



© British Standards Institution. No part of this publication may be photocopied or otherwise reproduced without the prior permission in writing of BSI.

British Standard Guide to
Stock control
Part 3. Replenishment of stock

Guide du contrôle des stocks
Partie 3. Réapprovisionnement du stock

Leitfaden für die Lagerkontrolle
Teil 3. Auffüllung des Lagervorrats

Contents

	Page		Page
Foreword	Inside front cover	3. Bills of materials file	12
Committees responsible	Back cover	4. Stock and on-order list	13
Guide		5. Materials requirements planning (MRP) report	14
0. Introduction	1	6. Order action report	15
1. Scope	1	7. Weekly demands	16
2. Definitions	1	8. Typical ABC analysis of stock using computer calculations	22
3. Order quantities	1	9. Economic order quantity and minimum order quantity	25
4. Reorder systems	3	Figures	
5. Order timing: safety stocks and lead times	16	1. Purchasing and manufacturing EOQ graphs	2
6. Selective stock control	20	2. Inventory level of an item with respect to time ('ideal' conditions)	4
7. Master scheduling	23	3. Basic ROL system	4
Appendices		4. Stock record card: ROL system	5
A. Derivation of EOQ formula	24	5. ROL system	6
B. Economic order quantity (EOQ) and minimum order quantity (MOQ)	24	6. Pre-allocation ROL system (order cover)	7
C. Qualifications for use of EOQ formula	26	7. Two (and three) bin systems	8
Tables		8. Typical safety stock values	17
1. Typical programme control chart	10	9. Lead times for replenishment	19
2. Master production schedule	11	10. Typical ABC curve	21

Foreword

This British Standard has been prepared under the direction of the Quality Management and Statistics Standards Committee.

In all manufacturing concerns, capital is tied up in stocks of one form or another. Reducing this capital to the minimum level consistent with efficiency is the objective of stock and inventory control systems.

Undoubtedly, large sums can be saved by effective stock control, particularly in medium to large undertakings, but even in small organizations there is every reason for exercising a form of stock control, with excellent results.

Stock control demands careful preparation, discipline and determination to work amicably in a team involving all the

other functions of the organization. However, the reward can more than justify the effort.

This British Standard, in five Parts, gives comprehensive guidance in those areas that are considered essential for efficient stock control. The Parts are as follows:

- Part 1. Introduction to management of stock control
- Part 2. Demand assessment
- Part 3. Replenishment of stock
- Part 4. Data processing
- Part 5. Storekeeping

Compliance with a British Standard does not of itself confer immunity from legal obligations.

British Standard Guide to

Stock control

Part 3. Replenishment of stock

0. Introduction

In one sense stock control can warn of variances between planned and actual stock levels so that the controller is able to take any necessary corrective action. Stock control is always desirable in this context.

In another sense stock control can be used as a production control ordering system, which maintains a supply of manufactured and purchased items by ordering replenishments when appropriate. The stock control method of ordering has certain characteristics that limit the types of application in which it can be used economically.

1. Scope

This Part of BS 5729 provides guidance on the determination of a stock replenishment policy using three broad groups of reorder system. Information is given on which parameters to adopt, both generally and on an item-by-item basis, to take account of the nature of demand, order quantities, safety stocks, replenishment lead times and related costs. Additionally, procedures are provided for selective stock control and the related concept of master scheduling.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2. Definitions

For the purposes of this Part of this British Standard, the terms and definitions given in BS 3138 and BS-5191 apply.

3. Order quantities

3.1 General

3.1.1 When making or supplying to customer order, the *order quantity* is just what the customer ordered. When making or supplying for storage, however, the problem is to know how much to order; this problem occurs even in 'make to order' situations because the components or raw materials may still have to be made or purchased for storage. The *batch quantity* is the amount of a product or part produced or supplied under conditions that are presumed uniform and, for production control purposes, passing as a unit through the same series of operations.

