MANUAL

# SPARE PARTS

DEP 70.10.90.11-Gen.

November 1995

**DESIGN AND ENGINEERING PRACTICE**

## PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

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and
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The Hague, The Netherlands,

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The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

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All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

**TABLE OF CONTENTS**



**APPENDICES**

# 1. INTRODUCTION

## 1.1 SCOPE

This DEP specifies requirements and gives recommendations for the co-ordination, review, selection, purchase and disposal of spare parts for new projects and single equipment orders, with the aim of applying the principles of standardization and variety control. This DEP defines the responsibilities of personnel involved in the process including Contractors. It covers the selection and quantities of spare parts required for the commissioning, initial operation and normal operation of the plant.

This is a revision of the DEP of the same number dated February 1987.

The policies and decisions made at the beginning of a project have a significant effect on the cost of operating the plant or piece of equipment. At this stage consideration should be given to minimizing the life-cycle cost by using standardized items, exploring inter-company stocking of high value items and transferring stocks to Suppliers.

The presence of surplus or slow-moving stock represents waste both in terms of capital employed and resources devoted to their acquisition and care. The basic premise of this DEP is that items should only be stocked if the benefits of immediate availability outweigh the cost of holding the items in stock (which is approximately 25% of the purchase cost per year). This DEP provides some practical tools for deciding whether new items should be taken in stock, based on factors such as cost of stocking, delivery time, consumption rate and the operational penalty costs of not stocking them. In addition it provides recommendations about the quantity of each spare part to be purchased. The calculations for these decisions are incorporated in a computer program, "E-SPIR", the use of which is described in this DEP.

Application of this DEP will optimize the quantity of spare parts, and hence reduce capital and operating expenditure. Experience with recent projects has shown that by applying this DEP a 40% saving is possible in the procurement of spare parts (compared with the previous version of this DEP), as well as considerable savings in procurement and logistics operations after completion of the project.

Although they do not form an integral part of this DEP, the documents listed in the Bibliography (Section 7) give further background information.

## 1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F" as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and, where applicable, in supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environment, economic and legal aspects. The Contractor shall inform the Principal of any deviation from the requirements of this DEP to these regulations. The Principal may then negotiate with the authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

## 1.3 DEFINITIONS

### 1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier/Vendor** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the functional and technical requirements. The Principal may also include an agent or consultant authorized to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

### 1.3.2 Specific definitions and abbreviations

**Equipment** an engineered device designed to perform a specific function.

**E-SPIR** the electronic version of the SPIR.

**Goods** materials or equipment and any part or component thereof incorporated or to be incorporated therein.

**Project** an undertaking as a single integrated activity of the design, engineering, procurement and construction or installation of property, plant or equipment, or the development of new products. For the purpose of this DEP, direct-charge purchases of equipment and the related spare parts activities are considered as project activities.

**Spare part** a piece of material, identical to the original, which can be used to replace a part of equipment during its economic life-cycle.

**SPIR** **S**pare **P**arts and **I**nterchangeability **R**ecord.

This is a Standard Form (DEP 70.10.90.81-Gen.) included in the Standard Forms binder (DEP 00.00.10.05-Gen.). The electronic version of this is the E-SPIR.

## 1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (6) and bibliographic references are listed in (7).

## 2. RESPONSIBILITIES

### 2.1 INTRODUCTION

The contract, project specifications and planning sheets prepared at the start of the project should define staff responsibilities in relation to all spare parts activities.

The appropriate priority level should be given to the spare parts review process among the many project activities. In the spare parts review process check points should be established at which to verify the actual activities.

Local circumstances such as applicable software systems, the existing coding system and the presence of an inventory should be defined and it should be decided how the information contained in the existing inventory is to be communicated to the relevant parties during the project.

### 2.2 RESPONSIBILITIES OF DIFFERENT DISCIPLINES

Table 1 provides an overview of responsibilities for the situation in which the Principal organises the procurement of equipment and spare parts. The detailed responsibilities are described in the remainder of this Section.

**Table 1 Responsibility Matrix for spare parts when organised by the Principal**

| SPARE PARTS CATEGORIES | SPECIFY and SELECT by: | AUTHORISE by: | | PURCHASE and DELIVER |
|---|---|---|---|---|
| | | Technical | Commercial | |
| **Insurance spare parts** | Design Engineer, liaising with Maintenance Focal Point | Project Engineer and Maintenance Focal Point | Supplies Department Management | With main equipment to stock |
| **Commissioning spare parts** | Maintenance Focal Point, liaising with Design Engineer | Design Engineer | Project Engineer | With main equipment |
| **Initial spare parts** | Maintenance Focal Point, liaising with Project Engineer | Maintenance Focal Point | Supplies Department Management | By Maintenance, to stock before plant start-up |
| **Operating spare parts** | Maintenance Focal Point | Maintenance Focal Point | Supplies Department Management | By Supplies Department, to stock |

NOTE: For definitions of spare parts categories refer to (3.3.1).

#### 2.2.1 Project Engineer

The Project Engineer has overall responsibility for execution of the project. With respect to spare parts, the Project Engineer:

- ensures that a spare parts policy referring to this DEP is addressed in the contract and project execution plans;
- ensures adherence to this DEP;
- ensures that Contracts and Project Specifications are clear on standardization and the use of vendor lists (specimen contract clauses are available in Appendix 2 of this DEP). Vendor lists should be checked against existing equipment available with the Principal;
- ensures that possible plant shutdown costs in relation to equipment failure are available to those staff who make decisions about the purchase of back-up equipment and Insurance spare parts. In order to make the right decision to stock or not to stock it is essential to know the equipment penalty costs that the Principal would incur (see also Section 4). These costs should be known in the design phase. Alternatively, but

not preferably, the equipment classification code can be entered on the equipment list;

- ensures that contracts and project specifications include a spare parts review process in line with the Activity and Responsibility Matrix (Appendix 1). The Project Engineer specifies the need for a Spare Parts Co-ordinator and assistants and assigns responsibilities to them;
- decides whether the review, selection and purchase of Initial spare parts are included in the scope of the project (this is generally recommended);
- ensures that a purchase control process is in place and that spare parts requirements (provision of E-SPIRs, section 4.1.1) are properly specified in the enquiry and purchase order documents;
- ensures that the spare parts selection criteria are well understood;
- ensures that vendor spare parts recommendations and documents, including E-SPIRs, comply with the specifications and are received on time, distributed and actioned;
- ensures that a spare parts data gathering procedure is in place. This may include software deliveries;
- authorizes all purchases of Commissioning and Insurance spare parts for the project and arranges the raising of material requisitions for these;
- ensures proper action will be taken on surplus materials and spare parts;
- if a project is contracted out, reviews the responsibilities of the Contractor in relation to all spare parts activities (see also Section 5);
- ensures compliance with the procedures.

### 2.2.2 Design Engineer

The Design Engineer(s) has/have the technical authority for the equipment supplied for the project. For reasons of standardization and variety control the Design Engineer should select sources for materials in such a manner that the variety of types is restricted as far as possible, with the aim of minimizing capital investment of plant installed and the stocking of spare parts. Single Suppliers should be selected for individual categories of equipment, such as groups of pumps, electric motors, instruments, valves, etc. Design selections shall also restrict the number of sizes of pumps, fittings, electric motors and other equipment and standardize these for the various applications.

With respect to spare parts, the Design Engineer:

- verifies technically that the spare parts recommendation matches the equipment supplied (correct models, equipment is actually fitted, etc.);
- makes recommendations regarding design, repair intervals and vital components, particularly for vital equipment and Insurance spare parts;
- technically authorizes Commissioning spare parts;
- in liaison with the project economist, advises the Project Engineer on the calculated equipment penalty cost to the Principal. These cost estimates are required to decide on the purchase of Insurance spare parts, back-up equipment, and expensive Initial and Operating spare parts (see Section 4). Alternatively, but not preferably, the Design Engineer allocates the equipment classification code (see Section 3.2.3).

### 2.2.3 Spare Parts Co-ordinator

A Spare Parts Co-ordinator should be appointed at the project execution planning stage. The Spare Parts Co-ordinator will be the focal point responsible for co-ordinating and controlling all spare parts activities and will be directly accountable to the Project Engineer. The Spare Parts Co-ordinator should have a maintenance background as well as being familiar with the project. The size of the Project will determine the selection and role of the Spare Parts Co-ordinator. For example:

- on relatively small projects, the Project Engineer would perform the role;

- on medium-sized projects, a Maintenance Focal Point may be responsible for spare parts activities;
- on large projects a dedicated co-ordinator/team would be appointed;

In particular, the Spare Parts Co-ordinator should:

- establish and implement systems and procedures for the reviewing and progressing of all spare parts schedules to ensure availability in time for commissioning;
- refine cost estimates and monitor costs for all project spare parts activities;
- liaise closely with project, maintenance and procurement staff to ensure that purchase of project related spare parts proceed on time and within budget;
- monitor the quality of incoming E-SPIRs in liaison with the Standardizer;
- review spare parts schedules, co-ordinate technical responses, and follow up the specification and purchase of Commissioning and Insurance spare parts;
- co-ordinate the review, selection and purchase of Commissioning and Initial spare parts, ensuring their availability at the time of commissioning.
- locate and check Commissioning spare parts in relation to main equipment.
- ask for Initial spare parts to be drawn from stock as and when required.
- identify surplus materials and spare parts after commissioning, and ensure all unused spare parts are returned to stock or any surplus disposed of by offering them to the Project Material Co-ordinator;
- advise the project engineers to include the appropriate clauses and specifications in Contracts to cover the responsibilities of Contractors within the overall processing of spare parts.

