Concepts of Logistics System Design

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FPLM

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Abstract

This publication advocates a holistic approach to designing efficient logistics systems that can adapt to changing environments. It discusses some of the most important design issues and briefly describes several types of logistics systems.

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Acronyms and Terms

consumption records	Log recording quantities dispensed to each client and regular report that summarizes these data for higher-level management use.
FEFO	first-expiry, first-out
JSI	John Snow, Inc.
outlet	Facilities that dispense commodities to end users.
pull system	requisition system
primary supply point	Facilities that receive supplies from a source.
push system	allocation system
sources	Facilities outside the system from which commodities are supplied.
stock-keeping record	Must include inventory control cards; may include additional records.
transaction records	Records of the amount shipped from one facility to the next and records of amounts ordered (for requisition systems).
USAID	U.S. Agency for International Development

A frequent problem in logistics system design is that projects are undertaken piecemeal, without an organized framework for analysis. Consequently, systems are developed that are too complex or too inflexible to change as the program environment changes. The following pages discuss some of the most important issues in the design of logistics systems and describe briefly several different types of systems.

1.   The Purpose of Logistics Systems

The purpose of a logistics system is simple: it exists to obtain and move supplies and equipment in a timely fashion to the places where they are needed, at a reasonable cost. Matters are complicated by the fact that equipment and supplies usually cannot go directly from their source to the end user; they frequently must be held as inventory at one or more intermediate points along the way.

Remember, there are only four reasons for inventory to exist:

1. *Transportation efficiency*: It is not reasonable to ship single bottles of pills across the ocean or to deliver MCH kits to a clinic daily; thus, shipments are made in batches of a size and frequency dictated by the transportation system.

2. *Safety stocks*: Because things come in batches, trucks break down, and roads wash out, and because actual demand usually cannot be predicted very accurately, facilities must maintain safety stocks to ensure that they do not run out in times of high demand and late resupply.

3. *Storage capacity*: If a facility close to the end user has limited storage space, then inventory must be held at the next higher level in the system, and must be delivered more often.

4. *Anticipation*: In a program that is growing or changing, it is necessary to store inventory in anticipation of demand that does not exist yet because of the length of time between ordering supplies and receiving them.

Any system that stores inventory for reasons other than these is a candidate for streamlining.

It is important to remember the overriding principle of logistics system design: the system must be simple. Its purpose is to move supplies, not to create paperwork. The important features of a logistics system are its physical structure and its management structure. Both of these are described later in this document.

2. The Physical Structure of the System

A logistics system's physical structure consists of two things: stationary facilities and the transportation links between those facilities. Logistics jargon further distinguishes those facilities (such as drug manufacturers) that are outside the system from which commodities are supplied; these are called "sources." Facilities that receive supplies from a source are called "primary supply points." Facilities that dispense commodities to end users are called "outlets."

Whatever names are used, there are six important things to know about the facilities themselves:

1. Where is the facility located?

2. How is it staffed?

3. What is the actual need for each commodity at the facility and how does this need vary over time?

4. What is the facility's storage capacity?

5. What are the storage conditions, and are they suitable for the items being stored?

6. How is the inventory controlled, and is it secure?

In describing the physical structure of the logistics system, it is important to note the number of links into each facility; the more links there are, the more confused the system is likely to be. At the top, the primary supply points probably will receive commodities from a number of sources. At lower levels of the system, however, it is usually desirable to limit each facility to receiving supplies through only one link (possibly with a different link for emergency backup).

Similarly, there are five important things to know about transportation links:

1. What types of transportation are available?

2. What size batches of commodities are cost-effective to transport?

3. How long does it take to get from one facility to the next?

4. How often can shipments be made?

5. Are the answers to these questions different during different seasons of the year?

With this basic information in hand, the logistics system's management structure can be analyzed.

3. The Management Structure of Logistics Systems

The essential questions in understanding the management structure of a logistics system are—*Who* decides what (and when and how many) commodities move through a link from one facility to the next, and *how* does he/she decide?

There are two general types of logistics systems:

1. *Allocation* or "push" systems

2. *Requisition* or "pull" systems

In an allocation system, the higher-level facility decides what commodities move down the system and when they move down. It "pushes" them through the system. In a requisition system, the lower-level facility orders commodities as the need arises, thus "pulling" supplies through the system.