3.1.2 The order quantity often has a big influence on stock holding costs, so it is not surprising that this was probably the first stock control problem to attract a mathematical type of solution.

3.1.3 The most commonly used methods, not only manual systems, but many computer 'packages' use EOQ as the basic approach. However, wherever the future demand is varying and is known or can be forecast accurately, modern systems are moving away from the idea of ordering a fixed quantity for storage. Current trends are moving towards ordering the actual quantity required only when it is needed. This is the basis of materials requirements planning (MRP) in its simplest form.

3.2 The EOQ formula (see figure 1). The principle used is simple. All the costs incurred are set down algebraically and the resulting expression is reorganized in terms of the order quantity. The value of this quantity that makes the total costs a minimum is then calculated. This quantity is known as the 'economic order quantity' (EOQ) and is given by the expression

$$EOQ = \sqrt{\left(\frac{2AS}{CI}\right)}$$

where

A is the annual* usage (quantity);

S is the processing or set-up cost per order;

C is the value of the item;

I is the stock holding (or inventory carrying) cost per annum* as a percentage of its value (e.g. 15 % = 0.15).

NOTE. Appendix A gives the mathematical proof and appendix B gives approximate results for the formula.

Many variants of this formula have been produced to extend or improve its usefulness, but the basic principle of minimizing cost is unchanged.

Although the formula is widely used, it should always be remembered that there are limitations.

3.3 Types of batch quantity

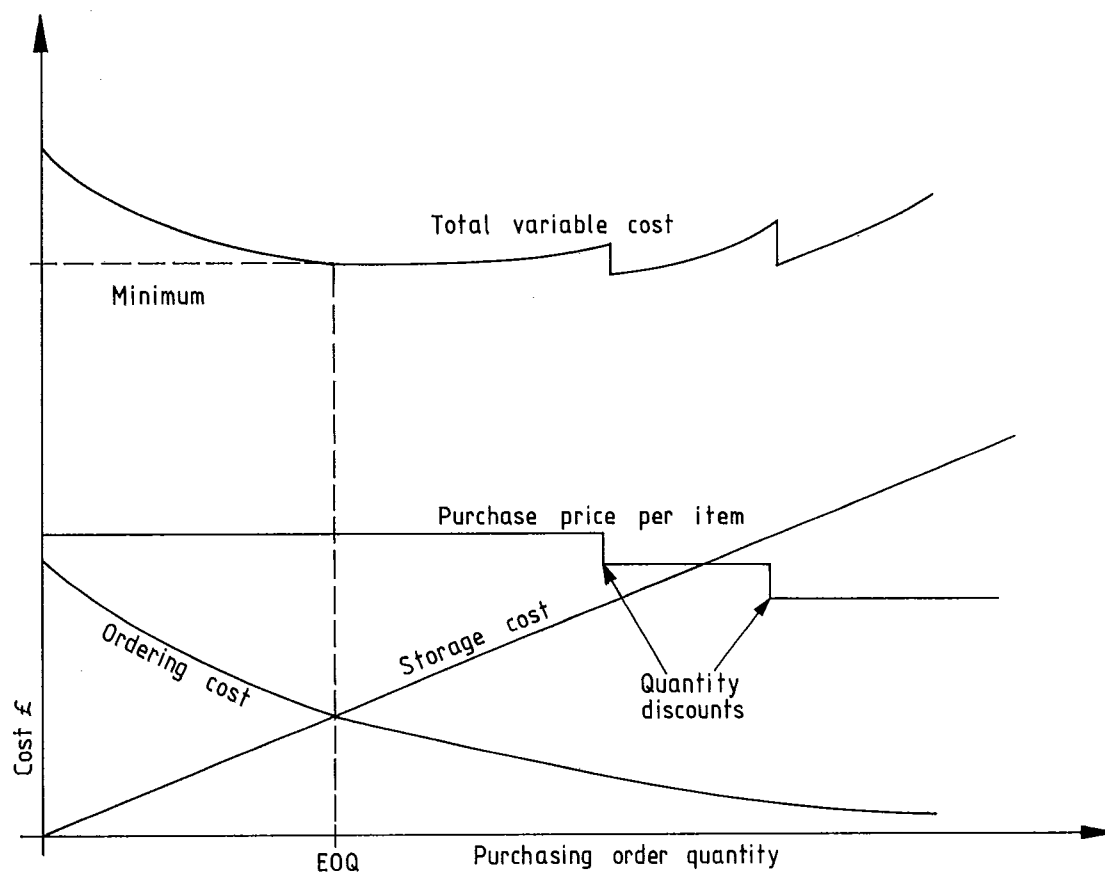
3.3.1 In a purchasing situation items are batched into sets for convenience, the two most important quantities being:

