

GCC/IBT/Labor Institute
Systems of Safety Materials Handling,
Hazardous Materials, Cranes and Slings
Awareness Training



Compiled by The Labor Institute and the
Graphic Communications Conference of International
Brotherhood of Teamsters (GCC/IBT)
OSHA Grant # SH-19486-09-60-F11
Draft 1.1

April 2010

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Introduction

Why Is This Training Taking Place?

The Graphic Communications Conference of the International Brotherhood of Teamsters (GCC/IBT), in cooperation with The Labor Institute of New York, received a two-year training grant from the U. S. Department of Labor's Occupational Safety and Health Administration (OSHA). OSHA announced a request for grant applications under its Susan Harwood Training Grant Program. GCC/IBT and The Labor Institute successfully applied for a grant to train workers and employers in materials handling including cranes, hazardous materials and slings in high hazard worksites as identified by OSHA and represented by the Graphic Communications Conference of International Brother of Teamsters. This grant was awarded in September 2009.

To accomplish these goals, GCC/IBT workers will be trained as trainers to train their peers, their managers and other workers in hazard awareness and prevention based on a Systems of Safety philosophy and perspective.

Worker-Trainers

The Labor Institute has a long history of involvement with health and safety efforts and training. **It is our belief that our membership is really the best resource for making our facilities safe and for protecting the community from harm.**

Together with GCC-IBT we are putting that belief into practice. That is why the GCC-IBT/Labor Institute* program is committed to conducting the training by GCC-IBT rank-and-file worker-trainers. In addition, the training will be done using a non-lecture approach, called the Small Group Activity Method, through which workers truly participate in their own education.

The average time a task takes to be worked through is 20 to 35 minutes. Activities have at least one task, sometimes more. A normal training day is eight hours, which is about five Activities including breaks and lunch.

* The Labor Institute is a nonprofit educational group, located in New York City, that provides innovative worker-oriented educational programs to unions and community groups around the country. The staff of the The Labor Institute are dues-paying members of USW Local 4-149.

The Small Group Activity Method (SGAM)

The training activities in this workbook use the Small Group Activity Method.

Why a Non-Lecture Approach?

Worker-oriented educators have learned the hard way that working adults learn best in situations that maximize active participation and involvement. The trainer-centered, lecture-style teaching methods used in most programs actually hurt the learning process, promote passivity on the part of workers, de-value our knowledge and skills and make us feel inadequate. As we all know, too many lectures “go in one ear and out the other.”

The Small Group Activity Method puts the learner in the center of the workshop. Participants are put to work in the workshop solving real-life problems, building upon our own skills and experiences. Instead of learning by listening, as we are expected to do in a lecture-style course, we learn by doing.

Origins

The Small Group Activity Method is based on a training procedure developed by England's Trade Union Congress (TUC). (The TUC is the organizational equivalent of the AFL-CIO.) The TUC used this participatory, non-lecture method to train over 250,000 shop stewards on health and safety issues in the 1970s and early 1980s. The Labor Institute in New York, which had pioneered a similar method around economic issues for workers, further developed the procedure into the Small Group Activity Method.

Through the use of this non-lecture approach, The Labor Institute has succeeded in training workers to be trainers. Since 1980, The Labor Institute has shared this method with over 200 different unions and community groups in the United States and Canada.

continued

The Small Group Activity Method (SGAM) (*continued*)

Basic Structure

The Small Group Activity Method is based on **Activities**. An Activity can take from 30 minutes to an hour. Each Activity has a common basic structure:

- **Small Group Tasks**
- **Report-Back**
- **Summary**

1. Small Group Tasks: The workshop always operates with people working in groups at tables. (Round tables are preferable.) Each Activity has a task, or set of tasks, for the groups to work on. The idea is to work together, not to compete. Very often there is no one right answer. The tasks require that the groups use their experience to tackle problems and make judgments on key issues. Part of the task often includes looking at factsheets and reading short handouts.

2. Report-Back: For each task, the group selects a **scribe** whose job it is to take notes on the small group discussion and report back to the workshop as a whole. (The report-back person was first called the “scribe” by an OCAW worker-trainer during a 1982 session with Merck stewards in New Jersey.) During the **report-back**, the scribe informs the entire workshop on how his or her group tackled the particular problem. The trainer records these reports on large pads of paper in front of the workshop so that all can refer to it. After the scribe’s report, the workshop is thrown open to general discussion about the problem at hand.

