

Ergonomic Guidelines for Small Lot Delivery Operations

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1.0 SCOPE

This document describes the design, assessment methods and physical requirements associated with material handling systems. This would include, but not limited to manual dollies, small lot systems and kitting. All possible designs and applications could not be anticipated in creating these guidelines. Where there are questions of adherence to this document, such as use of an “off-the shelf” design, always consult the responsible Ergonomics Department.

2.0 REFERENCED DOCUMENTS

See Appendix A for references broken out by specific area. Guidelines published by Ford Motor Company, General Motors LTD and the Automotive Industry Action Group (AIAG) are the key sources for information and methods discussed in this guideline. The AIAG OHS-5: Ergonomics Guidelines for Small Lot Delivery Systems was created with the participation of General Motors, Ford, Chrysler, Toyota USA, NIOSH, Liberty Mutual Research Institute for Safety and the UAW among other participants.

3.0 GENERAL

The approach taken in this guideline is comprehensive and does not focus solely on a single aspect of the task such as the maximum weight handled or the number of cartons or containers delivered per route. The following general areas will be addressed in this booklet:

- Material locations (height, reach):
- Load (container) weight and size
- Equipment (racks, tow tractors, trailers) design and configuration;
- Handling frequency (number of items handled per unit time or route;);
- Activity and element composition and times.

Material pull systems, lean material systems, *Kanban*, Electronic Pull Systems (EPS), PPS and Just-In-Time are different terms for the same basic system. This system uses strategies for the reduction of inventory and the delivery of material to the production line as it is needed. Materials are delivered in small lots and on a relatively frequent basis to the line in pull systems. Handling of material in totes in the pull system is performed manually by workers. Pull systems typically have the following features:

- ⇒ the jobs typically have a high degree of variation in the size, weight and frequency of items handled;
- ⇒ the jobs are repetitive but not cyclical, i.e., the same lifts, weights and carry distances are not repeated at exactly the same intervals;
- ⇒ the jobs are made up of composite activities (lifting, lowering, and carrying) of which the most limiting condition ergonomically may not be clear; and,
- ⇒ there are differences in pull system strategies (i.e., coupled vs. decoupled systems) and in different delivery schedules, etc.

Terminology and Concepts

- ⇒ Various terms have been used to describe small lot operations such as: “material mall,” “material supermarket,” “central material area” and “decanted marketplace. They all refer to kanban-based small lot delivery systems. All three terms mean essentially the same thing - material pull systems with small lot delivery by means of tow tractors.
- ⇒ **“Timed Route”** – most all small lot delivery routes are timed in some way such as the provision for a route every hour, etc. In Body Shop applications a “timed route” may refer to the delivery of subassemblies to the line at regular time intervals. Such deliveries are usually not small lot but subassemblies or parts in racks.
- ⇒ **“Electronic Pull System”** is a wireless system that is used in place of kanban pull cards for small lot delivery systems in several global locations.
- ⇒ **Coupled Operations** - refers to the system where the route driver both loads the tow tractor/trailer(s) in the CMA and makes the deliveries to the line.

- ⇒ **Decoupled Operations** - refers to the system where the tow tractor/trailer(s) are loaded by an attendant in the CMA. The route driver in a decoupled system only makes deliveries on-line and does not load the tow tractor/trailer(s). Some plants use CMA operations that are located offsite from the plant. The trailers are loaded by third parties or contractors and brought into the plant for delivery.

In this document the term “marketplace” will be used to refer to small lot marshaling areas and small lot operations in general.

General Description of Route Driver Job Responsibilities in Marketplace Operations

In the coupled Marketplace, a route driver is responsible for picking totes and boxes from the roller racks and loading them onto a trailer or dolly. Once all of the required stock has been collected, the route driver delivers the totes and boxes to lineside racks or platforms. While making the deliveries, the route drivers are required to pick up the empty totes and boxes and place them on the trailer. The route driver returns to the marketplace area once the totes and boxes have been delivered and deposits the empty containers onto the dunnage return area.

