discussed in ITC's practical guide in Import Management No. 5, Information for Better Import Management, a wide variety of sources of information is available to an importer. The present guide will refer to the more important ones:

- Sources of published information;

- Commercially-oriented market information and intelligence services;

- Trade representatives of foreign countries, and local foreign trade representative;

- Chambers of Commerce as well as associations of trade and industry, within and outside the country;

- Local agents of foreign suppliers;

- Other importers of the same or similar products;

- Service organizations (banks, freight forwarders, etc.);

During the bid evaluation process, the selection of a piece of equipment should be based on its quality and also on the quality and availability of the after-sales services and maintenance spare parts. The proposals considered should include not only the procurement cost for the equipment, but also an evaluation of expected maintenance costs over the utilization period. Inflation and fluctuations of exchange rates should be taken into account.

These are various bidding methods:

- Global tendering;

- Limited or selective tendering;

    - With pre-qualification;

    - Without pre-qualification;

- Negotiated purchasing.

Before issuing an invitation to bid, the documents should be prepared taking into consideration the type of bid, the number of invitations and the complexity of the goods to be imported. Special instructions to the potential bidders should be included at this stage concerning spare parts and after-sales services. If a sample copy of all general and specific terms and conditions, price revision formula and expected maintenance programme were added to the invitation to tender, this would require the bidder to include in the quotations all the information required. The selection of a supplier is then made easier.

The following format is suggested as an example of a bid submission form in the case of spare parts:

Bid Submission Form for Spare Parts

Name of bidder:

Address:

Item Number:

Commercial description:

Specifications:
To be used with:

Frequency of replacement:

Suggested order quantity:

Normal delivery lead time:

Country of origin:

Manufactured by:

Drawing number:

(to be included)

Patent number:
(if applicable)

Actual selling price: per

Specify incoterms:

Price revision formula:
(if applicable)

Normal recommended stock level:

Regional or international distribution network: (please attach list.)

Guarantee service by:

Other users known in area:

There is no single standard format covering all cases. The basic principle is to request the supplier to include in his quotation the above form for spare parts; this information would make the decision easier for the importer.

B. Bid Evaluation

This section deals with the bid evaluation process as it refers particularly to maintenance. For additional information, please see ITC's Practical Guide in Import Management No. 9, Bid Evaluation in Import Procurement.

Once the bids are received, the importer must make his decision as to which exporter should be given the order.

Bid evaluation means, first, a general technical analysis and, then, a cost analysis. A technical evaluation will be useful to determine, amongst others:

- The quality of proposed goods;
- The expected life-cycle of the proposed equipment or products, goods or spare parts;
- The assurance that specific requirements are met;
- The degree of technological complexity;
- The level of standardisation;
- The possibility of interchangeability
- The maintenance requirements;
- The training of personnel;

Such an evaluation will compare the quotations' contents with the bid specifications. For this purpose, the following table demonstrates the technical differences between several proposals. The equipment concerned in the example is a fork-lift truck.

	Supplier A	Supplier B	Supplier C
specifications met	Yes	Yes	Yes
Engine	4 L	4.2 L	3.7 L
Hydraulic system	standard	special	standard

Transmission	standard	special	standard
Expected life (before major maintenance)	25 years	30 years	20 years
Necessary training for maintenance	none	new technology	none
Number of spare parts	86	64	104
Special tooling	No	Yes	No
After-sales service	OK	None	OK
Known reliability	80%	10%	80%

With such technical information, another table of cost analysis will demonstrate the cost of equipment and the evaluated cost of maintenance. For the same example:

	Supplier A	Supplier B	Supplier C
Price Ex-works (in U.S. dollars)	27,300	22,350	31,000
Transport cost to site	6,300	5,200	1,300
Accessories	incl.	700	3,600
Patents' Fee	incl.	incl.	incl.
Guarantee one full year, parts and labour	not available	4,200	incl.
Training	not available	3,400	incl.
Duty	20%	15%	10%
Special crating	incl.	2,800	incl.
	Cost of maintenance per month		
(evaluation for expected life)			
- spare parts	425	876	463
- labour	850	1200	650
Total:	X	Y	Z

other considerations:

Other factors may influence the importer in his selection of the supplier, including:

- National standards applicable to the equipment;
- Availability of personnel for maintenance;
- Exchange rates on foreign currency;
- Possible alternative source of supply for spare parts;
- Financing possibilities or limits;

- Past performance of supplier;

- Level of technical assistance:

- Reciprocity;

- Special consideration to local vendors.

These tables will help the importer to weigh the relative importance of the technological and costs elements of the bids received. It is a well known fact that the cost of maintenance over the period of utilization can be higher than the acquisition cost. For this reason, the costs of spare parts and maintenance should be considered as a very important factor in the bid evaluation for capital goods purchases.

At the time of bid evaluation, a good practice consists in establishing a draft maintenance programme. This practice will ensure the availability of parts for preventive and corrective maintenance. A list of maintenance activities can be prepared, showing the spare parts needed for the useful life of the equipment. Such a list will be useful to prepare a monthly check list of spare parts required by maintenance planning officers. After, an annual equipment repair programme can be established. Finally, the list will cover the maintenance to be made annually for the life of the equipment.

These lists can be proposed by the supplier, but in most cases they will be prepared by a team of responsible officers from many sectors: purchasing, maintenance, operation, inventory control, finance, etc.

C. Close Contract Follow-up

A team of managers should be involved in close follow-up to the contract. This action may take place before delivery, at the time of delivery, at the time of payment and during the utilization period of the equipment, especially if there is a long-term agreement on after-sales services and spare parts supply.

Before delivery:

- Verification of specifications,

- Quality, quantity, expected delivery;

    - Visit to supplier;
    - Follow-up of communications;
    - Quality control at site:
        - during manufacturing;
        - before shipment;
    - Quality assurance system of supplier;
    - Sampling requirements.

