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OHS-5

Ergonomics Guidelines for the Small Lot Delivery System





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Published by: Automotive Industry Action Group 26200 Lahser Road, Suite 200 Southfield, Michigan 48033 Phone: (248) 358-3570 • Fax: (248) 358-3253

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The AIAG Safety, Health and Environmental Steering Committee and designated stakeholders approved this document for publication on March 14, 2007.

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FOREWORD

With the advent of lean manufacturing and small lot delivery systems, material handling has evolved from a mechanized system to a primarily manual system for many in the automotive industry. As a result, there are increased physical demands imposed on material handlers.

In response, auto industry manufacturers are interested in applying sound ergonomic practices and principles to their material handling system designs. A common goal is to minimize ergonomics-related occupational risk factors and maximize system productivity.

The intent of this document is to assist manufacturers in achieving these goals. The recommendations relate to material handling system design, task design, and task ergonomic risk analysis.

Application of these guidelines should result in improved safety, performance, and productivity when properly administered.

Users of this guideline may include packaging engineers, industrial engineers, ergonomists, ergonomics coordinators, material handlers, supervisors, operators, and worker representatives.

Each AIAG member or SLDS Document User must assess their situation and determine the applicability of this document. Most will find it to be of significant benefit when designing small lot delivery systems. While the document may also serve as a useful tool to assess existing situations, things like pending model change, technology and cost issues, etc will all have to be decided by the using company.

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ACKNOWLEDGEMENTS

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INTRODUCTION

Document Overview

This easy-to-use guideline provides not only a systematic process for analyzing and evaluating musculoskeletal injury (or disorder) risk factors in Small Lot Delivery Systems (SLDS) but also recommendations for the design of material handling tasks and material handling systems. This guideline contains recommendations, not mandates, which are applicable during material handling system 'design' and 'redesign' activities.

The scope of this document includes the following:

- Analysis of lift, lower, and carry tasks of full and empty containers
- Assessment of manual material handling jobs involving a combination of multiple different manually handled containers (weight, type, size, location, frequency)
- Analysis of delivery points (lift/lower origins, height, reach, and clearance)
- Depalletization process
- Tugger and trailer selection

Section 1 provides a basic description of a small lot delivery system. Section 2 provides ergonomic guidelines and recommendations aimed at reducing the musculoskeletal injury (or disorder) risk factors associated with individual tasks. It discusses the following topics:

- Rack and shelf design
- Horizontal reaches
- Container and tote characteristics
- Tugger and trailer characteristics
- Depalletizing stock
- Manual material handling techniques

Even if conditions are designed to optimize each lift to the degree feasible, the cumulative impact of multiple lifts may pose a hazard. To address this issue, Section 3 discusses analysis of the ergonomics of the cumulative activity of material handlers.

The recommendations in this document are taken from a variety of existing sources including the *Applications Manual for the Revised NIOSH Lifting Equation* (http://www.cdc.gov/niosh/94-<u>110.html</u>). These guidelines are designed to accommodate the physical capacity of at least 75 percent of the female population (encompassing approximately 99 percent of the male population) and accommodate the anthropometry of all but the smallest 5 percent of women and the largest 5 percent of men. Anthropometric data used to generate these guidelines are derived from U.S.

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populations¹. (1 inch (2.5 cm) was added to all anthropometric data to account for industrial footwear.)

SLDS are characterized by many complexities, including:

- The non-cyclical nature of a material handler's job
- Tasks that combine two or more activities such as lifting, lowering, carrying, walking, driving, etc.
- Variation in the roles and responsibilities of material handlers
- Frequently changing delivery schedules and routes.

To account for these, other analyses may be useful in addition to the ones presented in this document.

¹ Pheasant, Stephen. (2001). *Bodyspace: Anthropometry, Ergonomics and the Design of Work* (Second Edition). Philadelphia: Taylor and Francis Inc.



1 SMALL LOT DELIVERY SYSTEM (SLDS)

1.1 Background and Description

The terms *Small Lot Delivery System, material pull-system, lean material system, Kanban, Just-In-Time,* and *Decanted Card Marketplace* all describe essentially the same type of material movement system. Each system involves a set of strategies for reducing inventory and delivering material to the point of production when it is needed. Each system also shares similar ergonomic concerns related to manual material handling.

For the purpose of this document, *Small Lot Delivery System (SLDS)* will be the term used to describe a manual material handling system. **SLDS** are defined as:

Systems in which stock handlers manually and repetitively load containers in small lots from a storage area (per pull signal or Kanban) and deliver to the appropriate locations via a tugger and trailers. The deliveries are made multiple times throughout an eight (8) hour shift.



