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Standard Operating Procedure
for
Material Handling and Storage

REVISION

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1. PURPOSE AND SCOPE

1.1 Purpose

1.1.1 The purpose of this document is to establish minimum work practices and procedures for the handling and storage of materials in order to protect the health and safety of employees, whose work requires that they lift, move or handle materials at the College of Nanoscale Science and Engineering (CNSE) facility.

1.1.2 It is not the purpose of this document to supersede any other CNSE document that relates to material handling or storage. These documents include but are not limited to:

- a. **EHS-00011**: Gas Cylinder Handling
- b. **EHS-00005**: Chemical Handling and Storage
- c. **EHS-00040**: CNSE Crane Work Permits
- d. **EHS-00035**: Use of Powered Industrial Vehicles
- e. **EHS-00067**: Use of Overhead and Gantry Cranes, Hoists, Lifts and Slings

1.2 Scope

1.2.1 This document shall apply to routine material handling and routine material handling areas, and shall not apply to installation of equipment.

1.2.2 The material handling and storage procedures detailed in this document shall apply to operations that lift or move materials. These include but are not limited to:

- a. Traffic
- b. Stockroom
- c. Facilities
- d. Chemical Handlers
- e. Technicians
- f. Metrology
- g. Custodial
- h. Contractors and Field Services
- i. Office Workers

2. RESPONSIBILITIES

2.1 Environmental, Health and Safety Department (EHS)

2.1.1 The Environmental, Health and Safety Department shall provide, upon request, material handling information to supervisors and managers. This information shall include but not be limited to identification of material handling hazards, material handling techniques and applicable regulatory requirements.

2.2 Supervisors and Managers

2.2.1 Supervisors and managers shall be familiar with material handling hazards and material storage hazards that exist in their respective areas. Supervisors and managers shall ensure that proper equipment is available, and proper conditions exist, for employees to safely perform tasks.

2.2.2 Supervisors shall instruct employees on correct procedures related to material handling and material storage.

3. DEFINITIONS

3.1 Handler shall mean an individual handling a load.

3.2 Load shall mean an item, or items being handled using either manual or mechanical methods.

3.3 Material Handling shall mean movement of a load using either manual methods or mechanical methods.

3.4 Mechanical Device shall mean a hand-truck or cart, a powered industrial truck, a crane or a hoist, a freight elevator, or a conveyor.

3.5 Mechanical Methods shall mean the movement of loads utilizing a mechanical device.

3.6 Powered Industrial Truck shall mean a fork truck, a tractor, a platform lift truck, a motorized hand truck, or any other specialized industrial truck powered by an electric motor or an internal combustion engine.

- 3.7 Sling shall mean an assembly that connects a load to a mechanical device, and which is constructed of any of the following materials:
- a. Alloy steel chains
 - b. Wire ropes
 - c. Metal mesh
 - d. Natural or synthetic fiber rope (conventional three strand construction)
 - e. Synthetic web (nylon, polyester, and polypropylene)

4. **MECHANICAL METHODS**

- 4.1 Whenever practical, mechanical methods of material handling shall be chosen over manual methods. This is especially true for loads that weigh more than 42 pounds, and for repeated handling of loads.
- 4.2 Mechanical methods of material handling shall be implemented in accordance with the requirements of other applicable documents. These documents include but are not limited to the following:
- a. **EHS-00011**: Gas Cylinder Handling
 - b. **EHS-00005**: Chemical Handling and Storage
 - c. **EHS-00040**: CNSE Crane Work Permits
 - d. **EHS-00035**: Use of Powered Industrial Vehicles
 - e. **EHS-00067**: Use of Overhead and Gantry Cranes, Hoists, Lifts and Slings
- 4.3 Mechanical devices used for material handling shall be inspected in accordance with applicable specifications. Any deficiencies shall be reported to the Supervisor. The mechanical device shall not be used until the deficiencies are corrected.
- 4.4 Modifications and additions that affect capacity and safe operation of any mechanical device shall not be performed without the manufacturer's prior written approval.
- 4.5 The weight of the load being lifted or carried shall not exceed the stated load capacity of the mechanical device being used.

- 4.6 A load, or separate items of a load (e.g. boxes, bags, etc.) shall be prevented from moving during handling, if necessary. Methods to prevent movement include but are not limited to use of plastic wrap or straps.
- 4.7 Hand-trucks and carts shall be pushed rather than pulled.
- 4.8 Only one hand-truck or cart shall be pushed at any one time.
- 4.9 The height of a load shall not obstruct the handler's view of the direction of travel.
- 4.10 If the handler is using a hand-truck or hand-cart, and their view of the direction of travel is obstructed, they shall do either of the following:
- 4.10.1 Divide the load into two or more smaller loads, if possible, such that the height of each load does not obstruct the handler's view of the direction of travel, or
- 4.10.2 Obtain assistance from another individual for purposes of guiding them, and to ensure that the path of travel is clear.
- 4.11 A handler using a powered industrial truck may drive in whichever direction (forward or reverse) that provides the best visibility of the direction of travel.
- 4.12 In areas where mechanical methods are used to handle material such as loading docks and designated material handling routes, clearance signs shall be provided to warn of vertical clearance limits.
- 4.13 Aisles and passageways shall be kept free from obstructions, and floor surfaces of aisles and passageways shall be kept in good repair.
- 4.14 Permanent aisles and passageways shall be appropriately marked.
- 4.15 Dock boards and bridge plates shall be properly secured to prevent their movement while being utilized.
- 4.16 Slings**
- 4.16.1 For the use of slings at CNSE please refer to EHS-00067: Use of Overhead and Gantry Cranes, Hoists, Lifts and Slings, Section 7.
- 4.17 Conveyors**
- 4.17.1 Each workstation of a conveyor shall be equipped with an emergency button or pull cord designed to stop the conveyor.
- 4.17.2 All segments of conveyors that are accessible to individuals shall be equipped with emergency stop cables designed to stop the conveyor.