At the time of delivery:

- Obtain from supplier:
    - Certificate of compliance;
    - Reference standards;
    - Technical design specifications;
    - Drawings of equipment and spare parts;
    - Special maintenance tools;
    - Preventive maintenance manual;
    - Instruction manual;
    - Installation instructions;
    - Wiring diagram;
    - Etc.

- Verify proper transit insurance on goods;

- Control freight forwarders from departure point;

- Advise concerned legal authorities;

- Etc.

At the time of payment:

- Consult direct users for advice;

- Check all documents:
  - Packing list
  - Bill of lading
  - Quality control report
  - Receiving list
  - Contract
  - Invoice
  - Legal authorizations for customs, taxes, import permits, etc.
  - Make sure that all parts of the contract have been fully delivered by the supplier:

    - Preventive maintenance programme;
    - Required spare parts;
    - All drawings and specifications;
    - Instruction manuals;
    - Etc.

During the utilization period:

- Annual revision of the preventive maintenance programme;

- Planning of spare parts required on an annual basis;

- Follow-up on prices in case of price revision formula for spare parts;

- Constant survey of market indexes;

- Replacement of parts under guarantee;

- Constant searching for alternative suppliers of spare parts;

- Comparison of actual cost of maintenance with:

  - Promised cost of supplier;
  - Cost of new technology;

- Follow-up and control of maintenance training;

- Evaluation of overall reliability.

D. Import Purchasing Methods

Several purchasing methods can be used by an importer: from global tender to direct negotiation. The main concern should be to obtain the spare parts as per the specific objectives of the project or for the needs of the maintenance of the imported equipment.

One of the best methods consists in buying spare parts with the equipment on a long term agreement, including a price revision formula. In this method,the basic negotiations will take place only once, at the time of the contract. During the utilization period, the negotiation can be limited to other aspects: quality, reliability, delivery of exact quantities at the right time, etc.

Purchasing by sealed tender is also a good, safe and honoured method to increase competition amongst suppliers but, under certain circumstances,

direct purchasing by negotiations with identified suppliers can be the best method to ensure adequate maintenance services and availability of spare parts. In such a case, it is important that the importer's team prepares an effective negotiation strategy in advance, taking account of the volume of purchases, technological factors and other relevant issues.

Too often, buying organizations do not know how to negotiate. For the supplier, the strategy consists in knowing as much as possible about the buyer's requirements, constraints and financial capabilities. Much of this information is often freely provided by the buyer organization, thus becoming like a kitchen strainer. As a result, the vendor often knows more than the procurement officer. The negotiation strategy should be the concern of all the members of an importing organization; it is the responsibility of the procurement officer to co-ordinate a global strategy and assign roles to colleagues, taking the leadership in all communications with the supplier.

When it is time to import, although the supplier knows the product specifications, he may not be aware of the degree of urgency, or the buyer's level of stock, or the competitors from which he has also received offers. In negotiation there generally exists a number a major unpredictable factors; success then consists in taking advantage of the unknown.

The negotiation, however, should take place without sacrificing the effectiveness of the maintenance programme. Therefore, the key solution is the preparation of the draft preventive maintenance programme followed by a procurement plan for required services and spare parts.

E. Contractual Clauses

Many countries have standard clauses for use in government contracts. Unfortunately, too many of these "ready to use contract formats" do not take into consideration the maintenance requirements, neither do they include a long term agreement for the supply of after-sale services or spare parts. Sometimes, equipment is imported under financial aid programmes from countries which will impose their own contractual clauses, without any reference to maintenance.

The best contracts are normally prepared at the start with "ready to use" clauses, but they are modified, to suit the objectives of the specific import operation being carried out. This exercise should thus be undertaken on a case-by-case basis, using a similar or standard format as a starting point.

In addition to standard national contracts, international sales conventions also exist. An important one is the "United Nations Convention of Contract for the International Sales of Goods". The convention applies to enterprises which have their place of business in countries which participate in the convention.

As far as equipment and capital goods are concerned, the UN-ECE (United Nations Economic Commission for Europe) has published the "General Conditions for the Supply of Plant and Machinery". Also, FIDIC (International Federation of Consulting Engineers) has produced its "Conditions of Contract (International) for Electrical and Mechanical Works" (including erection on site). These publications may be used as a basis for the preparation of contract. In addition, ITC has prepared a compendium of standard terms and conditions of contract in import management of various categories of goods which may be used as a reference to this effect.

For information purposes, Annex I of this guide presents clause number 49 of the FIDIC conditions of contract, concerning maintenance and defects.

In order to help the importer draw up an import contract for capital goods and equipment, including spare parts, the following checklist presents some of the subjects to be covered by the contractual clauses.

FOREWORD:
- Definitions and interpretation;
- Identification of parties;

- Contract documents;
- General obligations;
- Notices.

A. QUALITY

- Terms of reference;
- Complete description of utilization;
- Commercial description (not restrictive);
- Reference to standard;
- Reference to samples, trade names, drawings, etc. (not restrictive);
- Quality assurance;
- Quality control (types of inspection);
- Nomination of inspection agency;
- Acceptance and rejection;
- Packaging requirements;
- Quality certifications;
- Commercial guarantee;
- Preventive maintenance programme;
- After-sales services;
- Country of origin;
- Patent's rights;
- Sub-contractors
- Etc.

B. QUANTITY

- Methods of control;
- Lot identification;
- Special marking and identification;
- Part-shipment;
- Certificate of weight survey;
- Etc.

C. PRICE

- Validity;
- Incoterms;
- Price revision formula and sources of indexes;
- Payment conditions;
- Documents required for payment;
- Insurance;
- Bank guarantee;
- Taxes, duties.

D. TIME:

- Dates of delivery (schedule);
- Performance guarantee;
- Shipping conditions;
- Default to deliver;
- Duration of contract.