3. Summary: Before the discussion drifts too far and wide, the trainer needs to bring it all together during the **summary**. Here, the trainer highlights the key points, and brings up any problems and points that may have been overlooked in the report-back. Good summaries tend to be short and to the point.

Activity 1: Hazards of Material Handling including Cranes, Slings and Hazardous Materials

Purpose:

To understand the potential hazards of handling and storing materials.

This Activity has two tasks.

Task 1

Factsheet Reading Method for Task 1:

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: 1) The knowledge and experiences workers bring into the room and 2) the factsheets contained in your workbooks.

The factsheet method, described below, builds upon your knowledge through the introduction of new ideas and concepts.

The process is as follows: Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table. The idea is for each of you to take ownership and responsibility for the information contained in your factsheets and to describe it to the others in your group.

Factsheets will be assigned as follows:

Once everyone has read their assigned factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in order as they were assigned (1 through 7), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Starting with the scribe and moving to the left, count out loud from 1 to 7. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5, the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 7 on the following pages.

1. Vital to our Operations

Handling and storing materials involves diverse operations such as:

- Hoisting tons of paper rolls with a crane,
- Driving a truck loaded with shredded paper sheets,
- Manually carrying bags and material and
- Stacking drums, barrels, or skids.

The efficient handling and storing of materials is vital to industry. These operations provide a continuous flow of raw materials, parts and assemblies through the workplace and ensure that materials are available when needed. Yet, the improper handling and storing of materials can cause costly injuries.

2. Potential Hazards of Material Handling

Workers frequently cite the weight and bulkiness of objects being lifted as major contributing factors to their injuries. In 1990, back injuries resulted in 400,000 workplace accidents.

The second factor frequently cited by workers was body movement. Bending, followed by twisting and turning, were the more commonly cited movements that caused back injuries. Back injuries accounted for more than 20 percent of all occupational illnesses, according to data from the National Safety Council.

3. Major Material Handling Accident Causes

A material handling accident analysis revealed that the six major problem areas which accounted for a large number of accidents include:

- Up-down motions used to lift and place load and unload trucks, shelves, carts or bins.
- Inadequate positioning to move an object.
- Push-pull motions used to move carts or material on conveyors on a level surface.
- Inadequate team handling: Two or more people assigned but moving material without success.
- Inadvertent actions: Misperceptions in size, weight or balance.
- Outsize of bulky material: Attempting to move materials beyond the individuals ability without success.

In addition, workers can be injured by falling objects, improperly stacked materials or by various types of equipment.

When manually moving materials, workers should be aware of potential injuries, including the following:

- Strains and sprains from improperly lifting loads or from carrying loads that are either too large or too heavy.
- Fractures and bruises caused by being struck by materials or by being caught in pinch points; and
- Cuts and bruises caused by falling materials that have been improperly stored, or by incorrectly cutting ties or other securing devices.

Source: "Army Material Handling Accident Analysis" conducted by Allen McMichael, Dave Durbin, and Gerald Gamache, *Human Factors and Ergonomics Society Annual Meeting Proceedings*, 1988, vol. 32, no. 15, pp. 889-891(3).

4. Moving Materials

When manually moving materials, workers should seek help:

- When a load is so bulky it cannot be properly grasped or lifted,
- When they cannot see around or over it or
- When a load cannot be safely handled.

When mechanically moving materials, avoid overloading the equipment by letting the weight, size and shape of the material being moved dictate the type of equipment used for transporting it.

5. Handling Materials, Blocking and Handles and Holders

All materials handling equipment have rated capacities that determine the maximum weight the equipment can safely handle and the conditions under which it can handle those weights.

The equipment-rated capacities must be displayed on each piece of equipment and must not be exceeded except for load testing.

Blocking

When a worker is placing blocks under raised loads, they should ensure that the load is not released until his or her hands are clearly removed from the load. Blocking materials and timbers should be large and strong enough to support the load safely. Materials with evidence of cracks, rounded corners, splintered pieces or dry rot should not be used for blocking.

Handles and Holders

Handles and holders should be attached to loads to reduce the chances of getting fingers pinched or smashed.

For loads with sharp or rough edges, wear gloves or other hand and forearm protection. To avoid injuries to the hands and eyes, use gloves and eye protection. When the loads are heavy or bulky, the mover should also wear steel-toed safety shoes or boots to prevent foot injuries if the worker slips or accidentally drops a load.

6. Crane Hazards

Only thoroughly trained and competent persons are permitted to operate cranes.