### 2.2.4 Maintenance Focal Point

The Maintenance Focal Point to co-ordinates the spare parts review in the maintenance department with a view ensuring operation and maintenance of the facility after hand-over. The Maintenance Focal Point (possibly delegated to a spare parts analyst) is responsible for:

- liaising with the Design Engineer (see Table 1) for the selection of long lead and Insurance spare parts, to ensure that they are ordered with the main equipment;
- analysing E-SPIR forms, specifying, selecting, advising quantities to be purchased (Section 4), printing stock proposals and arranging approval;
- proposing revisions of stock levels (possibly including those specified in "call-off" or stockist agreements) if the project develops in such a way that the numbers of main equipment items installed will increase considerably (see also section 4.1.5);
- updating the maintenance system with the relevant data of the coded items from the E-SPIRs;
- technically authorizing Initial and Operating spare parts.

### 2.2.5 The Project Material Co-ordinator (PMC)

The PMC is the focal point in a project organization for all materials and logistics activities related to the project, including cost control for these activities. The PMC should provide assistance to the Project Engineer and be consulted in the planning phase of the project. The tasks of the PMC include:

- monitoring, reporting and co-ordinating the status and cost of materials and activities;
- co-ordinating the E-SPIR follow-up process to ensure timely availability;
- arranging for proper close-out of the project with respect to surplus materials.

### 2.2.6 The Standardizer

As a member of the standardization and coding section, the tasks of the Standardizer include:

- establishing/maintaining a tracking register for progressing and actioning E-SPIRs;
- screening E-SPIRs for completeness of data and attached documentation;
- reviewing spare parts material requisitions attached to stock proposals raised by the Maintenance Department;
- identifying MESC numbers for items already stocked;
- coding material items and preparing buying descriptions.

### 2.2.7 The Stock Analyst

The tasks of the Stock Analyst include:

- providing the Maintenance Focal Point with data on prices and delivery times, including (where relevant, see also section 4.1.3) prices based on "rush" deliveries;
- exploring inter-company stocking of high value insurance spares;
- reviewing the impact of project spare parts on existing stock levels;
- purchasing spare parts and scheduling stock items;
- exploring opportunities to enter into strategic alliances/partnerships with key suppliers.

## 3. PROCESS

### 3.1 KEY PRINCIPLES

The following principles should be adopted in each project for the control of spare parts activities:

- appoint a single Focal Point (the Spare Parts Co-ordinator) to control all spare parts activities;
- resources and budgets must be allocated in good time to achieve the above;
- calculate possible equipment penalty costs to the Principal or (alternatively) state equipment classification codes before any decision is made on the purchase of back-up equipment or Insurance spare parts;
- buy no spare parts without a proper review, using E-SPIR to avoid duplication.

The process to be followed is described in detail below.

## 3.2 THE PROCESSES FROM SPECIFICATION UNTIL SURPLUS REVIEW OF SPARE PARTS

The key activities and sequences in specifying, reviewing, selecting and purchasing spare parts are described below. The processes are different for Insurance, Commissioning, Initial and Operating spare parts. The overall process is illustrated in Appendix 1.

### 3.2.1 Specification of spare parts requirements in enquiry and purchase documents

Specification of all spare parts requirements should form part of the enquiry and purchase requisition, and these requirements shall be explained to the vendor. The main points to be noted are:

- clauses covering standardization and variety control should be included (see Appendix 2);
- quotations for major equipment shall be accompanied by a recommended spare parts listing which should be itemized and priced separately. It should:
  - state costs of supplying the various categories of spare parts;
  - identify long lead items that should be supplied with main equipment;
- specify the requirement for E-SPIRs to be submitted by the Vendor with the final drawings at the latest (see Appendix 2);
- relevant vendor documentation shall accompany completed E-SPIR forms. Depending on equipment complexity this should include cross-sectional drawings, process engineering flow schemes (PEFSs), parts lists, skid layouts etc.;
- state that spare parts shall be boxed, marked and labelled separately (see Appendix 2).

### 3.2.2. Cost control

For each project an overall budget estimate shall be made for the required spare parts. The cost of spare parts should be used as one of the factors evaluating tenders. Following submission of detailed spare parts quotations the budgets shall be refined and costs tightly controlled against these on an order-by-order basis. Normally, Insurance, Commissioning and Initial spare parts are purchased on the project budget, while the Initial spare parts could be credited to the project after hand-over of the facilities to the operator.

### 3.2.3 Equipment failure penalty costs or classification codes

Before any spare parts review activity can take place the Project Team should have calculated the penalty costs to the Principal due to possible equipment failure. These cost estimates, which should be made in the design stage, are required to decide on the purchase of insurance parts, back-up equipment and spare parts and should be provided to all staff involved with the review and selection of spare parts (see 4.1.3). If the penalty costs are not available from a project team (e.g. for existing installations), the Principal's economist and scheduling department should be able to provide more details on such costs, bearing in mind that downtime cost may relate to all or part of an installation and may include consequential damages.

If the equipment failure penalty costs cannot be calculated or reasonably estimated then equipment classification codes should be allocated. This option is not preferred. For definitions of classification codes see below.

#### 3.2.3.1 Equipment Classifications

*Vital equipment*

Equipment of which a breakdown would cause an immediate and unacceptable penalty, or create an immediate danger to health, safety or environment.

*Essential equipment*

Equipment used in primary operations for which standby capacity is built into the plant or spare units of equipment are available.

*Auxiliary equipment*

Equipment which, in view of its function, can be allowed to remain temporarily out of operation without having a serious effect on the operations and without reducing safety below an acceptable level.

### 3.2.4 Review of equipment quotations

The Project/Design Engineers shall review the equipment quotation and give advice on critical spare parts to the Spare Parts Co-ordinator.

The Spare Parts Co-ordinator shall refine the spare parts cost estimate, collate recommendations and specify Insurance and long lead items for review by the Maintenance Focal Point and approval by the Project Engineer.

The above review is followed by the process of specification and obtaining authorization.

### 3.2.5 Insurance and long lead spare parts

The Spare Parts Co-ordinator should review the need for Insurance spare parts with the Maintenance Focal Point and Project Engineer (see also 3.3.2).

- The Project Engineer should raise material requisitions for back-up equipment, Insurance spare parts and long lead spare parts. The Project Engineer should also raise a stock proposal for Insurance items and long lead spare parts which should be forwarded to the Spare Parts Co-ordinator and authorized by the Maintenance Focal Point.
- The Spare Parts Co-ordinator shall discuss any Insurance spare parts with the Maintenance Focal Point.
- The Maintenance Focal Point should review the Stock Proposal and arrange for authorization before passing the proposal to the Standardizer.
- The Standardizer shall code Insurance and long lead spare parts and set up buying descriptions.
- The Stock Analyst shall purchase the specified items after authorization of the Stock Proposal.

### 3.2.6 Review and specification of Commissioning spare parts

The Spare Parts Co-ordinator should review the need for Commissioning spare parts (see also 3.3.3). Depending on the policy of the Principal, Stock Proposals are not always required for Commissioning spare parts, but such parts should be limited to tools which remain with the equipment and be of low value (less than a few hundred US dollars per piece of equipment). More expensive parts should follow the route of Initial spare parts and be authorised by a Stock Proposal.

### 3.2.7 Review and specification of spare parts for maintenance

Following placement of equipment orders, vendors shall submit detailed spare parts recommendations on the E-SPIR which should be received within 6 weeks after order placement or at the latest with the final drawings. If not received they should be expedited. E-SPIRs and accompanying documents shall be reviewed sequentially by the:

- Project Engineer, with assistance from Design Engineers, for compliance with specifications;
- Standardizer for registration, tracking and checking of E-SPIRs;
- Maintenance Focal Point, who shall recommend for purchase any Insurance spare parts which have not been identified before and specify all Initial and Operating spare parts on the E-SPIR. For selection of spare parts to be stocked and the number of spares to be ordered, see Section 4. The Maintenance Focal Point shall raise Stock

Proposals, arrange for authorization and pass on the E-SPIR to the Standardizer;

- Standardizer, who shall code the recommended spare parts and set up buying descriptions;
- The Stock Analyst shall purchase the specified items after final authorization of the Stock Proposal.