E. OTHERS:

- Responsibility of seller;
- Required level of inventory for spare parts;
- Default in provisioning of spare parts;
- Arbitration;
- Force majeure;
- Export and import licences;
- Amendment of contract;
- Claims;
- Liquidated damages;
- Previous correspondence;
- Governing laws;
- Cancellation of contract.

A contract is an agreement between two or more persons whereby they promise to do or to refrain from doing a set of specified actions. A contract should be clear and all actions should be determined. The emphasis, for a buyer of equipment, should be on the after-sales services and the provisioning of spare parts. Clauses concerning preventive and corrective maintenance are an essential part of such a contract.

Chapter 5

PROCEDURES, STANDARDIZATION, SPECIFICATIONS

A. "A priori" Controls

Import regimes vary from one country to another. In some cases, the import procedures are simple; permits can be obtained with no significant delay. In other countries, however, the authorized procedures for import call for a series of controls which compel the importer to plan almost perfectly and to seek all possible ways to avoid undue delays.

This planning is possible when spare parts for preventive maintenance are concerned. For corrective maintenance, however, delays must be eliminated,and regulations should be put in place by the government to allow urgent or emergency imports of spare parts.

Within such emergency regulations, procedures are accelerated to obtain the necessary import permits and bank credits with acceptable delay.

Although these import procedures may exist, they remain "a priori" controls as they compel an importer, even in an emergency, to go through a series of administrative procedures before importing.

Under these circumstances, importers often react by keeping a higher stock of spare parts than necessary, so that they can fulfil adequately any urgent request. Cumbersome import procedures for spares are certainly a cause for all kinds of additional costs: cost of inventory, cost of urgent import, loss of credibility as far as suppliers are concerned, higher risks of failures, losses and obsolescence, etc.

Unfortunately, due to the import procedures, in some cases equipment and installations cannot be repaired or maintained because of a lack of spare parts in stock. These delays can affect a large portion of the population, particularly if essential services are concerned. They also adversely affect the local economy when production lines and distribution networks are ground to a halt.

It is extremely difficult to foresee the unpredictable. A relatively high proportion of the maintenance activity is of the corrective type and thus, by nature, unpredictable. However, the necessity of maintenance and the emergency requirements which often characterise it remain obvious.

When the authorization procedures cause delays of several months, it becomes very difficult for an importer to deal effectively with the maintenance needs for equipment and machinery, particularly after serious failures which create disastrous effects.

B. Accelerated Procedures (a posteriori controls)

In order to more effectively achieve a country's social and economic objectives, an import regime may preferably involve a system of "a posteriori" controls, usually when clearing customs. With this method, it is rather easy to speed up the customs clearance by releasing the goods to the importer in a relatively short period of time. Other systems allow custom clearing rooms and in-bond carriers, thus allowing in-bond goods to travel through the country to the importer's location before being finally inspected by customs. When the economy requires the suppression of administrative constraints, the system may allow the setting up of a bonded warehouse close to the production unit and a full-time customs officer is appointed to clear the goods as they

are taken from the warehouse. This is justified when the volume of imported goods is important.

"A posteriori" controls can be established in both a free economy as well as in a controlled economy. In the latter case, the import permits can allow some flexible budgetary allocations so imports of spare parts can be made on an urgent basis, particularly if this constitutes a social and economic requirement. Whatever the import form and the nature of the economy, such a system can eliminate the administrative constraints in case of essential and urgent maintenance.

Under this approach, the legal import controls can be "a posteriori" as long as the bank credit is issued beforehand. This contributes to better maintenance control and also, in the long term, to a reduction of the global import costs.

Import controls can be improved a great deal by a dynamic and flexible import system, and also by the quality, common sense and sound judgement of the intervening people. This approach implies that the importer is recognized as an essential economic agent, as imports may have a great impact on the country's social and economic life. On the other hand, the export of goods and services very often implies an import beforehand. This is particularly the case of imports of raw materials, components and spare parts required for export production. Efficiency in the various activities of import and export can be a conclusive factor in becoming competitive in the international market place, at the right moment.

C. Urgency Procedures

The old saying: "The exception proves the rule", is applicable to a maintenance programme as well as to an import system. Any system must allow for urgent cases whereby action and results rule over procedures. The imports of goods such as spare parts essential to the economy and drugs to save human lives, demand not only an accelerated procedure but also one that is geared to cope with extremely urgent requirements.

As far as equipment maintenance is concerned, such an urgency procedure can be essential. The failure of energy supply or shortages in stock of foods, drugs, medical apparatus and other such goods can have disastrous consequences.

Urgency procedures mean the possibility for an importer to obtain goods or spare parts within very short notice, even within hours. In such cases, even customs controls may be waived until the goods are actually being used (e.g., spare parts already installed in the equipment). Such flexibility may be essential in certain cases in which reality overwhelms the normal administrative process.

D. Standarization

The International Organization for Standardization (ISO) has produced a large number of proposed international standards; national standards institutes co-operate with this organization in the evolution of standards for world-wide adoption.

In general, a standard defines the following:

- Terms used;
- Scope of the specifications;
- Materials and related technical specifications;
- Methods of production (where applicable) and their control;
- Limits of tolerances to be adopted;
- Performance tests;

- Testing equipment and procedures;

- Certification (where applicable).

National quality control of imported products often requires the adherence to specified international standards and, in some cases,the setting up of national or regional standards such standards are then used as references in checking the quality of the imported goods.

A good international standard can be very useful for the quality control of an imported product, and may be used as a basis for the adoption of a national standard. Otherwise, different and possibly incompatible technologies would be adopted for essential services such as electrical power, aqueducts, sewer systems, etc. Standardization is of vital importance in maintenance. It is impossible to maintain, with a minimum of efficiency, an electrical distribution network with incompatible equipment and materials. It would be just as difficult and costly to maintain a national railway network with six different types of locomotives.