When loads are crated or covered, operators should know what they are lifting and what it weighs.

Plan lifts before starting them to ensure that they are safe. Take additional precautions and exercise extra care when operating around power lines.

Inspection procedure for cranes fall into two categories:

- Frequent inspection should be performed daily to monthly intervals. According to OSHA standard 1910.179(j)(2), the following items which should be inspected include deterioration or leakage in lines, tanks, valves, etc., hooks with deformation or cracks, hoist chains, rope reeving, all functional operating mechanisms.
- Periodic inspection should be performed in one to twelve month intervals. According to OSHA standard 1910.179(j)(3), deformed, cracked or corroded members, loose bolts, excessive wear on brake system parts, worn or worn sheaves and drums, etc.

A written record of periodic crane inspections should be kept.

All cranes must be inspected frequently by persons thoroughly familiar with the crane, the methods of inspecting the crane and what can make the crane unserviceable.

The severity of use and environmental conditions should determine inspection schedules of cranes.

Some mobile cranes cannot operate with outriggers in the traveling position.

When used, the outriggers must rest:

- On firm ground,
- On timbers or
- Be sufficiently cribbed to spread the weight of the crane and the load over a large enough area.

This will prevent the crane from tipping during use.

Hoisting chains and ropes must always be free of kinks or twists and must never be wrapped around a load.

Loads should be attached to the load hook by slings, fixtures or other devices that have the capacity to support the load on the hook.

Sharp edges of loads should be padded to prevent cutting slings.

Proper sling angles shall be maintained so that slings are not loaded in excess of their capacity.

All rim wheels, multi and single piece shall be removed from service if it is showing any of the following defects:

- Crack at welds;
- Cracked or broken components;
- Bent or sprung components caused by mishandling, abuse, tire explosion or rim wheel separation; and
- Component pitted due to corrosion or other structural damage that would decrease its effectiveness.

In a NIOSH study completed between 1992 and 2002, 719 cases were identified in which a mobile crane was the primary or secondary source of a fatal injury. The causes of these accidents include being struck by a falling or swinging object, contact with electrical current, fall from crane structure, moving crane from site to site and getting caught in crane moving parts.

Source: NIOSH Alert *Preventing Worker Injuries and deaths from mobile crane tip-over, Boom Collapse, and Uncontrolled Hoisted Loads*, NIOSH Publication No. 2006-142 and OSHA 29 CFR 1910.179.

7. Conveyor Hazards

When using conveyors:

- Workers' hands may be caught in nip points where the conveyor runs over support members or rollers;
- Workers may be struck by material falling off the conveyor; or
- They may become caught on or in the conveyor, thereby being drawn into the conveyor path.

Conveyor hazards such as nip points should be guarded whenever possible, as long as the guard would not create a greater hazard.

To reduce the severity of an injury, an emergency button or pull cord designed to stop the conveyor must be installed at the employee's workstation.

Continuously accessible conveyor belts should have an emergency stop cable that extends the entire length of the conveyor belt so that the cable can be accessed from any location along the belt.

The emergency stop switch must be designed to be reset before the conveyor can be restarted.

Before restarting a conveyor that has stopped due to an overload, appropriate personnel must inspect the conveyor and clear the stoppage.

Workers must never ride on a materials handling conveyor.

Where a conveyor passes over work areas or aisles, guards must be provided to keep employees from being struck by falling material. If the crossover is low enough for workers to walk into, it should be heightened to eliminate the bumping hazard. If it is impossible to move, the conveyor should be padded and have a continuous warning light or marked with a warning sign or painted a bright color.

Screw conveyors must be completely covered except at loading and discharging points. At those points, guards must protect employees against contacting the moving screw; the guards are movable, and they must be interlocked to prevent conveyor movement when not in place.

Additional information regarding different kinds of conveyor hazards can be found in *OSHA Publication 3170 Safeguarding Equipment and Protecting Employees from Amputations* at www.osha.gov/Publications/osha3170.pdf.

Task 1 *(continued)*

Purpose Restated: To understand the potential hazards of handling and storing materials.

Scenario:

XYZ Storage Facility had an immediate shipment to a local vendor. Three workers were assigned to move 130 pallets using a forklift and conveyor. Each pallet contained four 25 lb. totes filled with hydraulic fluid. The foreman was pushing the workers to finish the job before lunch. He assigned one worker a forklift and told him to load three pallets at a time onto the truck. He assigned the other two workers the task of pulling the remainder of the pallets out from the back corner so that the forklift can get to them.