The advantages of a requisition or "pull" system are that it can be based on current information about actual needs, and thus, in theory, is more accurate and less wasteful than an allocation system. Decision making is decentralized to lower levels and each manager has a narrower scope of concern. The disadvantages of requisition systems are related directly to these advantages; requisition systems will work only if accurate information about needs exists or can be obtained, and if lower level staff have sufficient management training and support to make decisions about ordering in a meaningful fashion.

Therefore, allocation or "push" systems are appropriate when accurate information on needs is not available or where management skill is concentrated at higher levels of the service system. If demand significantly exceeds supply, an allocation system must be used to divide scarce commodities among competing facilities. Where allocation systems are used, every effort should be made to base allocations on appropriate estimates of actual need.

This management structure may differ at different levels of the system; higher levels may requisition and then allocate to lower levels. Even at a single level, the system may be mixed. A regional warehouse might allocate stock to a health center every three months, but the health center may be able to request additional supplies, if needed, in the interim. Also, it may be desirable to use different procedures for equipment, which is essentially a one-time problem, than for supplies, which must be restocked on a continuing basis.

In addition to the question of who makes the decisions to move commodities, there is the question of how the decision is made. It already has been stated that the decision should be based on a projection of actual need; such an assessment is called forecasting. A full discussion of forecasting is beyond the scope of these few pages; here it is only important to note that an adequate decision-making process must include consider three things:

1. *Historical data*: The decision maker must consider the actual past use of commodities and how that use pattern has changed over time; normally, this can be done simply by graphing the data.

2. *Future program plans*: The decision maker must know what the future plans for the program are and have some way of realistically estimating the effect of those plans on the demand for commodities.

3. *Underlying assumptions*: The decision maker must use proper assumptions about how demand varies over time; for example, in a new program, demand is usually slow at first, then increases rapidly, and finally levels off.

The most important point about the forecasting decision is that reordering the same amount as used last month often is not an adequate strategy.

4. Information Flow

To make decisions, the managers of the logistics system need a certain amount of information; unfortunately, in most cases the amount of information collected exceeds the amount needed.

As the earlier discussion implies, only three things happen in a logistics system: commodities move down through the system, commodities are held in inventory at various points, and commodities are dispensed to users for subsequent consumption. Accordingly, there must be three different types of records in the logistics information system:

1. *Stock-keeping records*: These must include inventory control cards, but may also include additional records for accountability and prevention of theft.

2. *Transaction records*: These include records of the amount shipped from one facility to the next and records of amounts ordered (for requisition systems).

3. *Consumption records*: While some programs do without these, usually it is desirable to have some form of log recording quantities dispensed to each client and some form of regular report that summarizes these data for higher-level management use.

Figure 1 shows a minimal information system.

Decisions regarding the level of accountability and control in the logistics system should weigh the level of effort and the amount of paperwork required. In some cases, it may be less expensive to permit a certain amount of theft or shrinkage rather than to create a complex and unwieldy information system.

The inventory file is preferably an individual card for each item in stock, but could also be a page for each item in a ledger book. Regardless of the format of the inventory file, it must contain the following four items of information in an easily retrievable form:

1. Current stock level

2. Amount of stock on order (for requisition systems)

3. Historical data on times and shipment quantities, both into and out of the facility

4. Losses/adjustments

In addition, it may be convenient to show ordering rules for requisition systems directly on the inventory file, including items such as order point and order size, which are discussed below. For products with a limited shelf life, expiration or manufacture dates, lot identifiers, or quality control data may be needed. Figure 2 is a sample idealized inventory control card.

Any information beyond these basic data should be included in the inventory file only if a good justification for its use can be made. Routine reporting of any of these data to higher levels of the system must be carefully justified in terms of immediate utility for ordering or allocation decisions.