(a) the sanction quantity or quantity ordered from a supplier;

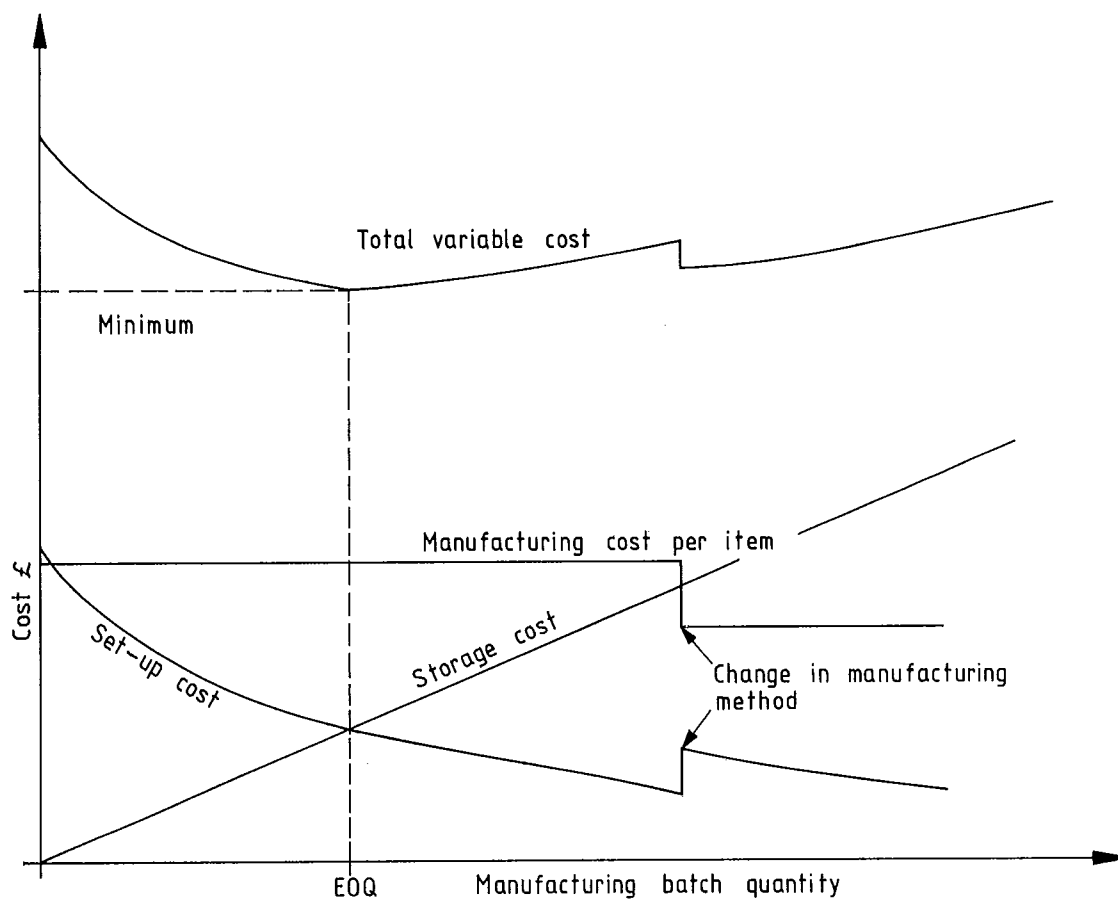
(b) the transfer quantity or delivery quantity.