Task:

Using Factsheets 1 through 7 and your experience, please answer the following question.

Make a list of what workers should do before starting this job.

Task 2

Factsheet Reading Method for Task 2:

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: 1) The knowledge and experiences workers bring into the room and 2) the factsheets contained in your workbooks.

The factsheet method, described below, builds upon your knowledge through the introduction of new ideas and concepts.

The process is as follows: Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table. The idea is for each of you to take ownership and responsibility for the information contained in your factsheets and to describe it to the others in your group.

Factsheets will be assigned as follows:

Once everyone has read their assigned factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in order as they were assigned (8 through 12), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Starting with the scribe and moving to the left, count out loud from 8 to 12. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 8 and 12, the person to their left will be responsible for Factsheet 9, etc. The numbers that you have assigned yourself correspond to Factsheets 8 through 12 on the following pages.

8. Slings

A sling is an assembly which connects the load to material handling equipment.

When working with slings, employers must ensure that they are visually inspected before use and during operation, especially if used under heavy stress. Riggers or other knowledgeable employees should conduct or assist in the inspection because they are aware of how the sling is used and what makes a sling unserviceable. A damaged or defective sling must be removed from service.

Slings must not be shortened with knots or bolts or other makeshift devices, sling legs that have been kinked must not be used. Slings must not be loaded beyond their rated capacity, according to the manufacturer's instructions. Suspended loads must be kept clear of all obstructions, and crane operators should avoid sudden starts and stops when moving suspended loads. Employees also must remain clear of loads about to be lifted and suspended. All shock loading is prohibited.

9. Importance of the Operator

The operator must exercise intelligence, care and common sense in the selection and use of slings.

Slings must be selected in accordance with:

- Their intended use,
- Based upon the size,
- Type of load and
- The environmental conditions of the workplace.

All slings must be visually inspected before use to ensure that there is no obvious damage.

A well-trained operator can prolong the service life of equipment and reduce costs by avoiding the potentially hazardous effects of:

- Overloading equipment,
- Operating it at excessive speeds,
- Taking up slack with a sudden jerk and
- Suddenly accelerating or decelerating equipment.

The operator can look for causes and seek corrections whenever a danger exists.

10. Sling Types

The dominant characteristics of a sling are determined by the components of that sling. For example, the strengths and weaknesses of a wire rope sling are essentially the same as the strengths and weaknesses of the wire rope of which it is made.

Slings are generally one of six types:

- Chain used because of their strength and ability to adapt to the shape of load,
- Wire rope is composed of individual wires that have been twisted to form strands,
- Metal mesh are widely used in metalworking and in other industries where loads are abrasive, hot, or will tend to cut web slings. Unlike nylon and wire rope slings, metal mesh slings resist abrasion and cutting.,
- Natural fiber rope should be used on only on light loads and not used on objects that have sharp edges capable of cutting,
- Synthetic fiber rope used for temporary work or
- Synthetic web made of nylon, dacron and polyester and used for temporary work.

Use and inspection procedures tend to place these slings into three groups:

- Chain,
- Wire rope and mesh and
- Fiber rope web.

Each type has its own particular advantages and disadvantages.

Factors that should be taken into consideration when choosing the best sling for the job include the

- Size,
- Weight,
- Shape,
- Temperature, and
- Sensitivity of the material to be moved and as well as the environmental conditions under which the sling will be used.

11. Field Lubrication and Storage

Although every wire rope sling is lubricated during manufacture and in order to lengthen its useful service life, it must also be lubricated “in the field.” Also, you should follow the manufacturer’s instructions regarding maintenance and storage.

There is no set rule on how much or how often this should be done. It depends on the conditions under which the sling is used.

The heavier the loads, the greater the number of bends, or the more adverse the conditions under which the sling operates, the more frequently lubrication will be required.

Wire rope slings should be stored in a:

- Well ventilated and
- Dry building or shed.

Never store them on the ground or allow them to be continuously exposed to the elements because this will make them vulnerable to corrosion and rust.

If it is necessary to store wire rope slings outside, make sure that they are set off the ground and protected.

Using the sling several times a week, even at a light load, is a good practice. Records show that slings that are used frequently or continuously give useful service far longer than those that are idle.

12. Discarding Slings

Wire rope slings can provide a margin of safety by showing early signs of failure. Factors requiring that a wire sling be discarded include the following:

- Severe corrosion,
- Localized wear (shiny worn spots) on the outside,
- A one-third reduction in outer wire diameter,
- Damage or displacement of end fittings—hooks, rings, links or collars by overload or misapplication,
- Distortion, kinking, bird caging or other evidence of damage to the wire rope structure or
- Excessive broken wires.