Figure 1.
Minimal Logistics Information System
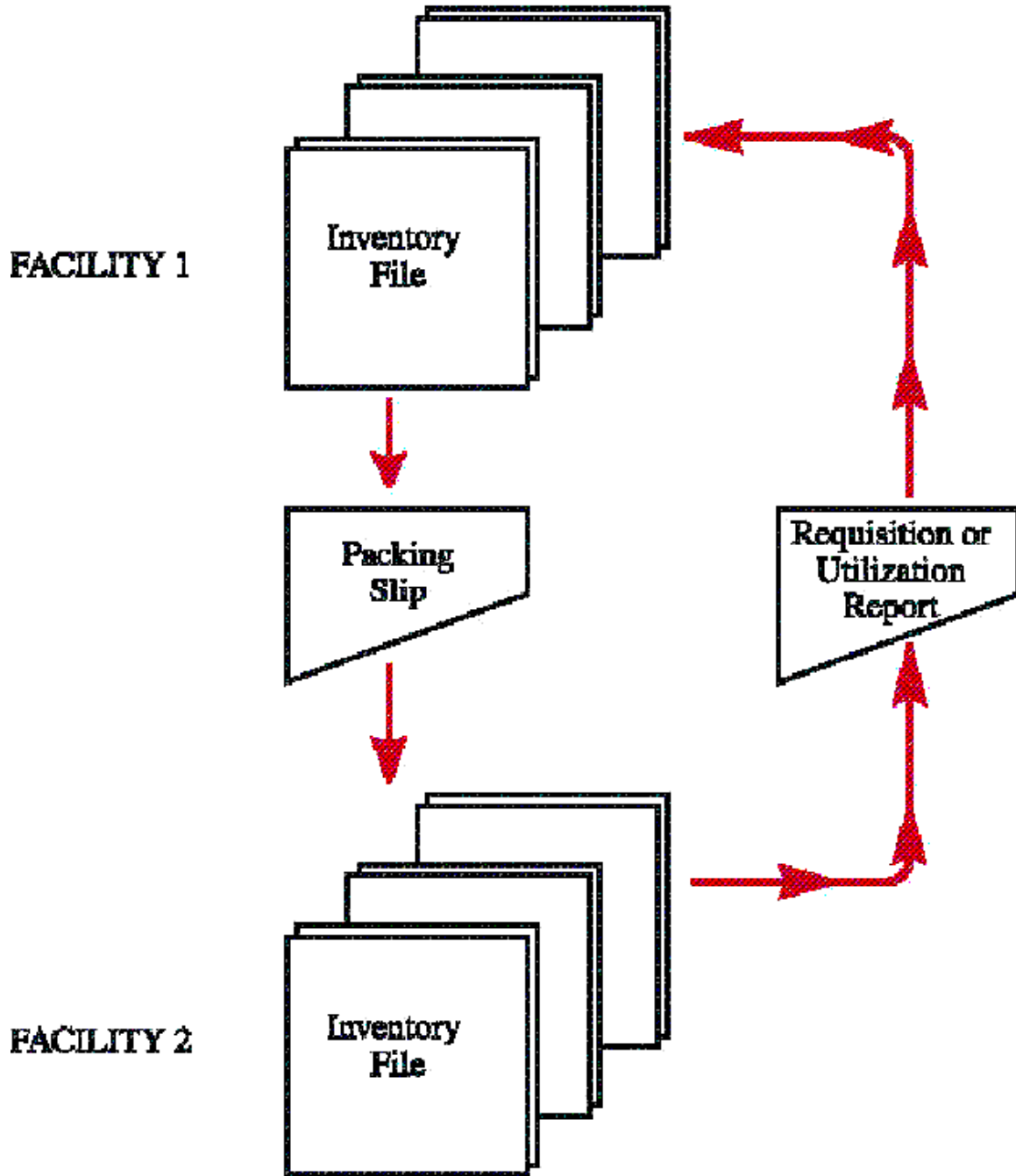
Figure 2.
Inventory Control Card

INVENTORY CONTROL CARD						
Commodity Number		**Description**				
Unit		**Maximum Stock**		**Minimum Stock**		**Location**
Date	**Transaction Reference**	**Quantity Received**	**Quantity Issued**	**Losses/ Adjustments**	**Quantity On Hand**	**Quantity On Order**

Transaction records are quite simple; they need specify only what is being ordered or shipped, by whom, and when. The purposes of transaction records are to:

1. Specify amounts being ordered (requisition systems only).

2. Provide authorization to ship/receive commodities.

3. Provide proof that goods shipped are actually received, and to initiate corrective action if they are not.

Figure 3 shows a sample idealized transaction form suitable for use in a pull system. Again, additional information should be included only if a definite use for it can be specified.