The SLDS uses small containers that are manually handled by individuals and transported on a cart (tugger, dolly, etc.). An SLDS is designed to replace and/or supplement bulk-delivery of material in large containers transported by forklifts. Two fundamental elements of an SLDS in an industrial/manufacturing environment are:

1. A designated material storage area in the plant in which racks are used to present manually handled containers/totes to a route driver. (Note: The designated small lot material storage area can be located off-site. In this case, a pull signal prompts the shipment of the small lot containers/totes to a plant, where they are delivered to the point of use via a route driver.)

2. A route driver who is responsible to deliver containers/totes to the point of use.

A typical SLDS process is shown below.



Figure 1: Activity Diagram for Small Lot Delivery Decoupled System



1.2 Roles and Responsibilities

The following responsibilities exist in most SLDS. However, the names of the jobs may vary across employers.

Dock Material Handler:

This person is responsible for receiving incoming material (in the form of palletized containers) off the dock and delivering the pallets to the 'market stocker' located in the material storage area. Also, the *dock material handler* is responsible for loading trucks to return empty palletized containers to their supplier.

Market Stocker:

This is the person who receives the palletized containers (incoming material from the *dock material handler*) and depalletizes them by removing each container from the pallet and placing the containers onto the storage racks in the designated storage locations. Also, the *market stocker* is responsible for palletizing the empty containers to be returned to the dock.

Market Attendant:

The *market attendant* is responsible for loading full containers onto the trailer and unloading empty containers from the trailer.

Route Driver:

The *route driver* is responsible for driving the trailers to each stop along the designated route, placing full containers on lineside racks for the operator's use and, picking up the empty containers to return to the market.

An SLDS can be 'coupled' or 'decoupled.' (A decoupled SLDS is shown above in Figure 1.) In a decoupled SLDS, roles are exactly as described above. In a 'coupled' SLDS, the *market attendant* position does not exist and it becomes an additional responsibility of the *route driver* to pick and place the full containers for delivery onto the trailer and to remove the empty containers that are returned to the market place from the previous route.

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2 ERGONOMIC GUIDELINES / RECOMMENDATIONS

This section provides ergonomic guidelines and recommendations aimed at reducing the musculoskeletal injury (or disorder) risk factors associated with individual (primarily lifting) tasks. It discusses the following topics:

- Roller Racks and Shelves
- Horizontal Reaches
- Container and Tote Characteristics
- Tugger and Trailer Characteristics
- Depalletizing Stock
- Manual Material Handling Techniques

2.1 Roller Racks and Shelves

Roller Rack Advantages

Most SLDS use shelves with roller units, called roller racks, for container storage. Roller racks have an ergonomic advantage over flat shelves in that they allow operators to pull containers more easily toward themselves before lifting them. This allows lifting to occur with minimized horizontal reach. An advantage of sloped roller racks is that they allow containers to flow by gravity to the picking operator, eliminating the need to pull/push the containers across the shelves. For ease of part retrieval, another option may include a tilt feature on the end of a roller rack.

Rack and Shelf Height Design Considerations

Whether roller racks or flat shelves are used, one of the more important considerations in rack design and configuration is the height of the hands during lifting to/from the racks. In general, a person's material handling capacity is greatest when hand height is between the knees and shoulders. Lifting frequently to/from below knee height increases fatigue and may increase back and other physical complaints. Lifting above shoulder height reduces lift strength and increases the risk of losing control of the load. It is recommended that:

- Shelves be positioned to allow an operator to place all containers within an optimal *hand* height, *not shelf* height, of 22-50 inches (56-127 cm).
- If constraints do not allow all containers to be placed in the optimal range, it is recommended that the heaviest containers be given preference.
- Lighter containers, up to 20 lbs (9.1 kg), may be placed in the 50-70 inches (127-178 cm) hand height range. The frequency of lifts in this range should be minimized.
- Handling containers at a hand height greater than 70 inches (178 cm) is not recommended. Hand heights below 22 inches (56 cm) should be used only with empty containers.
- To avoid excessively low reaches, the grasp point of these empty containers should be 10 (25 cm) inches or higher from the standing surface.

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Recommended hand height ranges are shown in Figure 2. Again, Figure 2 refers to *hand* height, *not shelf* height.¹

Figure 2: Recommended Hand Height/Container Weight Ranges for Small Lot Delivery Lifting/Lowering Tasks



(Note: Hand heights, not shelf heights, are shown.)

¹ Hand height (height of the large middle knuckle of the hand) should be measured from the standing surface.