Task 2 *(continued)*

Purpose Restated: To understand the potential hazards of handling and storing materials.

Scenario:

Three tons of re-bar was being lifted from the ground to the back of a flat bed truck. The load was slung with webbing straps. To put the load onto the flat bed, it would have to be moved over the cab of the truck. The load was most of the way over the flat bed when one of the straps failed and one end of the rebar load fell onto the cab. This resulted in the entire weight being on the remaining strap which then gave way. No injuries occurred. The investigation revealed the following facts:

- One of the webbing straps was frayed,
- Webbing straps were not load rated for material and
- There is no preventative maintenance schedule for slings.

1. What type of sling would you recommend for this type of lift?

2. List the reasons that a sling should be taken out of service.

3. What can be done to prevent this accident from happening in the future?

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Summary: Hazard of Material Handling and Storage

1. The efficient handling and storing of materials is vital to industry and it is accomplished in a number of ways.
2. Material handling and storage are dangerous workplace activities causing back injuries, strains, sprains, fractures, cuts and bruises from twisting and turning and being struck by falling or improperly stored materials.
3. Moving materials manually or mechanically is dangerous; handling materials should always be done with caution and mechanically where possible.
4. Blocking and handles should be used along with proper PPE.
5. Slings must be visually inspected before use and during operation, especially if used under heavy stress.
6. A damaged or defective sling must be removed from service at the earliest signs of failure.
7. Slings are generally one of six types:
 - Chain
 - Metal Mesh
 - Synthetic fiber rope
 - Wire rope
 - Natural fiber rope
 - Synthetic web
8. Choosing the best sling for the job include the size, weight, shape, temperature and sensitivity of the material to be moved, as well as the environmental conditions under which the sling will be used.
9. Lubrication and proper storage are essential in the proper upkeep of slings as well as following the manufacturer's recommendations for maintenance.

Note: See Appendix at the end of the book for more information on the importance of understanding the different types, strengths and job usage of slings. Also included is information about derricks, helicopters and additional information about cranes.