### 3.2.8 Control and progress of E-SPIRs

This shall be a joint effort involving the Spare Parts Co-ordinator, Project Engineer, Project Materials Co-ordinator and the Standardizer. The Spare Parts Co-ordinator shall ensure that the necessary systems for review of E-SPIRs are established and implemented. Regular meetings should be arranged to control progress on receipt and review of E-SPIRs, and the specification, selection, approval and purchase of the Commissioning and Initial spare parts.

To facilitate this process the Project Materials Co-ordinator or the Standardizer should establish and maintain an E-SPIR tracking register for each order using the project equipment list as a basis. This list should be used to track all E-SPIRs through the various review stages to ensure they are actioned within the agreed time frame. An overdue listing should be published on a regular basis for use as a progress tool by the Spare Parts Co-ordinator.

### 3.2.9 Coding

The coding of spare parts is a time-consuming but cost-beneficial exercise. It is important that coding is carried out up front. Coding includes the following tasks:

- screening spare parts against existing stocks before purchase;
- coding the spare parts before ordering;
- preparing buying descriptions for items to be purchased;
- returning completed documents to the Maintenance Focal Point in order for the maintenance system to be updated.

Coding before ordering enables the Supplier to label the spare parts with the allocated MESC number which will facilitate the identification upon receipt. Spare parts shall not be ordered without allocated MESC numbers. It is therefore of importance to code the Initial spare parts in an early stage in a project so that they are available in stock before operations commence.

It may also be considered to code items which will **not** be stocked. The coded items will be linked to the maintenance systems and will facilitate future direct-charge purchases for planned maintenance.

### 3.2.10 Purchasing

Purchasing procedures are the responsibility of the Purchasing Department and are outside the scope of this DEP. However, it should be noted that:

- the Stock Analyst shall purchase authorized new stock items and, if required, schedule requisitioned but existing stock items (spare parts are normally not scheduled);
- for projects with large quantities of spare parts, the Maintenance Focal Point shall discuss stock levels with the Stock Analyst so that stock levels can be increased when required. When changing stock quantities, Section 4.1.5 should be followed when deciding on the minimum stock requirements;
- the option of buying spare parts at quoted price within one year should be included in the purchase order of the main equipment (see Appendix 2);
- any spare parts orders shall be priced per item and contain clauses covering packing, identification and labelling with MESC numbers and manufacturers' part numbers (see Appendix 2).

It is essential that all information on the Initial spare parts is included in the inventory control

records of the Principal before arrival of the spare parts. This will assist correct stocking and enable the user to find any required spare part.

### 3.2.11 Surplus project material

The Principal should have policies in place for the administration and valuation of surplus project materials. The Project Engineer should be involved in developing this policy, which should be agreed before Purchasing begins. Subjects for coverage by a project surplus policy include:

- ownership of and responsibility for surplus between the project and Supplies department or between the Principal and Contractor;
- coding, identification and valuation of surplus;
- use of buy-back arrangements;
- credits to be given (if any) on return of project surplus to general stock;
- incentives to projects to use existing surplus. Such incentives might include issue of existing surplus at less than full value, or even at zero value;
- responsibility for review of outstanding materials requirements, such as outstanding orders and scheduled requirements;
- project closure.

#### 3.2.11.1 Project administration

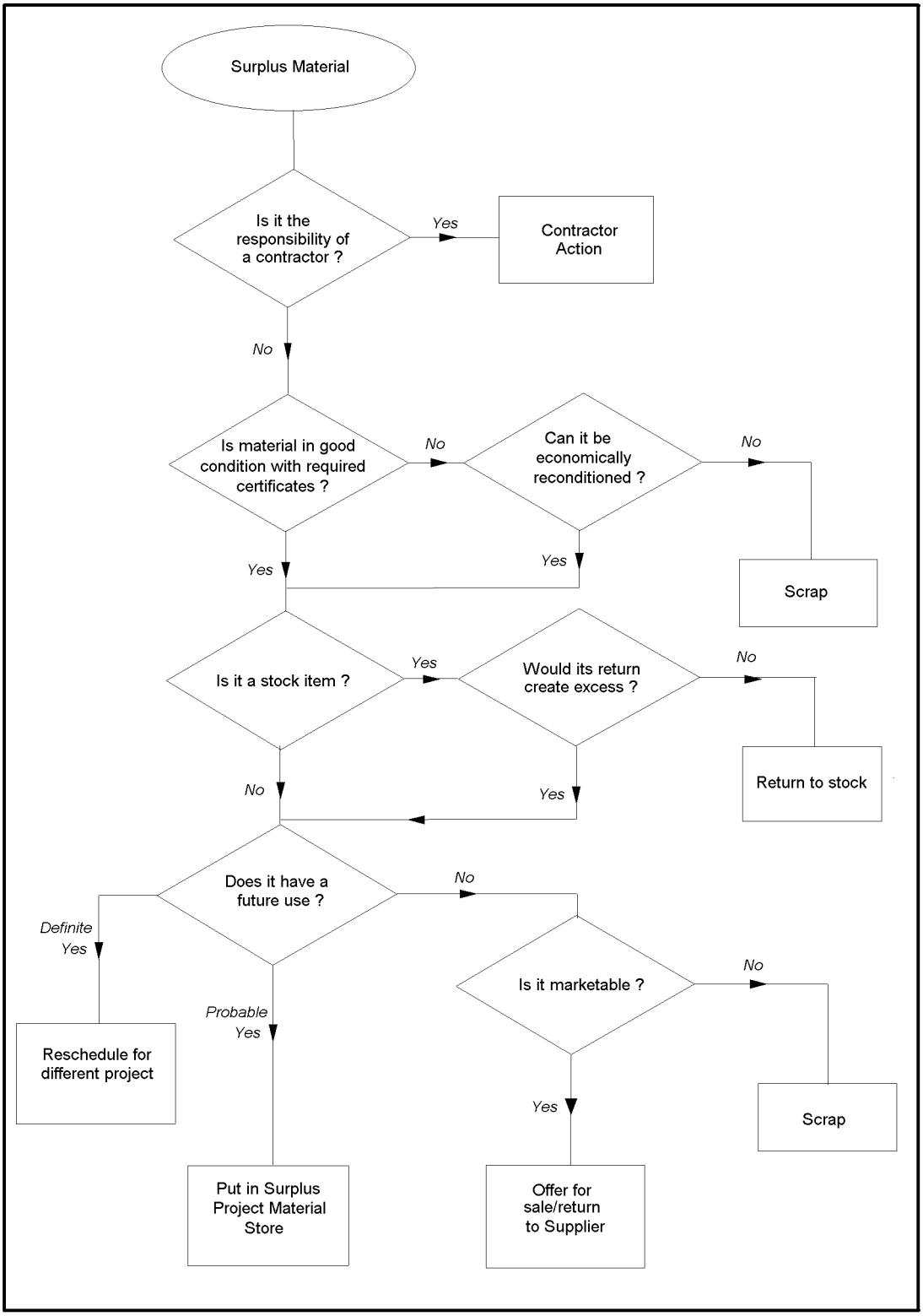
A significant proportion of surplus in a project can be due to lack of discipline in project administration. If design changes result in reduced requirements for an item, it is important that action is taken to cancel orders or to transfer material to other users as soon as possible.

- Change control procedures should be in place to monitor and approve changes to detailed design. The Project Engineer and Project Materials Co-ordinator play an important role in this process.
- If use is made of scheduled requirements (reservations made against stock for future requirements) the Principal should have a procedure for review of scheduled requirements which remain unused after the required-on-site date. Any scheduled requirements which will not be needed should be deleted.

#### 3.2.11.2 Project closure

A sound project closure procedure is essential for proper management of project surplus. At the time of physical completion of a project, a full review of unused materials and outstanding orders should be carried out. Outstanding orders should be cancelled unless an order can be economically re-scheduled for another project. In major projects it may be possible to conduct partial close-outs at the end of major phases of the project to identify surpluses as early as possible. All unused project materials should be identified, coded and described including materials held in stock, lying at the construction site, or held by a Contractor. Action to be taken should be determined in accordance with the project surplus policy. Figure 1 gives an example of a decision tree which will be appropriate in many cases.

**Figure 1 Flow chart for surplus materials**



## 3.3 SPARE PARTS CATEGORIES AND BASIS FOR SELECTION

### 3.3.1 Spare parts categories

3.3.1.1 Insurance spare parts

Insurance spare parts (see 3.3.2) are those parts of equipment, equipment assemblies or complete items of equipment that are required for replacement of items not subject to deterioration by normal use, but failure of which is critical for continued and safe operation of the equipment or plant.

3.3.1.2 Capital Insurance spare parts

Capital Insurance spare parts (see 3.3.2) are Insurance spare parts having a high value. Due to their high value (and local tax regulations) there may be a financial advantage to the Principal of including them within the assets of the company. They are usually taken into stock against zero value.