Both of these quantity variants are independent variables to which different values can be assigned. The sanction quantity has no direct effect on the stock level, but increasing its value up to the limit dictated by the risk of obsolescence tends to reduce both purchase price and purchasing costs. Reducing the purchasing transfer quantity has a major effect on the stock level. It may in certain circumstances also increase costs but these increases are usually avoidable.

**A* (the usage quantity) and *I* (the holding cost) need not be annual values but have to be expressed in the same units of time.



(a) Purchasing graph



(b) Manufacturing graph

Figure 1. Purchasing and manufacturing EOQ graphs

3.3.2 In a production control situation items are also batched into sets for convenience, the four most important quantities being:

- (a) the sanction quantity or quantity authorized for manufacture;
- (b) the run quantity or quantity of an item that is usually processed at a work centre, before changing over to another item;
- (c) the transfer quantity or the quantity of an item that is transferred as a batch between work centres;
- (d) the set-up quantity or the number of items (not necessarily all the same) that are processed at a work centre at the same set-up.

All of these batch quantities are independent variables to which different values can be assigned. Each of them has different economic effects. The sanction and set-up quantities have a direct effect on preparation costs, constituting an approximately fixed cost per batch and have no direct effect on the stock level. The run and transfer quantities, on the other hand, have a major effect on the stock level, but have no direct effect on preparation costs.

3.4 Care in applying EOQ. There are many situations where the EOQ formula, which is simple to use, provides the 'ideal' quantity. However, in some situations, it can only give a result better than an intuitive guess, i.e. it can be used with qualifications but requires discretion in its use (see appendix C). There are several situations where the EOQ should not be used at all.

3.5 Using EOQ in practice. Separate calculations for every one of a large number of items in an inventory would be a lot of work and unnecessary. Grouping into families can help, but generally the EOQ is applied only to the higher usage items, which usually amount to only about a third of the total number.

Even then, the work is further shortened either by using computer packages or by using tables. Some useful tables are reproduced in appendix B. These give not only the 'true' EOQ but also the various minimum manufacturing quantities (MMQs) if the theoretical minimum cost is allowed to be exceeded by 1 %, 2 %, 3 %, 4 % and 5 % respectively.

3.6 Dynamic balancing. One interesting development on the ordinary EOQ calculation is called 'dynamic balancing' and extends EOQ applicability to cases where the demand is *not* constant. The method is used to calculate successively the costs of ordering and holding enough stock for 1, 2, 3, . . . , n periods until a minimum cost is reached. The following calculation gives an example of dynamic balancing but demonstrates that this technique really requires computer aid if it is to be applied to more than a small number of items.

Example

Suppose the demand for an item is:

Period	1	2	3	4	5	6	7	8	9	10	11	12
Requirement	40	10	5	35	45	5	5	40	35	20	30	30

Let the running cost be £ 5 per item

Let the set-up cost be £20

Let the holding cost be 10p per item per period

If enough are ordered for period 1 only (40 items) the unit cost (in £) is given by

$$5 + \frac{20}{40} + \frac{0.1(40 \times 0)}{40} = 5.5$$

If enough are ordered for periods 1 and 2 (50 items), the unit cost (in £) is given by

$$5 + \frac{20}{40 + 10} + \frac{0.1(40 \times 0 + 10 \times 1)}{40 + 10} = 5.42$$

Similarly successive unit costs work out at:

£5.40 for 55 items

£5.36 for 90 items

£5.37 for 135 items

The first EOQ is 90 items (for periods 1 to 4).

3.7 Other techniques

3.7.1 General. Other techniques for EOQ calculation involve more detailed operational research (OR) techniques, such as the Wagner Whitin algorithm and dynamic programming.