Beyond the inventory file and transaction records, inventory systems with many levels will have some sort of summary reporting for management control purposes. The summary report could include only stock balances, but also may include information on issues and receipts, stock destroyed or expired, and so forth. Again, report only information that will actually be used for decision making. A sample of such a summary report is shown in figure 4. The consumption records from which such reports are generated will vary from program to program depending on what services are provided and tracked. Figure 5 shows a sample consumption log form from a comprehensive family planning program.

With the dramatic recent decreases in the prices of computer hardware and software, now it is possible for even small organizations to consider automation of their logistics information systems. A variety of commercial and public sector general software programs have been written for this purpose, including several designed specifically for logistics management in health and family planning programs. Any organization desiring to automate should investigate the applicability of these packaged programs before attempting to develop customized software on its own. They should also remember two essential facts: the price of computer programmers (as opposed to programs) continues to go up, not down, and automation should be considered only AFTER a rational, streamlined commodity distribution system is in place.

Figure 3.
Requisition and Issue Voucher

REQUISITION AND ISSUE VOUCHER					
Requisition and Issue Voucher No.: _____					
Date: _____ **Ship to:** _____					
			_____		
			_____		
REQUISITION			**ISSUE**		
Article	**Quantity on Hand**	**Quantity Requested**	**Shipped**	**Received**	**Remarks**

REQUISITION
Requested by: _____   Date: _____

Approved by: _____   Date: _____

ISSUE:
Approved by: _____   Date: _____

Shipped by: _____   Date: _____

RECEIPT:
Received by: _____   Date: _____

(make 4 copies)

Figure 4.
Quarterly Report & Request for Contraceptives

QUARTERLY REPORT & REQUEST FOR CONTRACEPTIVES

Province:_____ District:_____ Location:_____
Facility type: Depot: ± District Store: ± SDP/Clinic: ± Other:_____
Report for Quarter Beginning:_____, 19___ Ending_____, 19___

Contraceptive	Beginning Balance	Received This Quarter	Dispensed / Issued	Losses/ Adjustments	Ending Balance	Quantity Needed
Microgynon						
Neogynon						
Microlut						
Nordette						
Trinordial						
Depo-Provera						
Noristerat						
NORPLANT						
Copper T						
Multiload						
Condoms						
Foaming Tablets						
Gloves						

Submitted:_____ Date:_____

Explanation of losses:_____

_____

_____

Figure 5.
Daily Activity Register (Family Planning)

DAILY ACTIVITY REGISTER (FAMILY PLANNING)

S.D.P./Clinic S.D.P./Clinic
Name: _____

Number: _____

Month: _____

Year: _____

Date	Name of Client	Client Number	Client Type		Contraceptives Dispensed at this Visit																Referrals		Gloves	Comments/Remarks
					Oral Contraceptives							Injectables			IUD's									
			New	Revisit	Microgynon	Neogynon	Eugynon	Microlut	Nordette	Logynon	Trinordial	Depo-Provera	Norsterat	NORPLANT	Copper T	Nova T	Multi-load	Condoms	Foaming Tablets	Sterilization	Natural FP		

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5. Types of Inventory Control Systems

As discussed earlier, there are two primary questions to answer in logistics system design. (1) Who will make the ordering decision? (2) What is the smallest amount of information on which those decisions can be based? The ordering decision must answer two questions:

1. How much should be ordered?

2. When should it be ordered?

A full discussion of the types of logistics systems is beyond the scope of this paper. In theory, however, there are only three different types:

1. Fixed order size, variable order interval systems

2. Fixed order interval, variable order size systems

3. Combination systems

In a fixed order size, variable order interval, or *order point* system, a specific fixed amount of a commodity is ordered whenever inventory falls below a certain level, called the *reorder point*. Thus, for example, the decision rule might be, "Whenever there are fewer than 500 capsules of tetracycline, order 1,000 more." The trick is to choose the reorder point so the new shipment is guaranteed to arrive before the remaining supply is exhausted. The advantage of this type of system is that it gives control on an item-by-item basis and, therefore, minimizes excess stock. The disadvantage is that it is difficult to predict the transportation schedule and to batch many items for shipment. Therefore, where transportation is difficult or time-consuming, such systems are less appropriate.