Without a national standardization programme, equipment maintenance costs will most likely increase because of the continuous on-the-job training required on the various technologies, and also because of the additional variety of spare parts needed.

When equipment parts or spare parts are imported, the purchaser must prepare the specifications keeping in mind the effective standards in effect or other rules existing elsewhere. It is at this stage of preparation of the specifications that a description with a well-detailed end use of the goods may improve the level of understanding between the importer and the exporter.

Even if maintenance is a state of mind, it requires a strict application of available standards and accurate specifications. Because of a lack of a proper technological information network, too many developing countries depend largely on information received only from suppliers. A familiar saying reminds us that: "To hold the information is to hold the power". In any case, it is better to verify before rather than after.

For this reason, an importer who is ready to choose a technology for which standards may apply, should consult with organizations which might be able to pass on general information to be used for comparison purposes. When an importer is aware of the availability of several technologies, he can then make a better choice which may have consequences over the utilization period of the imported goods, as the equipment will have to be maintained in good operating conditions for a number of years.

E. Sources of Information

Following are some organizations in developing countries which have set up information banks to assist enterprises in selecting the most appropriate technologies:

- Institute and Technical Information Centre for Science and Technical Information of China;

- The Hong Kong Productivity Centre;

- Technology Resource Centre of the Philippines;

- Pakistan Scientific and Technological Centre;

- Singapore Institute of Standards and Industrial Research;

- National Research Development Corporation of India;

- Asia and Pacific Centre for Transfer of Technology (India);

- Korea Advanced Institute of Science and Technology;

- National Scientific and Technical Information Centre (Koweit);

- Fundaçao de Technologia Industrial (Brasil);

- National Council for Science and Technology of Mexico.

On the other hand, several United Nations and other international organizations also provide information services pertaining to technological choices, the standards, etc., in particular:

1. Food and Agriculture Organization of the United Nations (FAO):

   - AGRIS: Agricultural technology sciences;

   - CARIS: Data bank on agricultural research institutes

2. International Labour Office (ILO):

   - LABORDOC: Data on technological changes, in liaison with

   - SCD: United States

   - IDRC: Canada

3. United Nations Industrial Development Organization (UNIDO):

   - INTIB: Industrial and Technological information bank

   - LINK: Data bank pertaining to Institutions and Suppliers of Technologies

   - TIES: Information on clauses and Conditions in Technological contract

4. World Intellectual Property Organization (WIPO):

   - This organization runs a programme which provides information on patents.

In addition, Annex II of this guide presents national information sources from certain developed countries which have, in the past, participated in technological transfer and in project financing.

Finally, it is worth mentioning the establishment of national maintenance institutes, such as I.N.M.A. (Institut National de Recherches en maintenance) in Algeria. Its functions are to:

- Define maintenance concepts (control, management);

- Develop maintenance engineering techniques;

- Establish maintenance standards;

- Assist national organizations in maintenance planning;

- Participate in the organization of training programmes in maintenance;

- Coordinate and sensitize on maintenance questions through working sessions, symposia, etc.

Importers in developing countries should leave no stone unturned in raising the level of quality and the frequency of their maintenance activities. If equipment and capital goods investments are to be considered as an essential part of the development phase, maintenance must be given a higher priority. Without adequate maintenance, investments may lose their usefulness and, as a consequence, the development of the country may be jeopardized or at least delayed.

Chapter 6

PRICE REVISION FORMULA

A. Objectives

One of the many business risks facing an importer in a developing country lies in the fact that his supplier does no often give him any insurance as to the delivery of spare parts or even the after-sales services needed for the maintenance of purchased equipment. The supplier's stability in this regard is of great importance; in fact, the importer should make sure that his supplier life cycle of the supplied equipment. As it is difficult to provide for bankruptcy or the closing of a firm, it is advisable for the importer to obtain from his supplier a list of his other clients who have purchased similar equipment and, most probably, have identical spare parts in stock. For the same reason, it would be useful to obtain the list of subcontractors who have manufactured the spare parts. Indeed, several manufacturers are only designers and assemblers; by preference, they leave the highly specialized subcontractors to produce the components (eventually spare parts). When the importer knows the supplier's subcontractors, he can call on them if the supplier disappears. Finally, the importer can also request the supplier to provide a list of the various depots (wholesalers, distributors, etc.) for services and spare parts.

When the purchased equipment is highly technical and complex, it is advisable for the importer to obtain all the detailed drawings of each component, with the corresponding references to international standards. This information will serve the importer later when he wishes to obtain the spare parts locally or from other more performing suppliers. It is important to keep in mind that equipment with a very long useful life will require spare parts after many years of service. Over this period, the purchaser-importer can look-up his detailed data bank to purchase the necessary services and parts from the best possible sources.

A second business risk for an importer is to find himself in a captive market. Some suppliers sell equipment at very low prices, according to their marketing strategy, with the hope that the early low profit would be made up later on the spare parts. The importer thus, tied into a given technology, is often taken into a situation where he can hardly negotiate the price for future delivery of spare parts. He is then at the mercy of this technological market, with no purchasing power. To cope with this risk, the importer who wishes to buy spare parts at a negotiated price will come to an agreement on such a purchase before finalizing the equipment acquisition.

To avoid any dispute on prices, the importer and his supplier can use a price revision formula. Under such a formula, the two parties will agree on a given price for the spare parts, based on prices quoted along with the equipment. These prices will be used, along with the formula and a pre-determined index as reference, to calculate the prices to be paid later on.

A price revision formula does not give any assurance as to the delivery of pieces on time, with the right quantities and quality. It applies only to holding the prices within an agreed frame for the first few years of operation. It does not hold the importer to buy all spare parts from such a supplier; it compels the supplier to supply the spare parts, when these are ordered, at a calculated price based on the price revision formula included in the equipment import contract. The importer may have to negotiate a clause releasing him from the obligation to buy, but forcing the supplier to sell at a price in accordance with the formula.