3.7.2 ABC weeks' worth. A very simple order quantity system uses the ABC parameters (see 6.2) together with known or forecast future needs (or historical usage) to order, for example, four weeks' worth of needs (usage) for class A items to one year's worth for the tail end of class C items. In using such a system the approach can be modified to cater for regular and sporadic usage or special items.

3.7.3 Operational research (OR) techniques. The EOQ and dynamic balancing techniques are really simple OR models of the real world. More detailed OR techniques can be used for special environments, e.g. seasonality. In considering such techniques the benefits have to be compared with costs of the technique and be related to the benefits available from the simpler systems, remembering that a simpler system may be easier to implement or change.

4. Reorder systems

4.1 General. There are three broad groups of systems that are used to ensure that reordering of items is performed effectively. These are as follows:

- (a) fixed order quantity systems;
- (b) fixed reorder interval systems;
- (c) varying order quantity and reorder interval systems.

The first two groups are simplifications of the third group, generally requiring fewer resources but providing a less than 'ideal' result. The third group is essentially more complicated but can provide the best results given the necessary resources (staff, computers, etc.) to run it. This group includes the MRP technique.

These three systems are best explained using the 'saw tooth diagram' (see figure 2) as an approximation of the way in which inventory is consumed and replenished.

The 'saw tooth diagram' is an 'ideal' representation of the real world in which the following problems often occur:

- (a) actual usage varies and is not a straight line graph;
- (b) quantities ordered vary from time period to time period;
- (c) the lead time for procurement varies;
- (d) random effects and many other factors.

4.2 Fixed order quantity systems

4.2.1 General. This first group of systems uses a fixed order quantity to simplify the total situation and to make it more manageable.

The simplest of all the fixed order quantity systems is the reorder level or order point system.

4.2.2 Reorder level (ROL) system (see figure 3)

4.2.2.1 General. The ROL system forecasts, using the average weekly (or period) usage, when stock will run out. It then subtracts from that future run-out time a fixed procurement lead time to establish a date and hence a stock level at which reorder action is needed.

4.2.2.2 Stock record card procedure for the ROL system

NOTE. A typical stock card for the ROL system is shown in figure 4 and a basic procedure in figure 5(a).

The following points have to be considered when designing the card and operating the procedure.

- (a) In certain instances the current on-order position may need to be taken into account (see figure 5(b)).
- (b) Recent 'requests to order' may not yet have been actioned by buying, etc.
- (c) A follow-up procedure to ensure timely order placement can be an asset.