- 4.17.3 Emergency stop features of conveyors shall be designed so that they must be reset before the conveyor can be restarted.
- 4.17.4 Authorized personnel shall inspect the conveyor and clear stoppages before restarting the conveyor that has stopped due to an overload.
- 4.17.5 Individuals shall not ride on a conveyor.
- 4.17.6 Guarding shall be installed in areas where conveyors pass over work areas or aisles to prevent individuals from being struck by falling objects.

5. MANUAL METHODS

5.1 Lifting a Load

- 5.1.1 The requirements of this section shall not apply to loads that weigh 15 pounds or less.
- 5.1.2 Do not attempt to manually lift and load that weighs more than 42 pounds.
- 5.1.3 Request assistance when manually lifting a load, if you deem it to be necessary. Factors to consider include but are not limited to:
 - a. The weight of the load
 - b. The distributed weight of the load
 - c. The shape of the load (materials greater than 10ft in length)
 - d. Protruding parts
 - e. Height from which the load is to be lifted
 - f. Height to which the load is to be placed
 - g. The distance the load is to be carried
 - h. The condition of the path of travel
 - i. The composition of the load (e.g. composed of loose material, composed of smaller items such as boxes, bags, bundles, etc.)
- 5.1.4 If a material greater than 10ft in length needs to be manually carried then 2 handlers must carry the load together. Each person must support one end of the material.
- 5.1.5 If two people are lifting a load, they should be approximately the same height.

- 5.1.6 Do not attempt to lift a load if an obstacle is positioned between yourself and the load. Move the obstacle or reposition yourself between the load and the obstacle.
- 5.1.7 Avoid lifting a load that is stored above the height of your shoulders. Under these circumstances, use a ladder to reposition yourself so that you will not need to lift the load above your shoulders.
- 5.1.8 If a load is to be carried after being lifted, check the entire path of travel to ensure that the path is free of obstructions and that the footing is solid. Movable obstacles should be cleared from your path of travel and locations of immovable obstacles should be noted.
- 5.1.9 Stand squarely in front of the load, as close as possible, with your feet approximately one “shoulder-length” apart.
- 5.1.10 Bend at your knees while keeping your back straight, and grasp the load.
- 5.1.11 Keep the load close to your body.
- 5.1.12 Lift the load gradually by straightening your legs while keeping your back straight, and avoiding quick, jerky motions.
- 5.1.13 If the load seems too heavy or bulky at this point then mow the load back to its’ resting surface, and get assistance or use a mechanical device.
- 5.1.14 If the load seems reasonable to handle at this point then continue lifting the load.
- 5.1.15 Do not twist your body when handling a load. If you need to change your facing direction, then change the position of your feet.

5.2 Carrying a Load

- 5.2.1 Before lifting a load, check the entire path of travel to ensure that the path is free of obstructions and that the footing is solid. Movable obstacles should be cleared from your path of travel and locations of immovable obstacles should be noted.
- 5.2.2 If carrying a load will obstruct your view of the path of travel, mechanical methods should be used instead. If mechanical methods are not feasible, obtain assistance from another individual in order to guide you, and to ensure that the path of travel is clear.
- 5.2.3 While carrying a load, hold it firmly and as close to your body as possible.

- 5.2.4 Do not twist your body when carrying a load. If you need to change your direction of travel then change the position of your feet.

5.3 Lowering a Load

- 5.3.1 Face the spot you have chosen to lower the load.
- 5.3.2 Lower the load by bending at your knees, keeping your back straight.
- 5.3.3 Keep your fingers away from the bottom of the load as you set it down.

5.4 Moving a Load

When transporting a load from one location from another, use a cart. It is always preferable to push rather than pull because pushing is less stressful, since the weight of the body is used and a more neutral posture can be maintained. Wear appropriate footwear to provide traction and prevent slippage. Aisles should be at least 4' wide.

5.4.1 Cart Design

- a. Cart should have a dead-man brake system when used on inclined surfaces.
- b. Cart handholds should:
 - Be at about elbow height (~53")
 - Be as close to outer edge as possible (avoid crushing injuries) while being able to leverage for turning and positioning
 - Have no sharp edges or ridges. The fingers and palm should contact handle without overlapping
- c. Cart height should be such that employee can see over cart and load otherwise follow 4.10.1 and 4.10.2.
- d. Cart should have 4 wheel/casters and a proactive wheel maintenance program should be followed.