It is for the importer to negotiate such a binding clause with his supplier. The purchaser is interested in buying equipment; he can, however, lay down the condition of the price revision formula which would offer him some assurance of a reasonable price for the spare parts and the after-sales service. It is at this stage that the price revision formula must be negotiated. Once the equipment is purchased, there is less of a chance for the importer to come to such a negotiated agreement.

When a price revision formula has been negotiated and included in an equipment import contract, this can be an incentive for the supplier to stock spare parts in the importing country itself. The obligation for the supplier to carry such a minimum level of stock can also be included in some negotiated contracts; the client must be advised of any eventual closing of the firm so that the importer, in turn, can purchase his parts immediately before the closing, or plan some other actions.

B. Price Index

A price revision formula is used as a basis to fix the price of the spare parts and for the after-sales service during the years of equipment usage. To come to this agreement, the price index must be determined so that the prices can be increased (or decreased) each year. A price index is a percentage of annual increase in costs for a given economic sector. In some countries, such price indexes by sectors are published by governments; in some cases they are published by specialized trade and industry associations, but the data is recognized officially. Sometimes, detailed price indexes can be obtained through trade and industry journals, such as Usine Nouvelle in France. This information can normally be obtained either directly from the source or through embassies and trade missions posted in the importing country, chambers of commerce, and others. Developing countries can also obtain this information from international organizations such as ITC.

It is important to choose the index which fits the specific nature of the commodity. It is needless to use a general cost of living index and apply it to industrial equipment. In most price revision formulas, the supplier's gross profit margin is shown separately, as well as labour cost and material cost. To the labour cost, there is a corresponding index showing the annual increase in wages and salaries in the supplier's country for each category of employees involved. This also applies to materials; if steel is concerned, the corresponding index will be used. A special approach is sometimes necessary if one material used has a greater than normal importance in the total price of goods. For instance, if plastic represents 50% of the price while other materials represent 10%, two price indexes can be used: one for plastic and the other for the other materials. The source and the specificity of the indexes used must be clearly defined at the time of negotiating the equipment import contract. They are the references which will be used for the duration of the agreement. This duration for a price revision agreement may vary, from as little as one or two years to as many as five years or more, depending on the relative negotiating positions of the buyer and the seller. It may also be renegotiated once the fixed-term agreement expires. It is to be noticed that no index has to be included in the price revision formula for gross profit margin: it is assumed in the formula that, for the duration of the contract, the percentage of gross profit on materials and labour prices remains constant.

The principle laid down for the use of the price index of the supplier's country consists in making the supplier accept to increase (or decrease) his purchase price only in relation to the actual increases (or decreases) affecting the overall cost of manufacture in the same economic sector in the supplier's country.

With positive indexes, prices increase. If the indexes become negative, then the prices must decrease. An agreement between the parties requires the supplier to advise the new price at the beginning of each year or any chosen period, according to the agreed formula, and at the same time, to include a copy of the official indexes used. The importer can then verify at his leisure; he can accept or dispute the truthfulness of the information received before purchasing any other goods at the new price based on the formula.

This mathematical formula used in the price revision formula can be a compromise between parties who wish to come to a long-term agreement. It can be an interesting tool to control future maintenance costs. A serious importer must have some assurance into obtaining negotiated prices for after-sales services and spare parts if he wishes to control his global procurement costs, including equipment utilization.

C. Examples of Formulations

There are several possible formulations to a price revision. For a better understanding, some examples are given below (prices are considered constant for a period of twelve months), in which the following definitions apply:

P0: Price of origin. The price given by a supplier at the time of purchase of the equipment, spare parts, or the hourly rate for after-sales services as from day one, over the first twelve months of the contract.

P1: Price obtained from calculation which establishes the price for twelve months, as from the thirteenth month to the twenty-fourth inclusive.

P2: Price obtained from calculation which establishes the price for the period after the twenty-fourth month, that is, from the twenty-fifth until the thirty-sixth month inclusive.

In this respect, if prices are calculated for each twelve-month period, the importer will then pay:

P0: Months 1,2,3,4,5,6,7,8,9,10,11,12.

P1: Months 13,14,15,16,17,18,19,20,21,22,23,24.

P2: Months 25,26,27,28,29,30,31,32,33,34,35,36.

(and so on...)

GP: Gross profit margin agreed with the supplier for the duration of the contract. It is given as a percentage with relation to the sales price. This margin is usually negotiable, the basis being the supplier's mean gross profit for the previous years. This gross profit can be checked by analysis of the supplier's financial statements.

LI: Labour price index. Yearly index or rate of increase for the price of labour.

RMI: Raw material price index. Yearly rate of increase for the raw material price.

%L: Percentage of cost of labour in the price.

%RM: Percentage of cost of raw material in the price.

Example of formula:

$$P1 = \frac{[(PO \times \%L) \times (1+LI)] + [(PO \times \%RM) \times (1 + RMI)]}{(1 - GP)}$$

Example of calculation:

PO = 1.00 US Dollars

GP = 20% or 0.20

%RM = 20% or 0.20

%L = 60% or 0.60

These prices and percentages are generally determined and fixed for the term of an agreement.

When calculating the price P1, the indexes to be used in this example are as follows:

LI = 6% or 0.06

RMI = 5% or 0.05

The above indexes are likely to vary each year.

The formula can now be computed in the following manner:

$$P1 = \frac{[(1.00 \times 0.06) \times (1 + 0.06)] + [(1.00 \times 0.20) \times (1 + 0.05)]}{(1.00 - 0.20)}$$

First solution step:

$$P1 = \frac{(0.60 \times 1.06) + (0.20 \times 1.05)}{(0.80)}$$

Second solution step:

$$P1 = \frac{(0.64 + 0.21)}{(0.80)}$$

$$P1 = \frac{0.85}{0.80}$$

P1 = 1.06

Therefore, in this case, P1 equals 1.06 US Dollars, that is, the price which should be paid between the thirteenth and the twenty-fourth month inclusive.