The responsibilities of the route driver involve a variety of manual material handling tasks. As a result, the work area layout of the route driver should be evaluated to determine if it complies with the ergonomic guidelines that have been created. Following the work area and process recommendations will help to decrease the exposure to risk factors that have been associated with manual material handling injuries.

4.0 Material Location

Note: the term “rack” is taken to refer to the storage unit itself while “shelf” refers to a level on that unit that is used to hold material. See the following pictures of typical roller racks employed in Marketplace operations below.



The unload (pick) end of the roller rack in a Marketplace.



The loading end of the roller rack in the Marketplace. In this picture, there is an extra level of storage for extra inventory, and this stock is accessed using motorized lifting equipment.

For the picking of material in the marketplace, utilize **roller racks** (shelves have roller units) instead of flat racks for most sizes of containers. Recommendations for shelf heights are based on the height of the hands as containers or cartons are grasped and lifted out of the rack. Recommended ranges are given in **Figure 1**.

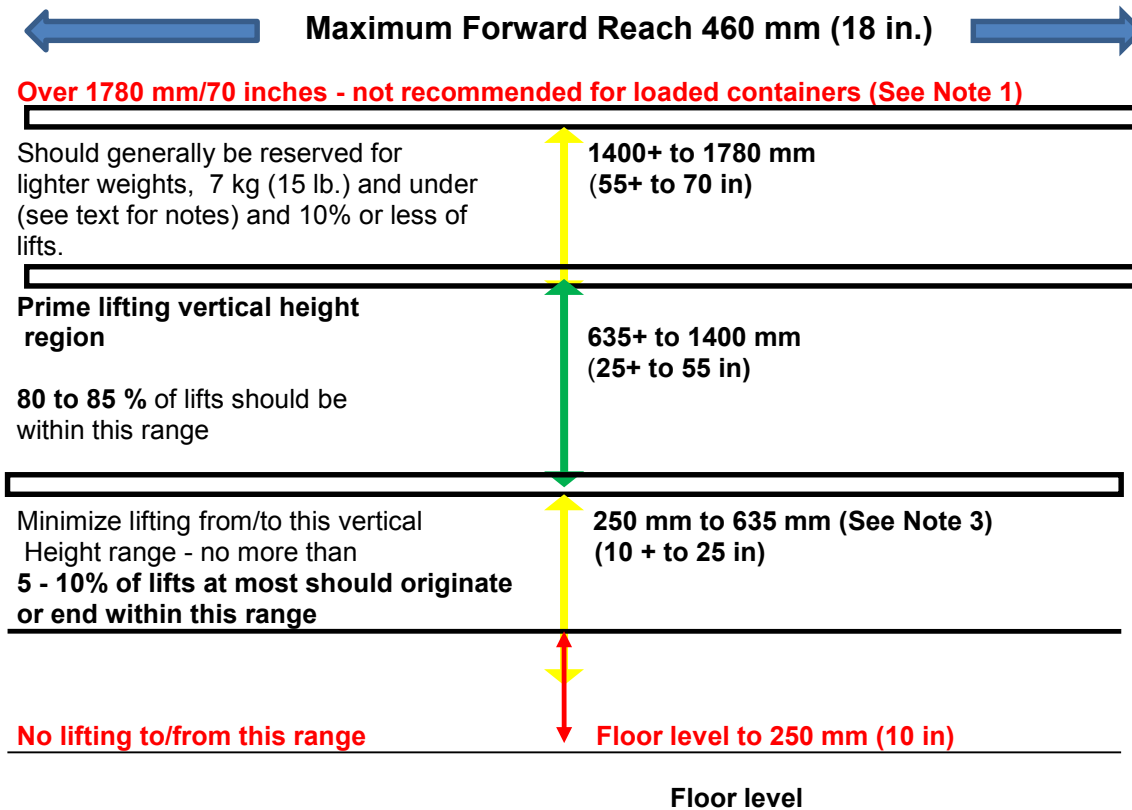
Determining Shelf Height

Consider the **heights** of containers when setting shelf heights. Most returnable containers and totes will have handles that place the hands **200 mm (8 in)** or more above shelf height when grasped. As such, the shelf may be lower than the recommended range with the hands maintained within it.