3.3.1.3 Commissioning spare parts

Commissioning spare parts are those required to prepare the equipment for start-up (see 3.3.3).

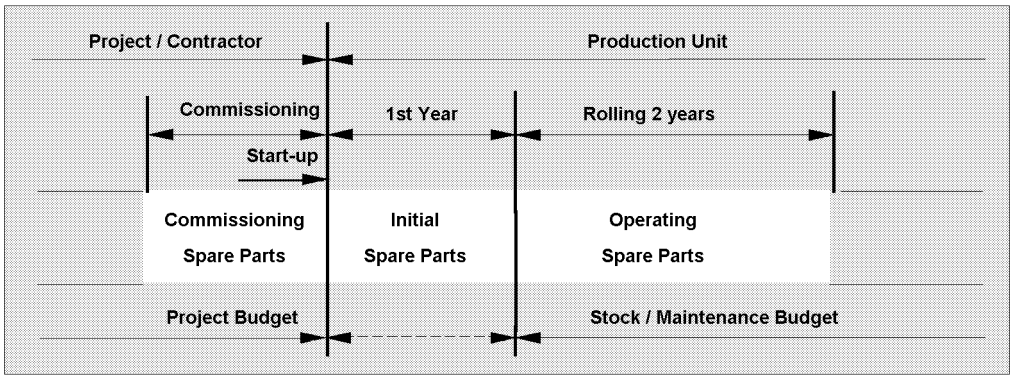
3.3.1.4 Initial spare parts

Initial spare parts are those required to safeguard the operation of equipment during the running-in and starting-up periods **and** the first year of operation. Initial spare parts shall be on site prior to start up (see 3.3.4).

3.3.1.5 Operating spare parts

Operating spare parts are those required for normal operation and day-to-day maintenance in the two-year period of operation after the first year of operation (see 3.3.5).

**Figure 2 Overview of Commissioning, Initial and Operating spare parts**




3.3.1.6 Consumable spare parts

Consumable spare parts are those which will be required regularly, e.g. because of wear, deterioration or routine need.

3.3.1.7 Replacement spare parts

Replacement spare parts are those which are ordered with direct-charge against the maintenance budget on the basis of prior inspection or for planned overhauls.

### 3.3.2 Insurance spare parts

3.3.2.1 General

Insurance spare parts are selected on the basis that certain equipment is classified as "vital" (i.e. that inoperability of such equipment would compromise safety of the facility or would result in an unacceptable penalty to the Principal). No back-up equipment is installed.

Insurance spare parts shall be coded by the Standardizer, boxed separately by the Supplier, and delivered to the Supplies Department for inspection and storage. The coding should identify that they are Insurance spare parts and should distinguish Capital Insurance spare parts from Insurance spare parts.

3.3.2.2 Capital Insurance spare parts

These are high value Insurance spare parts which would only be used in abnormal circumstances (major damage or failure). They may be components or complete units and typically are complete pumps, large valves, motors, transformers, turbo-machinery cartridges, rotors, heat exchanger tube bundles, etc.

The stock decision should be based on the outcome of a calculation with the four parameters used in the E-SPIR formula (see Section 4.).

Prior to purchasing action, a careful investigation should be made of the cost of the Capital Insurance spare part, recognising that the annual cost of stocking is in the order of 25% of the purchase price. The cost should be compared with, and evaluated against, alternative methods of minimizing the penalty to the Principal should an unforeseen breakdown occur, e.g.:

- repairing the damaged part, either locally or at the factory. Compare the cost for repairs and freight with the operational losses whilst the plant is out of operation;
- ordering a new part when required, and awaiting its arrival before repairs to the plant can be carried out. Compare the risk of cost for both material and freight with the operational losses during the delivery time.

In this connection, the financial implications of capitalizing insurance items should be taken into account. Where local regulations allow, the high value insurance items should not be included in the spare parts stock value, but capitalized with the parent equipment. A value of 15 000 US dollars may be used as a guide for the capitalization decision. Items of lesser value are taken in stock against full value.

Capital Insurance spare parts should be purchased simultaneously with the main equipment, since this will be more economic and enable complete shop testing.

The Principal is responsible for initiating any orders for Capital Insurance spare parts. The Principal's existing Capital Insurance spare parts should only be used by the project with the agreement of the Maintenance and Operations departments of the Principal, and should not be re-ordered until a decision has been made on practicability of repair or replacement under warranty.

### 3.3.3 Commissioning spare parts

Commissioning conditions have a large impact on the types and quantities of spare parts requested, e.g.:

- exposure to weather, dirty environment;
- higher probability of damage/loss of material;
- testing and functional checking, with frequent opening of equipment for inspection;
- cleaning and de-preservation of equipment;
- design and construction field changes;
- equipment standing idle for long periods may be subject to deterioration;
- abnormal operating conditions during testing may lead to premature wear/failure;

- novel equipment with little or no operating experience.

Commissioning spare parts should be supplied with the equipment. They shall be available for pre-commissioning in the fabrication yard or site. Unused Commissioning spare parts should not be taken automatically in stock but subjected to the same rigorous review as any other new stock item. For surplus materials refer to (3.2.11).

3.3.3.1 Equipment Commissioning spare parts

These typically consist of filter elements, seals, joints, electrical and instrumentation components, calibration equipment, special tools, etc.

These are specified on the basis of:

- vendor recommendations which have been thoroughly reviewed and agreed;
- knowledge of **planned** commissioning activities;
- project experience gained from vendor tests in the factory.

The need for items with a unit value greater than USD 200 should be discussed with Maintenance before purchase by the project.

For efficiency reasons it may be decided that low value Equipment Commissioning spares will not be coded but will be boxed separately by the Supplier and delivered with the main equipment. Commissioning spare parts used will not be re-ordered and surpluses will be offered to Maintenance at the end of commissioning.

3.3.3.2 General Commissioning spare parts and consumables

These are consumables such as pipe, fittings, bolts, gaskets, electrical fuses, bulbs, cable, instrument tubing/fittings, lubricants, preservation fluids, recording paper, ink, chemical drying agents, etc. They are generally specified on a contingency basis, dictated by experience on previous projects.

As a general guide for **non** stock items, 2 - 5% extra material may be specified as a contingency for construction. For stock items the contingency should be lower or even zero depending on the unit price of the materials. General Commissioning spare parts should be checked before their purchase against the inventory of the Principal. Any requirements for commissioning above this percentage should be identified at an early stage by the Maintenance Focal Point and the Design Engineer and shall be authorized by the Project Engineer.

### 3.3.4 Initial spare parts

Initial spare parts overlap in some areas with Commissioning spare parts and Operating spare parts. They are required for the initial start-up and running-in and should cover the first year of operation. They consist typically of components such as bearings, mechanical seals, valves, instrument gauges, timers, filter elements, seal repair kits, gaskets, belts, electrical relays, electronic cards, fuel nozzles, etc.

3.3.4.1 Review and selection

The basis for the selection of Initial spare parts is the Supplier's recommendations as indicated in the spare parts documentation.

Experience has shown that the quantities of spare parts recommended by manufacturers are too high and for that purpose the spare parts recommended by Suppliers shall be thoroughly scrutinized against the Principal's operating and maintenance practices.

The E-SPIR includes a decision rule which provides the User with a recommendation to Stock or Not Stock. The decision rule is based on the elements of price, delivery time, expected consumption rate and penalty cost due to equipment failure (see Section 4 and Appendix 3.). The decision rule can also be applied manually.

If not using the E-SPIR, the Principal shall select the spare parts from the SPIR form in conjunction with the recommended equipment Classification codes.

Once a decision has been made that an item should be stocked, the quantities of items should be advised. In Section 4 of this DEP the mechanism of selecting and calculating the number of spare parts is explained in detail with some examples.

Proper attention shall be paid to:

- consumption levels, which may be somewhat higher in the initial operating stage than in the normal operation phase due to running-in of equipment;
- factors inherent in commissioning that may lead to premature failure;
- key operation and safety functions of the equipment;
- possible repair/exchange items.

The Initial spare parts should be coded by the Standardizer, boxed separately by the Supplier and delivered to the Supplies Department for inspection and storage. Along with identified Initial spare parts already in stock, they should be charged to the project when drawn out.

If the Initial spare parts, refurbished items or items replaced under warranty have been purchased by the project, they should be sent to stock at project close-out. The project will generally be credited on the condition that the parts have been inspected, do not cause excess stock and are properly documented (itemized prices) and labelled for identification.

### 3.3.5 Operating spare parts

3.3.5.1 Operating spare parts for overhaul or unplanned maintenance

Operating spare parts are those required for day-to-day maintenance after the initial year of operation. They are essentially the same as for the initial period and will be specified by the Maintenance Focal Point in accordance with the standard maintenance practice of the Principal. These parts may fail in use, there is no planned replacement interval and replacement is part of a corrective maintenance action.