EVALUATION

Activity 1: Hazards of Material Handling and Storage

1. How important is this Activity for workers? Please circle one number.

Activity Is Not Important			Activity Is Very Important	
1	2	3	4	5

2. Which factsheets are the most important to distribute to the workers? (Please list the page numbers.)

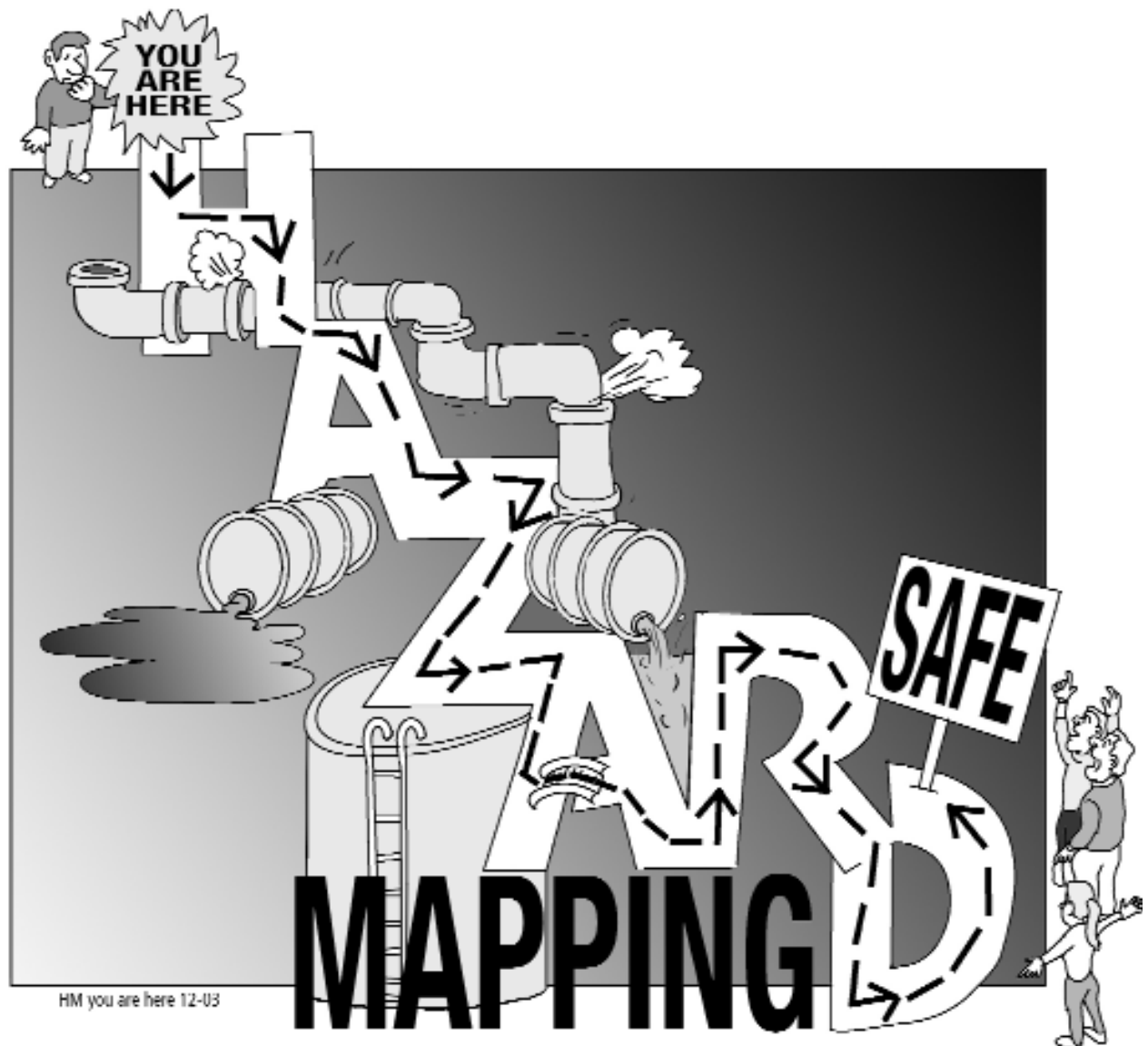
3. What would you suggest be done to improve this Activity?

Activity 2: Mapping Hazards at Work

Purpose

To learn how to develop a Hazard Map that workers can use to identify and locate hazards so that those hazards can be targeted for elimination.

This Activity has two tasks.



Task 1

Factsheet Reading Method for Task 1:

Factsheets will be assigned as follows:

Once everyone has read their assigned factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in order as they were assigned (1 through 6), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Starting with the scribe and moving to the left, count out loud from 1 to 6. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5, the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 6.

1. Using Hazard Mapping to Identify Possible Risks

A Hazard Map is a visual representation of the workplace where there are hazards that could cause injuries or illness.

The Hazard Mapping method draws on what workers know from on-the-job experience. The Hazard Mapping approach is best when conducted with a small group of workers with some similarity in their work. For example, a group of workers who do work in the same type of workplace or a group of maintenance workers who all worked in several buildings but do the same kind of work.

2. Using Hazard Mapping to Identify Area-Wide Hazards or Hazards in Specific Areas of Work

The Hazard Mapping process can be used to identify risks at a large workplace and to specify hazards associated with an **AREA, BUILDING, JOB CLASSIFICATION or PROCESS.**

After completing the large workplace map, it may be obvious that a more detailed map of certain areas or buildings would be helpful in “narrowing down” the processes, areas or jobs that have more dangerous hazards or where worker exposures to hazards are greatest.

For example hazard maps might target:

- Physical Hazards;
- Frequency of Exposure;
- Level of Exposure;
- A Specific Chemical or Agent; or
- Workers or Job Titles Most Likely to Be Exposed.

3. Why Hazard Map?

Hazard Mapping is only one method for identifying occupational safety and health hazards. If your workplace has other systems for identifying hazards, those results can be included on your Hazard Map.

The point of Hazard Mapping is to pool the knowledge about hazards from all of your coworkers so that you can organize to eliminate the hazards.



4. Hazard Mapping Labels

HAZARD CODE KEY		
	Blue	Electrical Hazard
	Green	Chemical Hazard
	Orange	Physical Hazard
	Brown	Flammable/Explosive Hazard
	Black	Other Hazards (specify)

Level of Hazard Key	
1	Low Hazard
2	Medium Hazard
3	High Hazard
4	Very High Hazard

Definitions of the four levels of hazards would vary from industry to industry and from site to site. Each workplace should develop their own definitions if desired.