A simple version of a fixed order size, variable order interval system is a *two-bin system*, in which goods are packed in standard sized bins that correspond to the reorder point. Each outlet initially is issued two bins. Supplies are drawn from one bin until it is empty, and then a new order is placed (preferably using a preprinted order form packed at the bottom of the bin). Supplies are then drawn from the second bin until it is exhausted, by which time the replacement bin should have arrived, and the procedure is repeated. The advantage of the two-bin system is that it requires no record keeping at the facility using it.

In a fixed order interval, variable order size system, the ordering time is fixed at, for example, one time per quarter, with the size of the order depending on stock remaining and projected use. The advantage of this type of system is that many items can be batched and shipped at the same time, thus reducing transportation problems. Moreover, the most current information is used in making the ordering decision. The disadvantages of the system are that it requires a full requisitioning process and associated paperwork, and that the judgment of managers at the lower levels must be sound.

A *mixed*, or combination system uses both strategies at the same time. Stocks are reviewed on a fixed schedule, but an order is placed only if inventory has fallen below a fixed reorder point. In logistics jargon, such systems are known as (s,S) systems, where s is the reorder point, and S is the amount that is requisitioned. S may be a predetermined absolute quantity, but it is more common to order the difference between the stock on hand and the desired maximum amount the facility wishes to store. This latter case is called a *min-max inventory system*.

A special version of the mixed system is called the *regular replenishment system*, in which the higher-level facility visits its outlets on a regular basis, replenishing or "topping off" stock up to the maximum amount S. This system also does not require record keeping at the lower level.

6. Storekeeping

The systems for physical control of inventory at each facility will vary depending on staff and storage space available. A number of general concerns should be addressed at each location, however.

The first consideration is security of the physical inventory. Minimum security measures include—

1. Ensuring that all stock movement is authorized by locking the storeroom, limiting access to persons other than the storekeeper and his/her assistants, and ensuring that both incoming and outgoing stock matches documentation.

2. Verifying authenticity of documentation by spot-checking signatures and so forth.

3. Periodically verifying inventory records by a systematic count of physical inventory.

The second consideration is the facility's physical layout. The ideal storeroom should have—

1. Two different points for receipt and dispatch of goods to provide for orderly flow of materials and to reduce opportunities for clerical error or theft.

2. A fixed location for each stocked item, with appropriate conditions (temperature, humidity) for the items being stored.

3. Adequate space for unpacking received material and for packing outgoing shipments.

4. A separate secure area for valuable items.

5. Adequate access to all items in the storeroom to allow for *first-expiry/first-out* (FEFO) handling.

Beyond these considerations, storage and handling of materials are governed by the characteristics of the items. Items with high turnover should be most easily accessible. Heavy items should be stored near the ground. Expensive items should be stored in the most secure area. For drugs and other perishables, temperature and humidity requirements must be considered.

Perishable items must be appropriately dated, preferably with the expiration date. If the manufacturer does not include the expiration date, it should be estimated from the manufacturing date, or, if no other date is available, from the delivery date. Many logistics systems include the expiration date on the inventory file card. While this may be convenient, it is much more important to include the expiration date directly on the item itself, and to strictly enforce a FEFO issue system.

These storekeeping procedures are common sense. Nonetheless, it is usually helpful to develop simple storage guidelines, wall charts, or checklists for warehouse staff. Figures 6 and 7 provide examples.

In sum, the storekeeping function, like any other function of the logistics system, requires little more than orderliness and efficiency. A warehouse that looks neat and organized probably is neat and organized; a warehouse that does not appear to be so, certainly is not.