Continuation of the example:

Now the price P2 is to be calculated with the following (sample) indexes:

LI: 8% or 0.08

RMI: 4% or 0.04

The same formula can be applied by replacing P0 with P1, as the increases are cumulative and the last reference price is the price of the previous period.

The formula then becomes:

$$P2 = \frac{[(P1 \times \%L) \times (1 + LI)] + [(P1 \times \%RM) \times (1 + RMI)]}{(1 - GP)}$$

First step of calculation:

$$P2 = \frac{[(1.06 \times 0.60) \times (1 + 0.08)] + [(1.06 \times 0.20) \times (1 + 0.04)]}{(1.00 - 0.20)}$$

Second step:

$$P2 = \frac{(0.64 \times 1.08) + (0.21 \times 1.04)}{0.80}$$

Third step:

$$P2 = \frac{(0.69 + 0.22)}{0.80}$$

$$P2 = \frac{0.91}{0.80}$$

P2 = 1.14

To go on with the example of price calculation, the importer would have paid the price of P0, or 1.00 US Dollars, for the first year; the second year a price P1, or 1.06 US Dollars; and, finally, the third year a price P2 or 1.14 US Dollars, based on the price indexes (labour and raw materials) which apply

in the supplier's country during the given periods.

Here is another example:

For a service contract in which only labour is involved, PO becomes an hourly rate. The formula, in this case, will be as follows:

$$P1 = \frac{(PO \times \%L) \times (1 + LI)}{(1 - GP)}$$

Example of calculation:

If: PO (price of origin) = 50.00 US Dollars/hour

%L (percentage of labour) = 75%

GP (gross profit margin of supplier) = 25%

LI (labour price index) = 6%

The P1 can be determined as follows:

$$P1 = \frac{((50.00 \times 0.75) \times (1 + 0.06))}{(1.00 - 0.25)}$$

The result is:

$$P1 = \frac{(37.50) \times (1.06)}{0.75}$$

or:

$$P1 = \frac{39.75}{0.75}$$

Therefore:

P1 = 53.00 US Dollars/hour

As seen previously, using formulas similar to those shown above, agreements between parties can be reached for relatively long periods of time. Thus, the contract prices for spare parts, for after-sales services or professional services should be negotiated along with the equipment purchase to ensure long-term cost control in imports.

D. Commodity Markets

The prices of raw materials generally fluctuate according to the rule of supply and demand; certain of these are traded in organized markets, called commodity exchanges, which publish the prices at specified intervals, often very frequently. In such cases, the price of origin and the indexes cannot be used in the price revision formula: prices at the opening or closing of the commodity market should apply, for specific dates or periods predetermined on the contract.

For example, for the supply of electric cables in which copper is the raw material used by the manufacturer, the price of copper in the formula will be the price given by the selected commodity exchange (e.g. London or New York) at a given period specified in the contract. For other materials (such as plastics, glues, etc.) The relevant price index of the supplier's country should be used.
As example:

PO: starting price for electrical cable, per meter: 26.00 US Dollars/meter

GP: Supplier's gross profit margin 15%

%CU: Percentage of copper 60%

%RM: Percentage other raw materials 10%

%L: Percentage of labour 15%

Total: 100%

(percentages prevailing at the time of quotation by the supplier)

In this case, copper alone accounts for 60% of the price, that is, 15.60 US Dollars per meter (60% of 26.00 US Dollars). Knowing the weight of the copper used per meter, this price requires the disclosure of the reference price, which is the copper value used in the preparation of the supplier's quotation. For example, the reference price can be: "this price is based on a copper value of 1.50 US Dollars per kilogramme".

In the following example, P1 is to be calculated when the price of copper is at 1.25 US Dollars per kilogramme.

If at 1.50 Dollars per kilogramme, the value per meter is 15.60, the value at P1 with a price of 1.25 US Dollars per kilogramme becomes:

$$\frac{15.60 \times 1.25}{1.5} = 13.00 \text{ US Dollars per meter}$$

Once this new value for copper is known, a similar formula to that previously described can be used.

In such a formula, PCU is defined as the price of copper at the time of calculation.

$$P1 = \frac{PCU + [(P0 \times \%L) \times (1 + LI)] + [(P0 \times \%RM) \times (1 + RMI)]}{(1 - GP)}$$

If:

LI equals 7% (or 0.07)

and

RMI equals 6% (or .06)

Then:

$$P1 = \frac{13.00 + [(26.00 \times 0.15) \times (1 + .07)] + [(26.00 \times 0.10) \times (1 + .06)]}{(1.00 - 0.15)}$$

The result is:

$$P1 = \frac{13.00 + (3.90 \times 1.07) + (2.60 \times 1.06)}{(0.85)}$$

$$P1 = \frac{13.00 + (4.17 + 2.76)}{0.85}$$

$$P1 = \frac{19.93}{0.85} = 23.45 \text{ US Dollars/meter}$$

The price paid by the importer of the cable for the first twelve months (PO) would thus be 26.00 US Dollars per meter; for the second year, the price (P1) would be 23.45 US Dollars per meter.

For the third year (P2) and on, the formula has to be modified slightly; new raw material and labour prices to be considered would be based on the price of the previous year.