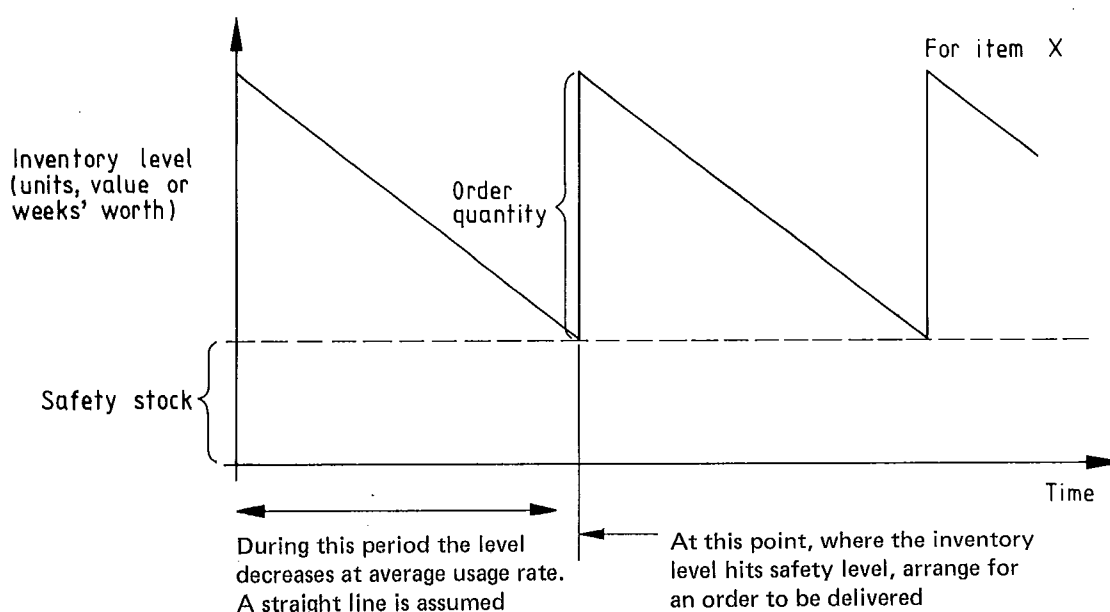


Figure 2. Inventory level of an item with respect to time ('ideal' conditions)

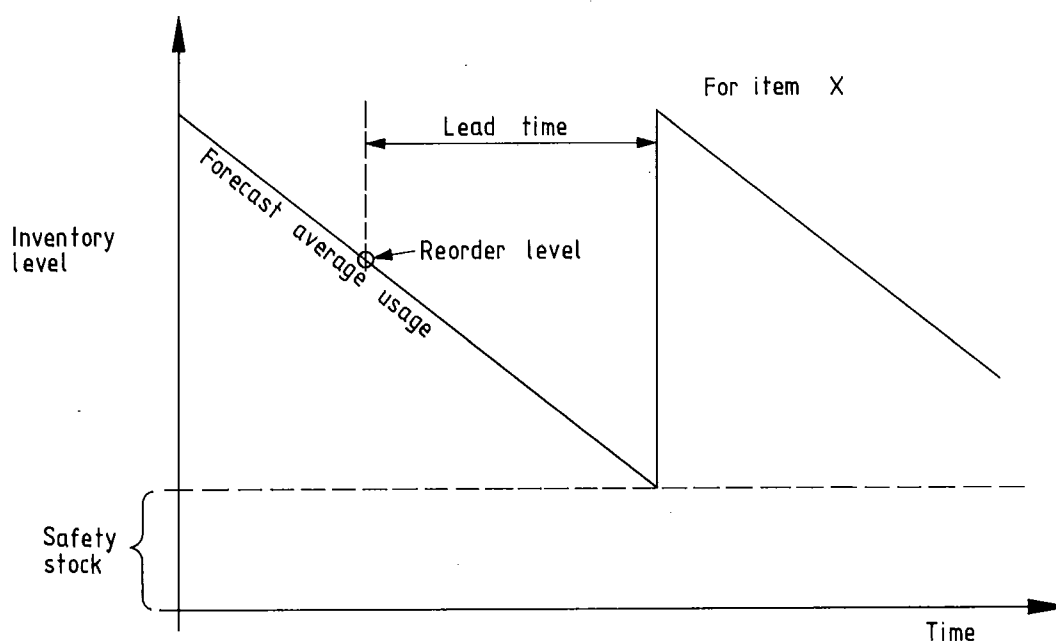
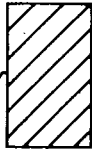


Figure 3. Basic ROL system

Coloured
flag

Description <u>WIDGET</u>		Item no.: <u>123456</u>			
General information					
	Lead time	ABC class	Reorder level	Reorder quantity	
Quantity, etc	4 weeks	B	1000	2000	
Date last review	11 May 19xx	12 Jun 19xx	13 Jly 19xx	9 Aug 19xx	
Reviewed by	*	*	*	*	
Type/method, etc	—		—	EOQ	
Stock movements Last stock check: 15 Oct 19xx					
Date	Quantity issued —	Quantity received +	Balance in stock	Quantity on order	Notes
10 Sept 19xx	200		1900	Nil	
14 Sept 19xx	500		1400	Nil	
29 Sept 19xx	400		1000	Nil	
3 Oct 19xx				2000	2000 Requested Ord. No. 123592
5 Oct 19xx	15		985		Stock check loss
15 Oct 19xx	500		485	2000	
25 Oct 19xx	250		235	2000	
7 Nov 19xx		2000	2235	Nil	Ord. No. 123592

*Initials of authorized person.