Figure 6.
Model Warehouse

PILLS

MFG: 12/94	MFG: 12/94
MFG: 1/95	MFG: 1/95
MFG: 2/95	MFG: 3/95
MFG: 6/95	MFG: 7/95
MFG: 12/95	MFG: 12/95

CONDOMS

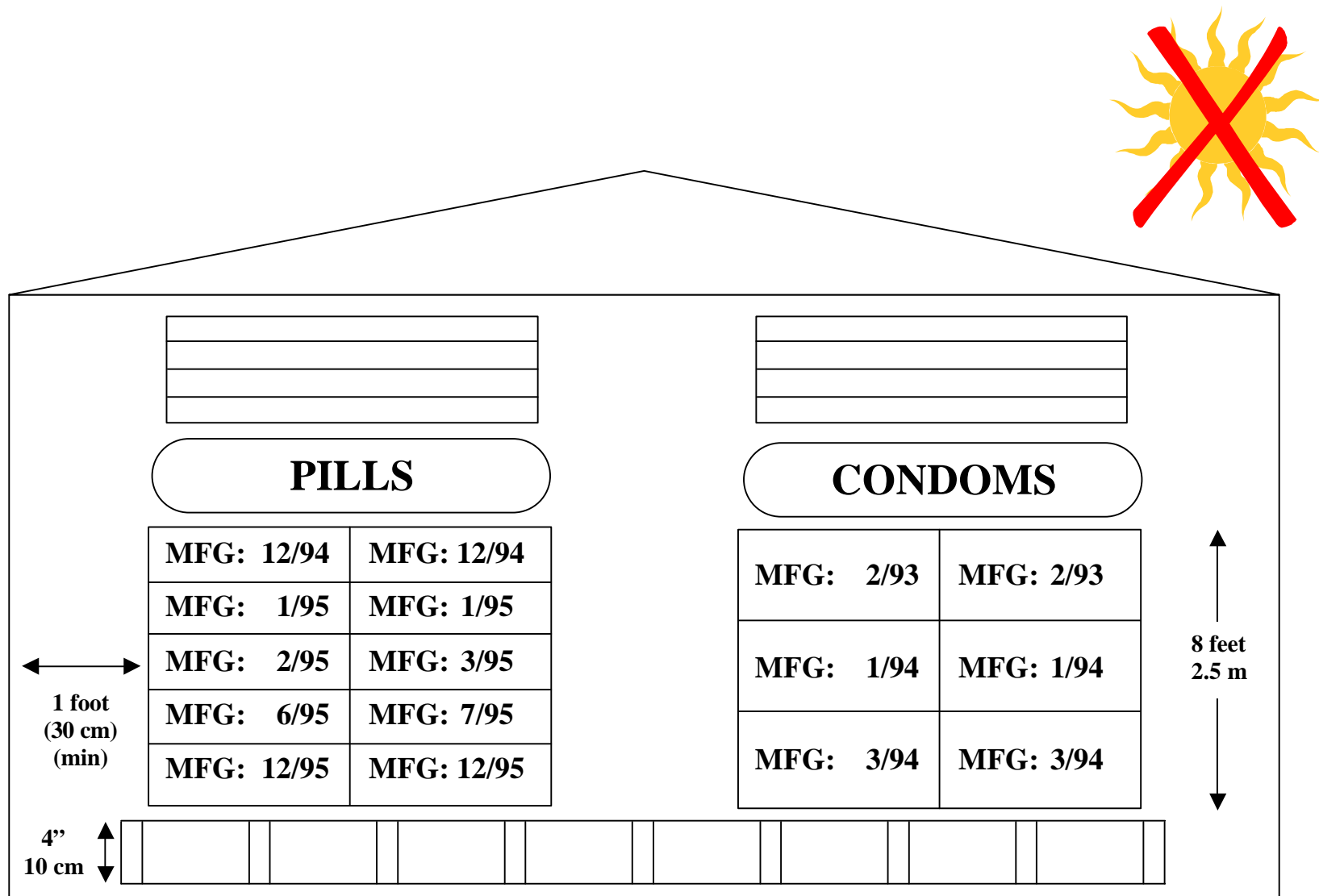|	
MFG: 2/93	MFG: 2/93
MFG: 1/94	MFG: 1/94
MFG: 3/94	MFG: 3/94

1 foot
(30 cm)
(min)

8 feet
2.5 m

4"
10 cm

Figure 7.
Guidelines for Proper Storage

1. Clean and disinfect storeroom regularly.

2. Store contraceptives in a dry, well-lit, and well-ventilated storeroom—out of direct sunlight.

3. Secure storeroom from water penetration.

4. Ensure that fire safety equipment is available and accessible.

5. Store cartons of condoms away from electric motors and fluorescent light.

6. Stack contraceptive cartons at least 10 cm (4 inches) off the floor, 30 cm (1foot) away from the walls and other stacks, and no more than 2.5 m (8 feet) high.

7. Arrange cartons so identification labels, expiry dates, and manufacturing dates are visible.

8. Store contraceptives in a manner accessible for *first-expiry, first-out* (FEFO), counting, and general management.

9. Store contraceptives separately, away from insecticides, chemicals, old files, office supplies, and other materials.

10. Separate and dispose of damaged or expired contraceptives without delay.