Disposable (cardboard) cartons usually lack handles or handholds of any sort and are lifted either with the hands at opposite corners or along the lower edges. Marketplace workers vary in their techniques although handling by gripping the lower edges is more common. In such a case hand height would equal shelf height. If the carton is grasped at opposite corners, one-half the height of the carton may be taken as the hand height; usually in the range of **100 to 200 mm (4 to 8 in)** above the shelf height.

The limits given in Figure 1 are based upon anthropometric, NIOSH 1991 Lift equation parameters and psychophysical lifting limits. If **only lowers** as opposed to lifts are performed from that height, the recommended weight limits may increase and demand a separate analysis.

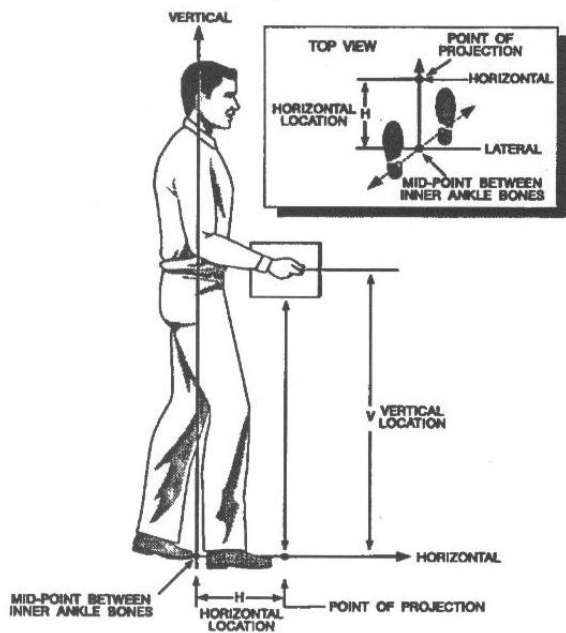
Figure 1
Recommended Range for Vertical Hand Height for lifts of loaded containers



Note 1 – Above 1780 mm/70 in may be used for empty containers that are < 4.5 kg/10 lb. Grasp height no higher than 1830 mm/72 in.

Note 2 – If totes with molded handholds are used at this height that do not allow the worker to reposition the hands during lifting, then consider re-orienting the containers or placing them at a lower height.

Note 3 – Locations with heights under 635 mm/25 in may be used for empty containers < 4.5 kg/10 lb. Avoid any lifting below 250 mm/10 in.



This figure shows how the forward reach distance is measured. The forward reach distance is synonymous to the horizontal location in the figure.

Lifts Below or Above the Recommended Vertical Limit

Minimize lifts below the hand height of 635 mm (25 in) or over 1780 mm (70 in). Lifts of **loaded or full** containers or cartons from heights below 635 mm (25 in) should constitute no more than 5 to 10 % of the total lifts. Use the space below 635 mm (25 in) or over 1780 mm (70 in) only for the storage of **empty** containers or cartons to be retrieved by the route driver. The lifts should be light enough to be performed using one hand and would not need to be counted against the total number of lifts of full containers **unless** the empty containers are in stacks that weigh over 4.5 kg (10 lb.) For items that are stored high, the grasp point should be no higher than 1830 mm (72 in). **NOTE:** While the vertical range of 635 to 1400 mm (25 to 55 in) remains the primary lifting range, some users have elected to place containers with weights of 11-14 kg (25 – 30 lb.) within a 635 to 1140 mm (25 – 45 in) vertical range.

Rack Design Features and Material Placement: Clearances

Provide sufficient clearance around cartons and containers placed within racks to allow sufficient grasp space for the hands and fingers.

- ⇒ If there is no handhold on the front of the container, then provide a span of at least 75 mm (3 in) between adjacent rows of containers (see **Figure 2**).
- ⇒ If a handhold is provided, then a minimum clearance of 25 mm (1 in) should be sufficient.

Figure 2
Clearances