- 5.4.2 The **maximum initial force** (the force required to overcome inertia, static friction, and physical interferences) suggested varies depending on push distance, push frequency, handle height, and gender. For a female pushing a load with a 53" handle height about 200 feet, the maximum initial force should be no greater than:

- a. 30 pound-force (lbf) for 1 push every 2 minutes
- b. 41 lbf for 1 push in an 8-hour shift

Push-pull calculators can be used to help assess forceful exertion during push, pull, or carry tasks. Calculating forces based on individual characteristics, duration and frequency of task can be performed at: <http://www2.worksafebc.com/ppcc/footer/about.htm>

NOTE: Push force does not equal the weight on the cart. Use a push-pull gauge to check the forces.

5.4.3

Based on experiments performed at CNSE, the following information provides examples of the pound-force needed to push and pull a total of 130 pounds in various scenarios. A cart with swivel castors weighing approximately 50 lbs with four full FOUPs of 300mm wafers (a full FOUP with 25 wafers weighs approximately 20 lbs), were pushed on tiled and carpeted surfaces and the forces were measured. Inclined surfaces were at or less than 3 degrees.

Initial forces observed for pushing and pulling on:

- Flat carpeted surface
Pull - 13.2 lbf, 14.1 lbf
Push - 12.0 lbf, 14.8 lbf
- NFN-to-NFS ramp with carpeted surface
Pull - 21.0 lbf, 23.2 lbf
Push - 17.5 lbf, 18.9 lbf
- Flat tiled surface
Pull - 9.8 lbf, 12.6 lbf
Push - 10.8 lbf, 10.2 lbf
- NFN ramp with tiled surface
Pull - 21.0 lbf, 22.0 lbf
Push - 21.0 lbf, 21.3 lbf
- NFN-to-NFX ramp with tiled surface
Pull - 20.9 lbf, 20.1 lbf
Push - 20.2 lbf, 19.8 lbf

Rotating the swivel caster on carpet added ~3 lbf to maximum initial force. Rotating the swivel caster on tile added an indistinguishable amount to the initial force.

Sustained Force is the force required to keep the object in motion. Examples of approximate sustained force needed are listed for the following scenarios for both pull and push:

- Flat carpeted surface: 7 lbf

- Flat smooth tiled surface: 5 lbf
- Ramp with carpeted surface: 11 lbf
- Ramp with smooth tiled surface: 9 lbf

6. PACKING AND UNPACKING MATERIAL

- 6.1 Hand protection shall be worn when handling, packing or unpacking loads with rough edges or surfaces.
- 6.2 Eye protection shall be worn when strapping and unstrapping materials and/or containers.
- 6.3 Be aware of sharp corners, edges and staples when packing or unpacking material.
- 6.4 Use cutting tools that are specifically designed for safe cutting, such as strap cutters.
- 6.5 When using a utility knife, cut in a direction away from your body.

7. STORAGE

- 7.1 Storage of material shall not create a hazard. Bags, containers, bundles, etc. stored in tiers shall be stacked, blocked, interlocked and limited in height so that they are stable and secure against falling, sliding or collapse.
- 7.2 Bagged material shall be stacked by stepping back the layers and cross-keying the bags at least every ten layers.
- 7.3 Material that cannot be stacked safely due to size, shape or fragility shall be stored on shelves or in bins.
- 7.4 Pipes and bars shall not be stored in racks that face the main aisles, which could create a hazard to passers-by when supplies are being removed.
- 7.5 Storage areas shall be kept free from accumulation of materials that constitute hazards from tripping, fire or explosion.
- 7.6 All stored material shall be a distance of 18 inches below ceilings, suspended ceilings, or sprinkler heads.
- 7.7 Boxed material shall be banded or held in place using crossties or shrink wrap.

- 7.8 Drums and barrels shall be stored in accordance with Specification EHS-00005: Chemical Handling.
- 7.9 Employees shall use a step ladder or step stool to reach loads that are located above the height of their shoulders.
- 7.9.1 Ladders shall be visually inspected prior to use at the beginning of each workday. Any deficiencies shall be reported to the Supervisor, and the ladder shall not be used until the deficiencies are corrected.
- 7.9.2 Choose an appropriately sized ladder based on the height that needs to be reached. While on a ladder, do not lean or reach beyond the length of your extended arm.
- 7.10 General Guidelines for Storage in Office Settings**
- 7.10.1 Storage cabinet drawers should be interlocked such that only one drawer at a time can be opened. Storage cabinets that do not have this feature should be secured to prevent the cabinet from tipping over.
- 7.10.2 Storage cabinets should be filled beginning with the bottom drawer or bottom shelf in order to prevent the cabinet from tipping over.
- 7.10.3 The most frequently used material should be placed at the middle height of the storage cabinet.
- 7.10.4 Storage cabinets should be emptied beginning at the top drawer or top shelf in order to prevent the cabinet from tipping over.
- 7.10.5 Loose material shall be stored below shoulder height to minimize potential for loose material falling onto persons pulling stock.