Although these spares are basically required during the equipment lifetime after the first year, the required stock level should be no higher than that required to cover the processing of a new order and the delivery time of the relevant spare parts. In Section 4 of this DEP the mechanism of selecting and calculating the number of spare parts is explained in detail with some examples.

3.3.5.2 Normal operating (replacement) parts for planned maintenance

Equipment parts which deteriorate gradually during their life cycle should be replaced during planned maintenance activities, and should be purchased direct-charge and not be stocked. As a result of prior inspection or planned maintenance they are requisitioned by the departments concerned. Sufficient time shall be allocated to order the particular spare parts required. Even though the precise timing of the shutdown may be condition-based, a nominal operating interval will have been established and the necessary overhaul kits or spare parts ordered in accordance with the period.

These parts should be coded to facilitate or automate the future process of requisitioning and ordering.

### 3.3.6 Other spare parts

3.3.6.1 Consumable spare parts

It is customary for the Supplies Department to be responsible for the stock replenishment of consumable parts taking into account the level of past consumption and based on estimated future consumption and planned future operations as advised by the departments concerned. A consumable part can be an Initial or an Operating spare part. Generally the rate of consumption determines whether it is called a consumable or not.

As well as obvious consumables (lamps, paint, etc.), piping components (pipes, flanges, fittings, bolts, nuts, gaskets, etc.) are also normally considered as consumables. The Project Engineer should liaise with the piping engineers to determine the piping components

to be proposed for stock (or to be included in supply agreements).

3.3.6.2 Kits

For practical reasons it may be effective to stock complete repair kits. Commercially they are only justifiable if it is expected that the majority of the parts contained will be used in one overhaul. The purpose of the kit should be well defined and known to the Supplier.

When an equipment overhaul is planned the complete kit will be issued to the maintenance engineer who will, after using some parts, return the kit via the Supplies Department to the Supplier. With a stock order the Supplier should be requested to replenish the kit and inspect the remaining parts to ensure that the kit will be fit for purpose at the next equipment overhaul.

3.3.6.3 Assemblies

Consideration should be given to ordering complete assemblies and instrument assemblies such as controllers, recorders, amplifiers, transmitters, printed circuit boards, regulators, chart drive units, pressure gauges, temperature gauges, pressure switches and common (control) valves. Ordering of assemblies is directly related to downtime penalty costs. Complete assemblies should be stocked if time and money will be saved by replacing a complete assembly instead of replacing the spare parts. Cost of stocking a complete assembly (25% stocking cost/year) should be compared with the risk of failure and the repair time or down time of the equipment.

Appendix 3 (Section 1.5, Example 3) gives some cases with specimen calculations to support a decision whether to stock a complete assembly or only the spare parts for the relevant assembly.

## 4. SELECTION AND NUMBER OF SPARE PARTS

### 4.1 INTRODUCTION

To support the Principal in reviewing and selecting spare parts, a form has been created called the Spare Parts and Interchangeability Record (SPIR). The form provides an overview of the relation between spare parts and the main equipment and identifies duplication of, and interchangeability between, equipment parts. The form instructs Suppliers to provide original manufacturers' part numbers.

This Section explains the mechanism of the E-SPIR and SPIR. The responsibilities of staff involved are described in (2) and the process of verifying correctness of the details submitted by the Suppliers is described in (3).

#### 4.1.1 E-SPIR or SPIR form

The SPIR is available in two versions, the Electronic SPIR (E-SPIR) based on specially designed software which can be used on a personal computer, and the SPIR Standard Form (DEP 70.10.90.81-Gen., contained in the Standard Forms binder DEP 00.00.10.05-Gen.). The E-SPIR is essentially the same as the SPIR paper copy but the E-SPIR is more efficient to use, reduces errors and saves expediting time. The Supplier is forced to complete the essential information fields, e.g. sub-suppliers' part numbers. Duplication of, and interchangeability between, equipment parts can be detected automatically. The Supplier shall submit detailed maintenance manuals, drawings and spare parts lists.

The E-SPIR contains a formula which supports the user in deciding whether to stock or not to stock (see 4.1.3).

#### 4.1.2 Selection of spares for stock

The spare parts selection is performed by the Spare Parts Analyst, who should be familiar with the environment in which the equipment will operate and the maintenance practices of the Principal, and should have access to all relevant documentation such as maintenance systems, manuals, drawings and the materials inventory. Spare parts for equipment already installed should be taken into account. The spare parts selection criteria recommended in the following sections are suitable for Insurance, Initial and Operating spare parts.

#### 4.1.3 To stock or not to stock?

In general, items should only be stocked if the benefits of direct availability outweigh the cost of holding the items in stock. The decision to stock, the initial quantity and take-off rates are significant factors in the concept of total acquisition cost of that item over the lifetime of its usage. The availability of surplus or slow-moving stock represents waste both in terms of capital employed and resources devoted to their acquisition and care.

##### 4.1.3.1 Stocking cost

This is the cost of keeping an item in stock and is approximately 25% of the purchase cost per year; this figure includes cost elements such as interest, write-offs, insurance, storage, preservation, deterioration, loss, staff and maintaining the data base. The Principal should compare the cost of holding its own stocks against the use of stockist agreements.

##### 4.1.3.2 The stock decision

The decision to accept new stock items should be based on elements such as the cost of stocking and the operational advantage of stocking. Four parameters are identified as the major components of the decision to stock or not to stock the item.

- Consumption rate;
- Purchase cost (to derive the stocking cost);
- Penalty costs (cost per day of equipment failure, due to waiting for spare parts);
- Lead-time.

Extra cost for "rush" orders should be compared with the benefits of reduced delivery times. The consumption rate and the penalty cost are not always available to the users, but a best guess will normally give the user some guidance for this decision. A decision rule formula

has been developed to support the user in deciding whether to stock or not to stock. The user can apply the formula manually or enter the above data in the E-SPIR. Details of the formula and some examples are given in Appendix 3.

4.1.3.3 Vital, Essential and Auxiliary equipment (classification codes)

Although these fields are available in the E-SPIR, the classification codes are not used in the formula. In fact, the penalty cost built into the formula replaces the classification codes. Exceptions to the rule can be made for safety equipment where factors other than purely economic may justify the holding of spare parts.

A stock decision should be based on the outcome of a calculation with the four parameters in the formula rather than using the above classification codes.

### 4.1.4 The Stock Proposal

As soon as the selection process is completed a Stock Proposal Form should be prepared. A hard copy of the Stock Proposal Form can be printed from the E-SPIR application. The Stock Proposal should be authorized by the Maintenance and Supplies Departments before the items are to be purchased.

### 4.1.5 Calculating the number of spares

Once it has been decided to stock a specific item, the next question is: "How many?". Multiple consumption may occur within a lead-time, requiring a higher minimum stock level to avoid a stock-out. Moreover, if several identical parts have been installed in the equipment, other identical parts might have to be replaced as well.

The decision of how many items to stock should be based on the time it takes to replenish the relevant part. The stock level of each spare part should be sufficient to cover the processing of a new order and the delivery time of the relevant item. The stock level may be increased where it is expected that consumption would be more than one piece during the replenishment period. Here too, a risk may be taken in order to minimize the quantities required. The extra cost for stocking a second or third item may well exceed the penalty cost. For low value items there may be an economic justification for increasing the order quantities.

Identical spare parts should be consolidated at a total plant level. By consolidating spare parts the estimated "consumption rate" and therefore the outcome of the E-SPIR formula will be influenced.

4.1.5.1 Inventory control

Traditionally, the Supplies department has been largely responsible for the stock levels and replenishment of stock item parts based on estimated future consumption, taking into account the level of past consumption and planned future operations as advised by the departments concerned. There is a growing tendency to give more responsibility for stock holding and storage cost to the users. A user code should be known to the stock analyst for all stock items. The users of stock items should warn the Stock Analyst as soon as possible if they expect declining or increasing consumption rates, or special replacement exercises which take place once only. Further details about inventory control and the review of non-moving stocks can be found in the GMM (Guide to Materials Management).

## 5. PROCUREMENT OF EQUIPMENT AND SPARE PARTS BY CONTRACTORS

### 5.1 CONTRACTING OUT

Contracting out the engineering, procurement and construction activities for a lump sum is becoming more common. It should however be noted that this can easily lead to the introduction of different standards resulting in increased variety. In the preparation phase of EPC (Engineering, Procurement and Construction) Contracts care shall be taken to ensure the inclusion of the relevant DEPs and Principal's specifications and procedures for standardization and variety control. The Contract should detail the processes of spare parts review, selection, coding, purchasing and handling of surplus.

The Contractor shall appoint a Spare Parts Co-ordinator to act as focal point for all matters concerning spare parts information including ordering.

For Standardization and Variety Control the Principal should include a set of clauses in the Contract. Specimen clauses are given in Appendix 2.