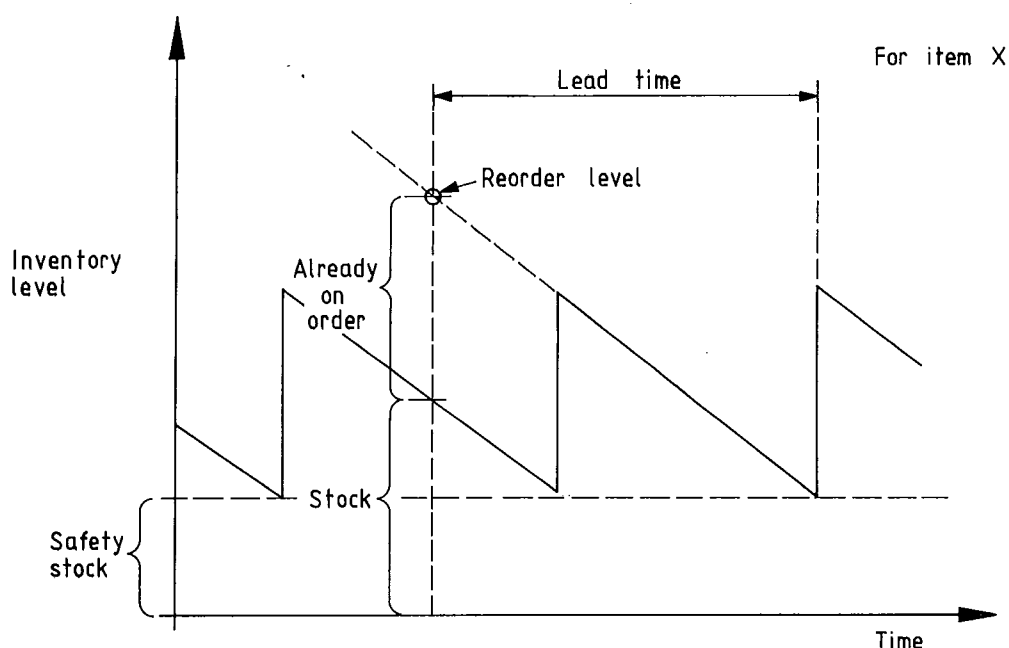
NOTE. Coloured flags

- e.g. red means running out
orange means reorder requested
blue means stock check requested

Figure 4. Stock record card: ROL system

1. Items issued from store against a requisition
2. Requisition quantified, signed and dated by storeman
3. Requisition sent (promptly) to stock record clerk
4. Stock record card updated
5. Stock compared with reorder level (ROL)
6. If below ROL, check on order
7. Request reorder as required
8. Tag card 'Reorder requested' and follow up every Friday until ordered
9. Enter order details onto card
10. Enter receipts and adjust quantity on order (watch out for deliveries almost equal to order quantities)
11. Enter stock checks as performed

(a) Basic ROL system procedure



NOTE. Here the ROL has to be compared with stock plus that already on order.

(b) Effects of ROL system procedure

Figure 5. ROL system

4.2.2.3 Advantages and disadvantages of the ROL system.
The ROL system is a very simple system to operate and to install. It is also a very simple system to mechanize using low cost computers or accounting machines.

In the absence of any mechanization it relies heavily on the stock record clerk who has to accurately and reliably perform a simple but repetitive task.

The disadvantages lie in the assumptions that have to be made in order to create a simple system.

The ROL system assumes that lead times are fixed and that there is little variation in usage pattern (i.e. that demand is of independent nature and is not related by a formula to other factors, such as finished goods sales).

In order to counter these disadvantages additional stockholding is often needed by way of safety stock.