In the previous example, the new calculation of P2 involves the following replacements in the formula:

(PO x %L) by: 4.17 (value at time of P1)

(PO x %RM) by: 2.76 (value at time of P1)

If the indexes at the time of calculation are:

LI: 8% (or 0.08)

RMI: 4% (or 0.04)

and if the copper price is 1.04 US Dollars per kilogramme, P2 is calculated as follows:

1st Step: calculation of copper value:

$\frac{15.60 \times 1.04}{1.50}$ = 10.82/meter (15.60 = price of copper at time of P0)

or:

$\frac{13.00 \times 1.04}{1.25}$ = 10.82/meter (13.00 = price of copper at time of P1)

Then, the same formula can be used, that is:

$$P2 = \frac{10.82 + [(4.17 \times (1 + 0.08)] + [(2.76 \times (1 + 0.04)]}{(1.00 - 0.15)}$$

and therefore:

$$P2 = \frac{10.82 + 4.50 + 2.87}{0.85}$$

$$P2 = \frac{18.19}{0.85}$$

P2 = 21.40 US Dollars/meter

The following summary can be tabulated for the next three years:

Summary Table

	Copper	Labour	Raw mat.	S.Total	Profit	Gross Value	GP	Prices
Percentage at beginning:	60.00%	15.00%	10,00%	85.00%	15.00%			100.00%
PO	15.60	3.90	2.60	22.10	15.00%	3.90		26.00
P1	13.00	4.17	2.76	20.53	15.00%	3.62		23.45
P2	10.82	4.50	2.87	18.18	15.00%	3.21		21.40

Annex III

Case Study on Maintenance

Case objective:

This case will deal with specific problems which developing countries are facing in preventive and corrective maintenance. Its main objective is to train the participants of a working party in solving the problem and, at the same time, to make them familiar with the maintenance concept.

Target groups:

- Procurement managers
- maintenance shop supervisors
- Bank managers

- Leaders of commercial and industrial firms
- managerial staff
- Managers of import training projects

Coordination Methods

First phase:

Case presentation by the coordinator who also points out the most important aspects of maintenance. (see guide)

Second phase:

Participants read and study the case.

Third phase:

Organize and form working parties or project group sessions of four persons (maximum).

Fourth phase:

Work sessions of all groups.

Fifth phase:

All session groups take turns in presenting their results before the general assembly of the participants.

Sixth phase:

Full assembly of all participants.

Seventh phase:

Coordinator's conclusions.

Proposed Schedule

First day:

First phase:	three hours
Second phase:	evening

Second day:

Third phase:	20 minutes
Fourth phase:	two hours

Third day:

Fifth phase:	30 minutes for each team
Sixth phase:	one hour
Seventh phase:	one hour

The work is spread over a period of three days. The participants have enough time to read the case very carefully on the first day. On the second day, they can prepare their presentations for the third day.

M.E.N.R. Elevators

The Ministry of Energy of the New Republic has its head office right in the centre of the capital city Metropolus. The population's growing needs in energy has forced the central government to authorize the expansion of the services to the population. The enlargement of the M.E.N.R. Head Office is the consequence of this expansion.

The plans for the preparation of the new section for the building have been given to a national enterprise. The proposed architectural style respects the environment and the present building, and yet, it reflects the dynamics of the Republic. The new three floor section will include two conference rooms and 56 offices laid out according to specific needs. In addition there with access to upper floors.

The construction will be under the responsibility of a national private contractor which has proven its qualifications on several occasions in the past. The import in materials are limited to: steel reinforcements, piping, valves and fittings, cement and elevators. All other materials and necessary supplies are available locally and will be purchased through dealers, craftsmen and local manufacturers to respect the social milieu and to help the national economy. Eventually, the maintenance of the building's new section will be looked after by the M.E.N.R. maintenance service, managed by Mr. Kido.

The maintenance service group includes the following team: one carpenter, one plumber, one painter, two gardeners, and part-time personnel looking after the office housekeeping, usually done after the working hours of the office staff.

Advisory Committee

The M.E.N.R. Minister has formed an advisory committee which will have the responsibility of supervising the preliminary project preparation. The committee leader, Mrs. Tadi, is a well known business lady of this country; she also acts as the President of the local Chamber of Commerce. Under her direction are: the Deputy Minister of M.E.N.R., two architects, an engineer, one university professor, the maintenance service manager, Mr. Kido, and Mrs. York, head of the M.E.N.R. purchasing department; their mandate is to act in an advisory capacity.

The choice of the architect, materials,plans, supplies, etc., are the entire responsibility of the advisory committee. The committee has full power to determine the need and then to realize the construction project entirely.

Elevators in Service

At one of the advisory committee meetings, one of the members asked Mr. Kido why the elevators presently in service in the building were continuously out of order. This point was pertinent as the new section specifications called for the same manufacturer.

Mr. Kido explained as follows: "The three elevators in service are continuously out of order because of a lack of spare parts. The necessary maintenance parts require from six to nine months of delays, of which two months are needed to obtain the budgetary approval from the Ministry. However, our most important problem is one of service. In the capital city, there is only one competent man to do the repairs. He does voluntary work for us as the national laws do not allow any payment for his services. In the past, the carpenter and I helped out every time someone was trapped in the elevator when the cab was stopped between two floors. In addition, I have mentioned on several occasions that we should not import elevators without knowing how to repair them. Nobody seems to listen!"

After this intervention, the committee looked at the proposal made by the same supplier. After a quick review, it was noticed that there was no reference to after-sales service, neither to spare parts availability. Mr. Kido then added: "I was working for the Ministry during the construction of the building and I had the opportunity to meet an employee of this supplier at the time of erection. They had, then, proposed some spare parts, but our budget for foreign currency was limited and, consequently, the spare parts were simply excluded from the order."

Mr. Kido added: "Moreover, these traction elevators are not necessarily the best choice for a three floor building; at that time it could have been better to select an hydraulic elevator."

Following these comments, the committee decided to ask for a preliminary study for a further decision as to the type of elevators to be used in the new building section. Mr. Kido was also requested to prepare a maintenance programme for the elevator presently in use; as an additional request, he was to prepare a preventive maintenance programme for the unit to be used in the new section of the head office.