5. Examples of Hazard Mapping Labels

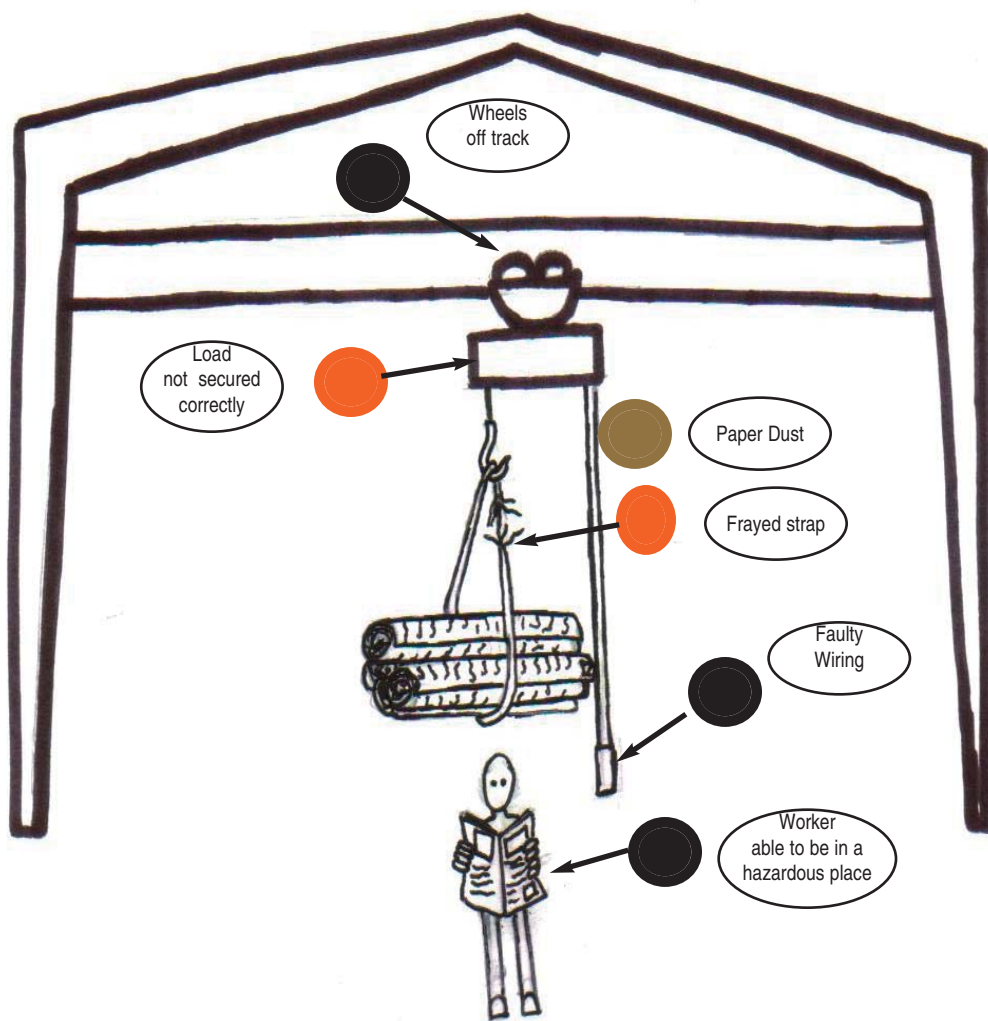
EXAMPLES: HAZARD CODES AND LEVELS OF HAZARD	
	A number "2" inside a Blue Circle indicates "Class 2, Medium Hazard, Electrical."
	A number "3" inside a Green Circle indicates "Class 3, High Hazard, Chemical."
	A number "4" inside an Orange Circle indicates "Class 4, Very High Hazard, Physical."
	A number "1" inside a Brown Circle indicates "Class 1, Low Hazard, Flammable/Explosive."
	A number "2" inside a Black Circle indicates "Class 2, Medium Hazard, Other Hazard."