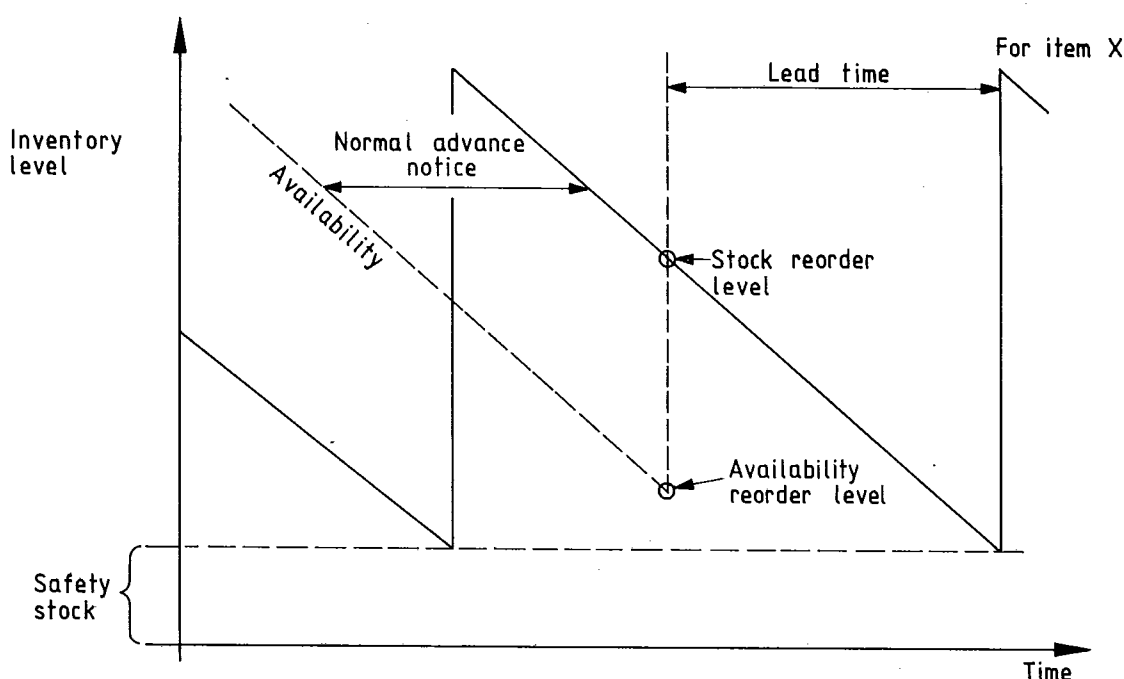
Additionally, lead times and usage levels have to be reviewed frequently (quarterly) and when they are changed, the reorder levels also have to be brought into line.

4.2.3 Pre-allocation ROL system (or order cover system).
Where usage variability is such that an ordinary ROL system becomes inadequate for reorder control, e.g. where price and/or usage are high, a pre-allocation system can assist in further reducing stockholdings but at the expense of a more complex and more time consuming system.

The outline procedure indicating that the stock card has to be updated twice is shown in figure 6(a). Details of how the system works are shown in figure 6(b).

1. Requisitions for items are made out some weeks in advance
2. They are pre-allocated on the stock card and an 'order cover' total maintained:
order cover = stock + on order - pre-allocated requirements
3. Requisitions are stamped 'Pre-allocated'
4. Reordering considers the availability total instead of the stock balance
5. After issue by stores the stock records are updated as follows:
 - (a) the stock record is updated
 - (b) if the requisition is stamped 'Pre-allocated', the order cover is left unchanged (unless the quantity issued is different from that requested)
 - (c) if the requisition is *not* stamped 'Pre-allocated', the order cover total is also updated by deducting the quantity issued

(a) Basic pre-allocation ROL system procedure



NOTE. Order cover = stock + on order - pre-allocated requirements.

(b) Effects of pre-allocation ROL system

Figure 6. Pre-allocation ROL system (order cover)