Preliminary Study

The conclusion of the preliminary study on the selection of the elevator was to address the supplier with a request for information along with a new proposal for hydraulic elevators. The same request included price and delivery for maintenance spare parts.

The attached appendixes present:

Appendix A: Sketch plan of a traction elevator

Appendix B: Sketch plan of a hydraulic elevator

Appendix C: List no. 1 of spare parts with prices and deliveries

Appendix D: List no. 2 of spare parts with prices and deliveries

Appendix E: Example of a preventive maintenance programme as proposed by the supplier for a hydraulic elevator.

Appendix F: Example of a preventive maintenance programme, as proposed by the supplier, for a traction elevator.

Appendix G: Comparative table of proposals received

The appendixes are now to be analysed by the committee. The Chairman asks the university professor to prepare a report which would include the following:

A - To emphazise the elevator standardization or the impact of a new model on costs.

B - The procurement global cost for each proposed elevator type for a period of ten years.

C - The costs and the steps to go through when setting a preventive maintenance programme for all units in service in the new head office, including the newly installed units.

D - Recommendations as to the training of the present maintenance personnel group.

In addition, the committee Chairman requests Mrs. York to write the contractual clauses for the procurement of the new elevators and for the preventive maintenance programme for both the old units and the new ones.

The training coordinator is to give to each working group one of the four mandates (one by group) already requested from the professor, while another group will be given the preparation of the contractual clauses. The groups can work from the proposed information in Appendix H of the case study.

Appendix C
(case study)

Spare parts list number 1

Hydraulic elevator:

(in US Dollars) Price C.I.F.

	Prices	Deliveries	Frequency

Limit switch no. 1	150.00	5 weeks	5 years
Limit switch no. 2	375.00	5 weeks	9 years
Oiler	1200.00	2 weeks	10 years
Hydraulic oil	100.00/litre	2 weeks	every month
Call button set	35.00	2 weeks	1 year
Light bulbs set	23.00	2 weeks	6 months
Electric cable	1450.00	5 weeks	8 years
Control box	835.00	5 weeks	8 years
Hydraulic pump	4500.00	5 weeks	15 years
Cylinder	12783.00	10 weeks	25 years
Set of Belts	57.00	2 weeks	1 year
Hydraulic valves set	392.00	2 weeks	3 years

Appendix D
(case study)

Spare parts list (number 2)

Traction elevator:

	Prices	Deliveries	Frequency
Safety switch	225.00	2 weeks	10 years
Motor	1400.00	5 weeks	10 years
Brakes	321.00	2 weeks	5 years
Belts set	74.00	2 weeks	5 years
Main steel cable	3789.00	10 weeks	7 years
Oiler	543.00	5 weeks	7 years
Call button set	35.00	2 weeks	1 year
Light bulbs set	23.00	2 weeks	6 months
Drive wheel	1834.00	8 weeks	5 years
Grease	58.00/litre	2 weeks	3 months

Appendix E
(case study)

Example of a preventive maintenance programme, as proposed by the supplier, for a hydraulic elevator:

<u>Each inspection:</u>

Check controller
Check starter unit
Wipe clear control and starter unit
Check oil in reservoir
Drain and wipe clean oil pan
Wipe clean pumping unit
Clean sweep machine room
Check oilers

Check doorstep grooves
Check all light bulbs
Clean sweep pit floor
Check cabin in operation and make necessary adjustments

Once every three months:

Clean metal brackets and rails
Clean cab roof
Check belt tension
Grease stabilizer sheaves

Once every six months:

Check doors
Check moving cams
Check door operator chain and belt
Check cab guide rails

Once a year:

Check flexible and lighting cable for tension
Grease motor
Check valve rear hoses
Check piston condition
Clean door bearings
Check door springs
Check "V" pulleys

Appendix F
(case study)

Example of a preventive maintenance programme, as proposed by the supplier, for a traction elevator:

Each inspection:

Check machine oil
Check motor oil
Check deflector sheaves
Lubricate machine gear box
Lubricate wheel tension sheaves
Check control
Check brakes
Wipe clean the machine and control
Clean sweep machine room
Check all lighting bulbs
Check doorstep groove
Clean, sweep pit floor

Once every three months:

Check machine cable
Check governor cable
Check steel brackets and rails
Clean cab roof
Check cables and springs for tension

Once every six months:

Check doors
Check moving cams
Check belt and door operator chain
Check selector chain or cable
Check cab guide rail

Once a year:

Clean doors
Grease deflector sheaves bearings
Grease generator bearings
Check flexible traveling and lighting cables
Check and test emergency brakes

Appendix G
(case study)

Comparative table of proposals received:

(in US Dollars)

	Elevators	
	Hydraulic	Traction
Purchasing cost C.I.F.	100.000	125.000
Insurance	5.000	6.250
Freight	9.400	7.600
Quality control	5.000	5.000
Crating	6.323	incl.
Others:		
Import permit	50	50
Customs duty	20%	20%
National tax on imported goods	15%	15%
Installation cost	54.221	45.875
Erection cost	83.000	54.870
Special tooling	2.500	2.300

Appendix H
(case study)

General information:

Prices of elevators:

Prices quoted for 6 passengers elevators (or one metric ton) maximum for three floors:

Hydraulic elevator: 100.00 US Dollars
Traction elevator: 125.000 US Dollars

Cost per year for minor repair maintenance made by supplier's technician:

Annual preventive maintenance costs

Hydraulic or traction elevator: 16.000 US Dollars per year including travelling expenses.

On-the-job training: (if required)

One month of training: 22.000 US Dollars

Minimum skill and knowledge of participants:

Two years of experience in erection or maintenance of elevators or a general knowledge in electricity.

Time required for inspection:

Once every three months: 4 hours

Once every six months: 8 hours

Every year: 18 hours

Note: A thorough cleaning is very important to keep the elevator in good operating conditions and especially to prevent fire in elevator case.