### 5.2 RESPONSIBILITIES BETWEEN PRINCIPAL AND CONTRACTOR

Responsibilities should be defined in the Contract in line with Section 2 of this DEP.

The responsibilities between the Contractor and Principal should be reviewed and defined for every activity of the spare parts process such as: requisitioning, cost control, expediting, E-SPIR review, selection, coding, purchasing, labelling, receipt and handling of surplus (see Section 3).

It should be agreed well in advance who is responsible for which category of spare parts (Insurance, Commissioning and Initial). In particular, the policies and responsibilities for the selection and final recommendation of order quantities of Insurance and Initial spare parts should be carefully reviewed and agreed. Normally this final responsibility should rest with the Principal. The basis on which the order quantities will be defined should be checked against the maintenance practices of the Principal. A mechanism shall be found to ensure that Contractor-purchased spare parts are checked against the inventories of the Principal.

Table 2 provides an overview of responsibilities for the situation in which the Contractor organizes the procurement of equipment and spare parts.

**Table 2 Responsibility matrix for spare parts when organised by the Contractor**

| SPARE PARTS CATEGORIES | SPECIFY and SELECT by: | AUTHORISE by: | | PURCHASE and DELIVER by: |
|---|---|---|---|---|
| | | Technical | Commercial | |
| **Insurance spare parts** | Contractor, in liaison with Principal | Contractor | Principal | Contractor, with main equipment to stock |
| **Commissioning spare parts** | Contractor | Contractor | Contractor | Contractor, with main equipment |
| **Initial spare parts** | Contractor, liaise policy with Principal | Contractor | Principal | Contractor or Principal, to stock |
| **Operating spare parts** | Contractor or Principal | Principal | Principal | Principal to stock |

NOTE: For the definition of spare parts categories, refer to (3.3.1).

## 5.3 THE PROCESS TO BE FOLLOWED BY CONTRACTORS

The Contractor may be made responsible for all or part of the process described in Section 3, but should in any case demonstrate that it has an organization in place which can cope with the process of review, selection, coding and purchasing of spare parts.

In all cases, spare parts should not be purchased before the responsibilities have been established for the following activities:

- utilizing the E-SPIR for gathering and handling spare parts information from Suppliers;
- expediting of E-SPIR information complete with the relevant documentation from the Supplier within an agreed time frame;
- selecting the spare parts and recommending the quantities to be ordered;
- coding the spare parts and checking parts availability against the inventories of the Principal;
- maintaining a database by the Contractor to verify identical parts for the total project;
- preparation and authorization of stock proposals;
- including agreed Purchase Order clauses. As a minimum requirement they should state that each spare part shall be labelled with the MESC number, the Supplier's part number and a short description (see also Appendix 2).

If the Principal is to carry out all or some of the above activities, the hand over of the spare parts documentation should be arranged. Documentation shall include hard copies of vendor supplied documents, drawings and the electronic database (including E-SPIRs) of the Contractor. Normally the Spare Parts Analyst of the Principal should receive the technical documentation while the Standardizer should receive the original Stock Proposals when the project has been completed.

### 5.3.1 Commissioning spares to be supplied by a Contractor or a Supplier

The Contract shall specify whether the Contractor or Supplier is responsible for the supply of Commissioning spare parts (see also Sections 3.2.6 and 3.3.3). If the Principal agrees, the Contractor or Supplier may purchase them from the Principal's inventory.

Moreover, the following should be agreed in advance:

- the coding (if applicable) of the spare parts is to be checked against the coding policy

of the Principal. If coding is carried out by the Contractor, there shall be close liaison with the Principal before the start of the coding activities;

- once the project is handed over to the Principal, the prices at which and conditions under which the Commissioning spare parts and general commissioning surplus will be taken over by the Principal. The Principal shall only accept items which are in a good condition, properly labelled with MESC number and Supplier's part number, and complete with documentation or certificates where appropriate.

### 5.3.2 Initial spare parts to be supplied by a Contractor

If the Contractor is to carry out the selection, coding and purchasing of the Initial spare parts (see also Sections 3.2.6 and 3.3.4), the following should be agreed in advance:

- that the selection of spare parts is fully in line with the maintenance practices of the Principal and this DEP;
- that the selection of spare parts is checked against the existing stocks of the Principal;
- that the Contractor shall maintain a database to identify interchangeable items (e.g. bearings, gaskets, couplings, etc.) for the total project;
- that the recommended quantities are in line with the stocking policies of the Principal and this DEP. The stock decision should be based on the outcome of a calculation with the four parameters in the formula (see Sections 4.1.3, 4.1.4 and 4.1.5) rather than using the classification codes (Vital, Essential or Auxiliary). Risk assessment (the "consumption rate" parameter of the formula) should be based on consolidation of identical parts for the total project. Generally quantities to be purchased should be sufficient to cover (but not exceed) the replenishment time of a new order and the delivery time of the relevant items;
- that the coding of the spare parts is checked against the coding policy of the Principal;
- once the project is handed over to the Principal, the prices at which and conditions under which the spare parts data base and Initial spare parts will be taken over by the Principal. The Principal shall only accept items which are in a good condition, properly labelled with MESC and Supplier's part numbers, and complete with documentation or certificates as appropriate.

## 6. REFERENCES

In this DEP, reference is made to the following publications.

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

**SHELL STANDARDS**

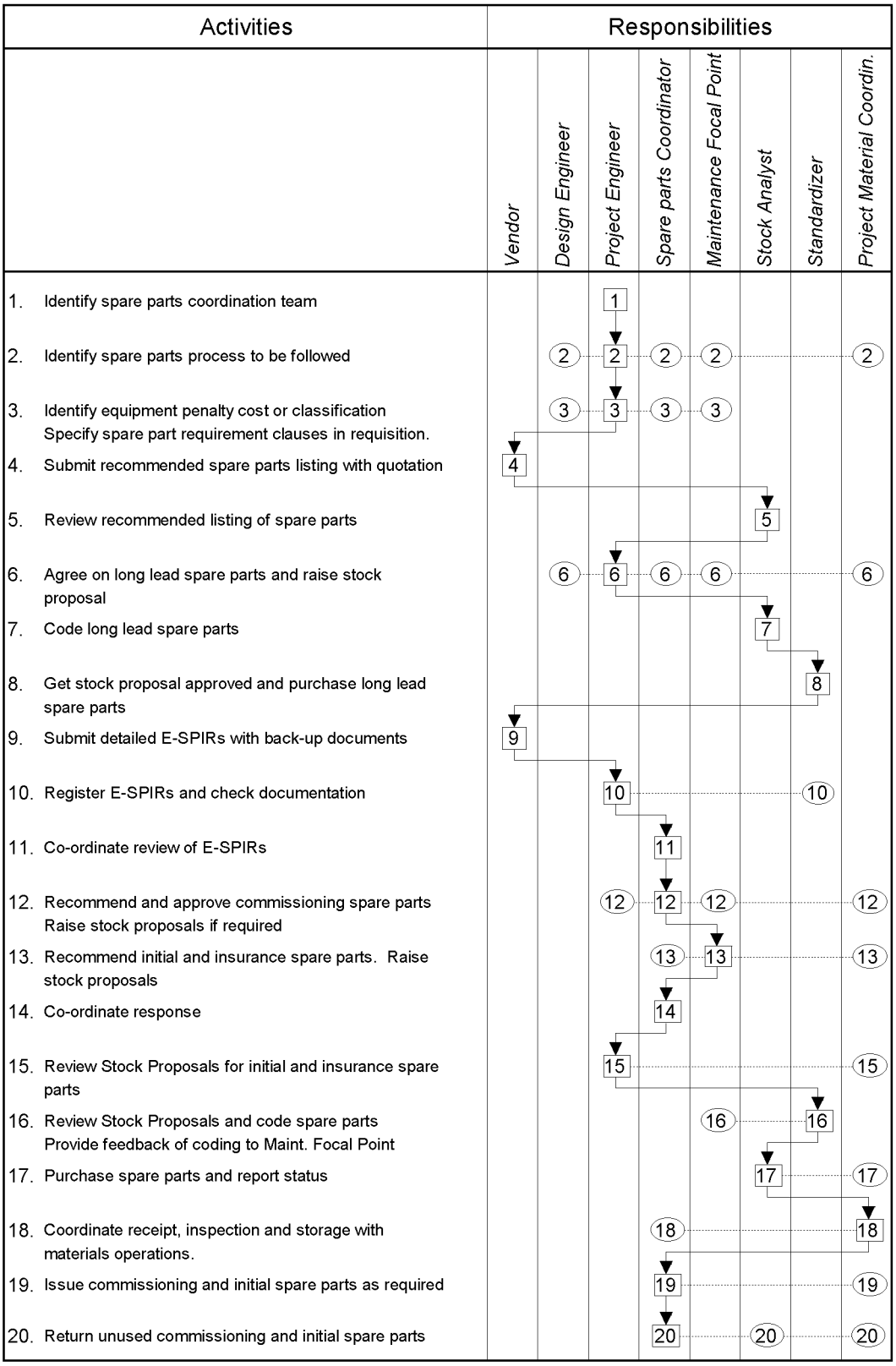
| | |
|---|---|
| Index to DEP publications and standard specifications | DEP 00.00.05.05-Gen. |
| SPIR Form (contained in the Standard Forms binder DEP 00.00.10.05-Gen.) | DEP 70.10.90.81-Gen. |
| Guide to Materials Management | GMM |
| Material and Equipment Standards and Code | MESC |

## 7. BIBLIOGRAPHY

NOTE: The following documents are for information only and do not form an integral part of this DEP:


| | |
|---|---|
| The Total Cost of Ownership (TCoO) Series: | |
| TCoO introduction and generic process model | EP 94-0351<br>PT 94-4018 |
| Getting the most from the Supplier relationship | EP 94-0353<br>PT 94-4020 |
| Maintenance Management Guidelines, Part 1. | MF 95-0160 |
| Maintenance Management Guidelines, Volumes 1 and 2. | EP 93-0750 |

## APPENDIX 1 SPARE PARTS ACTIVITY AND RESPONSIBILITY MATRIX FOR PROJECTS ORGANISED BY THE PRINCIPAL



## APPENDIX 2 SPECIMEN CONTRACT CLAUSES FOR STANDARDIZATION AND VARIETY CONTROL

*The following specimen clauses are included in this Appendix to make the Principal aware of factors relevant to standardization and variety control that may be suitable for inclusion in a contract (e.g. project specification, enquiry or purchase order) that the Principal may have with a Contractor. In this context, the term "Contractor" may also be adapted to apply to a Supplier of assembled equipment (e.g. a skid-mounted or packaged unit).*

*These standard clauses are specimens; they should not be adopted carte blanche but should be reviewed by the Principal and amended to suit the Principal's policies.*

1.1 GENERAL

a. The CONTRACTOR shall procure MATERIALS from Vendors on the appropriate "Lists of Selected Vendors" of the PRINCIPAL. The selection of Vendors from these lists shall not absolve the CONTRACTOR of its obligations under the CONTRACT.

b. The CONTRACTOR shall not assign or subcontract the supply of the MATERIALS or any major part thereof without the prior written consent of the PRINCIPAL. Any such permitted assignment or subcontracting shall not relieve the CONTRACTOR of its obligations under the CONTRACT.

c. MATERIALS purchased for the CONTRACT shall be in accordance with the relevant specifications. The CONTRACTOR shall promptly advise the PRINCIPAL of any MATERIALS for which the CONTRACTOR knows, or should know, that the Vendor plans to discontinue production.

d. The CONTRACTOR shall, within 2 months of CONTRACT award, obtain the PRINCIPAL's written consent if it considers that additional Vendors should be added to "Lists of Selected Vendors". Any amendments to "Lists of Selected Vendors" shall be at the PRINCIPAL's sole and absolute discretion.

e. The CONTRACTOR shall propose only those Vendors which are properly equipped to meet the requirements of the CONTRACT, and which are capable of providing proper technical support and competent after-sales services. The CONTRACTOR shall issue with each such proposal a "Vendor evaluation" report, stating clearly the MATERIALS the Vendor is qualified to supply.

f. The costs of evaluation of the proposed Vendor shall be for the CONTRACTOR's account. This evaluation shall include a quality assurance appraisal in accordance with ISO 9001 or equivalent.

g. Within 2 weeks of submission of the CONTRACTOR's proposal, the CONTRACTOR's proposed Vendor List shall be returned by the PRINCIPAL with the following annotations:

"a" Vendors not to be considered;

"b" Vendors unknown for the category of material specified and which may be evaluated later at the CONTRACTOR's expense;

"c" Vendors agreed by the PRINCIPAL and to be added as amendments to the "Lists of Selected Vendors".

If the PRINCIPAL does not annotate the proposed list within the aforesaid time, the proposed list shall be deemed to be not accepted by the PRINCIPAL.

h. The CONTRACTOR shall at all times update and distribute the amendments to the "Lists of Selected Vendors" in accordance with the established Lines of Communication, identified by date, document no. and revision indication.

i. The CONTRACTOR shall notify the PRINCIPAL of those Vendors it is proposing to amend to the "Lists of Selected Vendors" of relevance to the CONTRACTOR or its employees.

j. If the final amendments to the "Lists of Selected Vendors" cannot be agreed, procurement of materials shall only be from Vendors in the "Lists of Selected Vendors" as specified at the time of award of the CONTRACT.

k. The "Lists of Selected Vendors" shall take precedence over any DEP lists. If the information is conflicting or in cases of doubt the PRINCIPAL shall be consulted in writing and PRINCIPAL's decision shall be final.

l. The "Lists of Selected Vendors" are strictly confidential and the CONTRACTOR shall not divulge their contents to any Third Party. If the MATERIALS are subcontracted the CONTRACTOR will be allowed to provide the "List of Selected Vendors" or extracts from them to the Subcontractor, but the CONTRACTOR shall obtain from such Subcontractor a secrecy agreement in a form similar to that entered into by the CONTRACTOR with the PRINCIPAL.

m. For reasons of standardization the CONTRACTOR shall select Vendors for MATERIALS in such a manner that the variety of types is restricted as far as possible with the aim of minimising capital investment of plant installed and the operating expenditure of the plant (including the stocking of spare parts). The CONTRACTOR shall select a single Vendor for individual categories of MATERIALS, such as groups of pumps, electrical motors, instruments, valves, and the like. Design selections shall also restrict the number of sizes of pumps, electric motors and other equipment and standardize these for the various applications.

n. In the case of a "packaged unit" the CONTRACTOR shall ensure that all equipment and accessories supplied as part of the unit (e.g. instrumentation, pumps, valves and the like) shall be from Vendors detailed on the "Lists of Selected Vendors" and the amendments thereof agreed with the PRINCIPAL.

## 1.2 SPARE PARTS DATA

The Vendor shall include in the quotation the required Commissioning spare parts for the goods.

The Vendor shall complete the Electronic Spare Parts and Interchangeability Record (E-SPIR) for Initial spare parts and Operating spare parts for the goods, including "bought-out items", within six weeks after receipt of the Purchase Order.

The Vendor shall clearly mark the diskette of the E-SPIR with the Purchase Order reference and item number, unit type indication and serial number. A printed version of the E-SPIR lists shall be forwarded with the diskette. In the E-SPIR the description, drawing number, part number, quantity per unit, material specification, interchangeability of the parts and unit price ex-works (prices to be valid for one year) shall be given.

In the case of "bought-out items", the Vendor shall, in addition, specify the part number and name of the sub-supplier (original manufacturer).

If two or more parts can only be supplied as an "assembly", the drawing/part number shall be given for the assembly.

Spare parts lists shall identify the various parts with identification numbers and include sectional drawings/part lists.

**Definitions:**

- **Commissioning** spare parts are those required to prepare the equipment for start-up.
- **Initial** spare parts are those required to safeguard the operation of equipment during the running-in and starting-up periods **and** the first year of operation.
- **Operating** spare parts are those required for normal operation and day-to-day maintenance in the two-year period of operation after the first year of operation.

  NOTE: The quantities of each Initial and Operating spare part recommended shall be limited and shall take into account the known delivery time of the relevant part.

## 1.3 PACKING, MARKING AND LABELLING OF SPARE PARTS

Each part shall be properly tagged with a weatherproof label, showing the:

- MESC number;

- Manufacturer's unique part number;
- Description of the part;
- Expiry date for parts having a limited shelf life.

Small items with the same part numbers shall be tagged and packed together in a plastic bag or box, and the tag shall also be shown on the outside of the bag or box.

## APPENDIX 3 DECISION RULE APPLIED IN THE E-SPIR

1. GENERAL

The selection of spare parts is described in Section 4 of the main part of this DEP. This Appendix provides details of the formula incorporated into the E-SPIR which supports the user in deciding whether to accept new stock items.

1.1 FOUR PARAMETERS

The four parameters used in the decision to stock or not to stock the item are:

- Consumption rate;
- Purchase costs (to derive the stocking costs);
- Penalty costs;
- Lead-time.

### 1.1.1 Consumption Rate

The consumption rate is the estimated number of times the part is required per year. For making the estimate, historical data (if available) should be used. If the maintenance strategy is known it will be easier to estimate the consumption rate. The consumption index values to be used in the calculation are given in Table 1 in Section 1.4 of this Appendix.

### 1.1.2 Purchase costs

The purchase cost is the known cost price of an item based on a delivery to site, or system price, or the costs per item as indicated in the E-SPIR or inventory records of the Principal.

For the calculation of the Decision rule the purchase cost of the spare parts selection shall be in US Dollars. Table 1 in Section 1.4 of this Appendix gives the purchase cost index values to be used in the calculation.

### 1.1.3 Penalty Costs

The penalty cost is the total cost per day of not having the equipment running, due to waiting for spare parts. For the decision rule, a rough guess of the economic consequences is sufficient. The costs can be distinguished as direct and indirect.

Direct penalty costs are those costs which relate to the extra work incurred due to unavailability of the spare part e.g. expediting, cost of rush-ordering (air freighting), waiting time of technicians.

Indirect penalty costs are those which are related to the inability to utilise the equipment when required (e.g. production loss).

If standby equipment is installed the penalty costs are relatively low as no production is lost because of the unavailability of the spare part.

The need of spares is greatly influenced by the economic consequences of not having a spare part when it is needed. Penalty index values to be used in the calculation are given in Table 1 in Section 1.4 of this Appendix.

### 1.1.4 Lead-time

This is the time needed to obtain the part from the initial request until the moment the part is ready for use. This time is therefore longer than the delivery time specified by the Manufacturer. It also includes, for example, time for internal transport. Whereas the Manufacturer's delivery time should be specified on the E-SPIR, the other factors have to be assessed locally. The lead-time is an important factor, because it is assumed that the equipment is unable to function during this period, and therefore penalty costs are incurred. These penalty costs increase with the lead-time and consequently the lead-time represents the (total) waiting time for a part.

If the item is repairable, the repair time, if shorter, should be taken.

For call-off agreements and other direct delivery obligations of a Supplier a lead-time of nil should be taken. Lead-time Index values to be used in the calculation are given in Table 1 in Section 1.4 of this Appendix.

1.2 STOCKING AN ITEM

In the decision rule the costs of not stocking a part are compared with the costs associated with stocking the part. If the costs of not stocking a part are larger, the item must be stocked. As a formula, the decision rule is:

*"Stock at least one item if":* $0.25 \times P < C \times PEN \times L$

This simplifies the analysis a great deal, because only the values of these four variables need to be known:

| | | |
|---|---|---|
| P | = Purchase cost | (cost price of the item in US dollars) |
| 0.25 | = Stocking factor | (all costs associated with stocking the item as a percentage of purchase costs). |
| 0.25 x P | = Stocking cost | |
| C | = Consumption rate | (frequency of need for the part per year) |
| PEN | = Penalty cost | (estimated penalty costs in US dollars per day that the equipment is not able to function, due to unavailability of the spare part needed). |
| L | = Lead-time | (estimated days required to obtain the spare part when needed). |

1.3 HOW THE DECISION RULE WORKS

First, an estimate should be made or empirical figures obtained for the consumption rate, lead-time, purchase and penalty costs of a spare part. With these figures the User can apply the decision rule manually.

Use the data to find the corresponding index value in Table 1. By adding up the index values the sum will be either negative, zero or positive.

The decision rule then reads:

***"Stock at least one item if":*** **CsI + PrI + PenI + LtI > 0**

Conclusions to be drawn from the sum of the Index values are:

| | |
|---|---|
| *If the sum is negative:* | do not stock the item; |
| *If the sum is positive:* | stock the item; |
| *If sum is zero:* | reconsider the values, using common sense |

For sum values of -1 to +1 a check should be made to verify whether all estimates are correct.

If one value is unknown, the decision rule can still be applied by adding up the known index values and then seeing from the Table 1 what the value of the unknown index would need to be to make the sum greater than zero. It can then be judged whether this is reasonable.

If the recommendation gives cause for doubt, the values of the input parameters should be reconsidered to find the most realistic scenario.

1.4 INDEX VALUES

The Index Values for Consumption Rate (CSI), Purchase Cost (PrI), Penalty Cost (PenI) and Lead-time (LtI) are given in Table 1 below:

**Table 1 Index Values**

| Consumption Rate | | CsI |
|---|---|---|
| 12 or more | per year | 5 |
| 6 to 11 | per year | 4 |
| 3 to 5 | per year | 3 |
| 1.5 to 3 | per year | 2 |
| 1 per | 8 - 15 months | 1 |
| 1 per | 15 - 30 months | 0 |
| 1 per | 2.5 - 5 yrs | -1 |
| 1 per | 5 -10 yrs | -2 |
| 1 per | 10 - 20 yrs | -3 |
| less than 1 per | 20 yrs | -4 |
| | | |

| Purchase Cost (USD) | PrI |
|---|---|
| < 250 | 6 |
| 250 - 500 | 5 |
| 500 - 1 000 | 4 |
| 1 000 - 2 000 | 3 |
| 2 000 - 4 000 | 2 |
| 4 000 - 8 000 | 1 |
| 8 000 - 15 000 | 0 |
| 15 000 - 30 000 | -1 |
| 30 000 - 65 000 | -2 |
| 65 000 - 125 000 | -3 |
| > 125 000 | -4 |

| Penalty cost (USD per day) | PenI |
|---|---|
| 100 - 250 | -3 |
| 250 - 500 | -2 |
| 500 - 1 000 | -1 |
| 1 000 - 2 000 | 0 |
| 2 000 - 4 000 | 1 |
| 4 000 - 7 500 | 2 |
| 7 500 - 15 000 | 3 |
| 15 000 - 30 000 | 4 |
| 30 000 - 60 000 | 5 |
| > 60 000 | 6 |
| | |

| Lead-time | | | LtI |
|---|---|---|---|
| No lead-time | | | -10 |
| 1 | | day | -6 |
| > 1 | ≤ 2 | days | -2 |
| > 2 | ≤ 4 | days | -1 |
| > 4 | ≤ 6 | days | 0 |
| > 6 | ≤ 12 | days | 1 |
| > 12 | ≤ 21 | days | 2 |
| > 21 | ≤ 42 | days | 3 |
| > 1.5 | ≤ 3 | months | 4 |
| > 3 | ≤ 6 | months | 5 |
| > 6 | | months | 6 |

## 1.5 EXAMPLES TO STOCK OR NOT TO STOCK

*Example 1:* Bearing

| | | CsI | PrI | PenI | LtI |
|---|---|---|---|---|---|
| Consumption Rate | 1 bearing required every 4 years | -1 | | | |
| Purchase Cost | USD 600 | | 4 | | |
| Penalty Cost | USD 1500 per day | | | 0 | |
| Lead-time | 1.5 days | | | | -1 |

Applying the decision rule: ( CsI + PrI + PenI + LtI ) = ( - 1 + 4 + 0 - 1) = 2

*Recommendation:* Stock one bearing.

*Example 2:* Shaft

| | | CsI | PrI | PenI | LtI |
|---|---|---|---|---|---|
| Consumption Rate | 1 shaft required every 25 years | -4 | | | |
| Purchase Cost | USD 9000 | | 0 | | |
| Penalty Cost | USD 1500 per day | | | 0 | |
| Lead-time | 30 days | | | | 3 |

Applying the decision rule: ( CsI + PrI + PenI + LtI ) = ( - 4 + 0 + 0 + 3 ) = -1

*Recommendation:* Do **not** stock the shaft.

*Example 3:* Stock a complete assembly or the relevant spare parts only

The example compares the following options:

**Case a.** stock a complete assembly (repair time 1 day), or do not stock anything.

**Case b.** stock spare parts (repair time 6 days), or do not stock anything.

**Case c.** stock a complete assembly or stock spare parts.

In all cases the Consumption Rate and the Penalty Cost are the same.

| | | CsI | PrI | PenI | LtI |
|---|---|---|---|---|---|
| Consumption Rate | 1 assembly required every 15 years | -3 | | | |
| Penalty Cost | USD 1500 per day | | | 0 | |

**Case a.**

| | | | | | |
|---|---|---|---|---|---|
| **a.** Purchase Cost | USD 18000 (assembly) | | -1 | | |
| **a.** Lead-time | 2 months | | | | 4 |

Applying the decision rule: ( CsI + PrI + PenI + LtI ) = ( - 3 - 1 + 0 + 4) = 0

*Recommendation:* No decision, do more research.

**Case b.**

| | | | | | |
|---|---|---|---|---|---|
| **b.** Purchase Cost | USD 1200 (spare parts only) | | 3 | | |
| **b.** Lead-time | 2 months | | | | 4 |

Applying the decision rule: ( CsI + PrI + PenI + LtI ) = ( - 3 + 3 + 0 + 4) = +4

*Recommendation:* Stock the spare parts.

**Case c.**

| | | | | | |
|---|---|---|---|---|---|
| **c.** Purchase Cost | USD 18000 - 1200 = 16800<br>(assembly minus spare parts) | | -1 | | |
| **c.** Lead-time to repair | 6 days - 1 day = 5 days<br>(repair time - replace time) | | | | 0 |

Applying the decision rule: ( CsI + PrI + PenI + LtI ) = ( - 3 - 1 + 0 + 0) = -4

*Recommendation:* Do not stock the assembly.

**Conclusion:** *Do not stock spare assembly* since it is cheaper only to stock parts.