6. Example of a Hazard Map

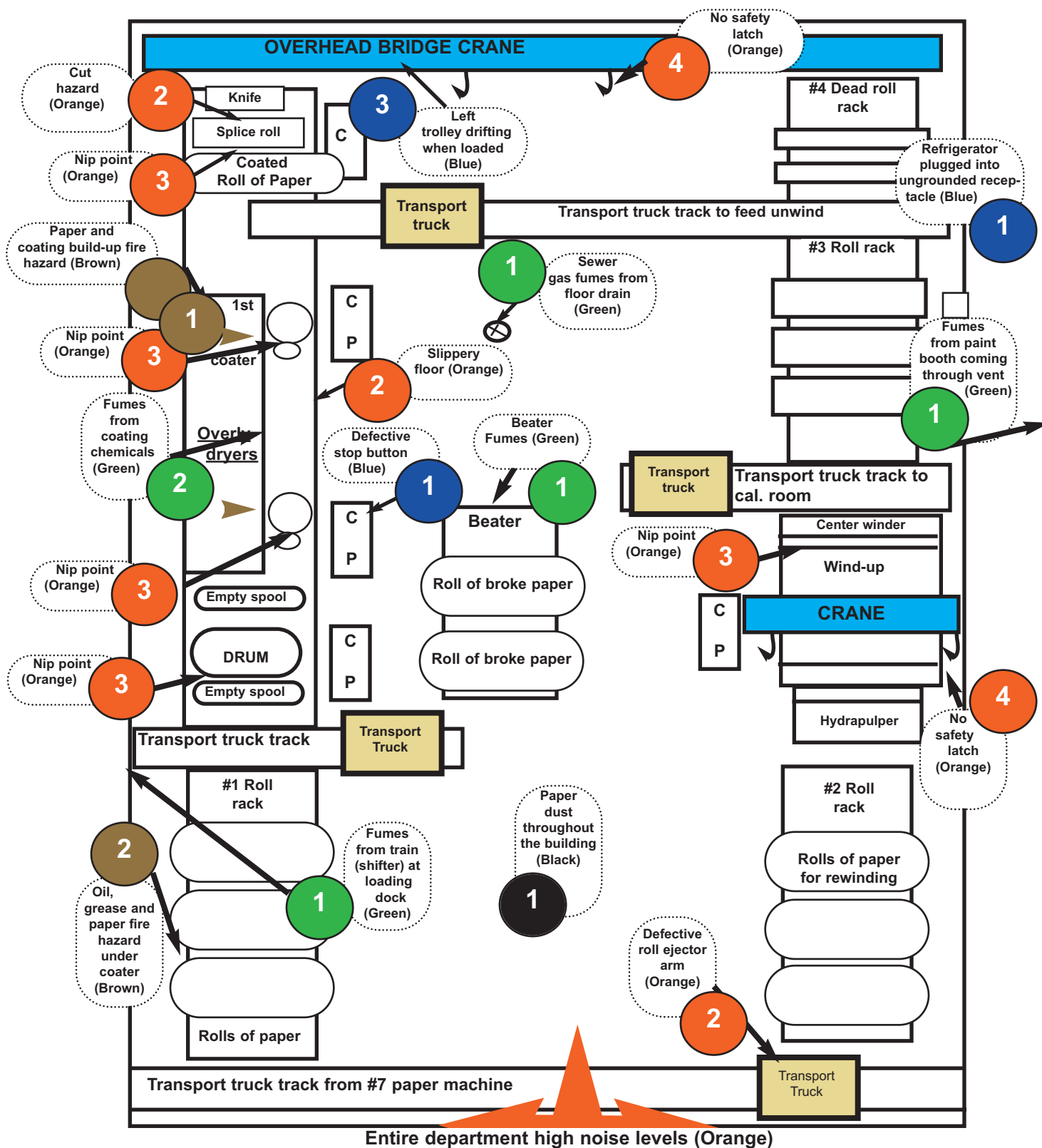
On the next page is an example of a hazard map. These are included to:

- Show how a workplace would appear when you identify present hazards and assign them a level of severity. The two examples shown are from a crane and paper plant (Factsheets 6a and 6b);
- Allow workers to begin to view their workplace with hazards in mind; and
- Begin to think about how to create a hazard map of an area in your workplace.

6a. Crane Diagram Example



6b. In a Paper Coating Room in a Paper Plant (One Small Area of Plant)



Task 1 (*continued*)

Purpose Restated: To identify potential material handling hazards at our workplaces.

Task

Now that you have read and discussed Factsheets 1 through 6, work together in your small groups, to map a work area where material handling equipment (i.e., cranes, conveyors, derricks, helicopters, slings, etc.) is used and draw a hazard map of the hazards.

Select a work area from one workplace that you think would be reasonable to map in this task. You will work together as a team to draw a map of this area. (A rough sketch will do fine for this activity.) Your trainer will provide a large sheet of paper to use for the Hazard Mapping. Be prepared to explain and show the highlights of your map to the entire class.

Begin by following the steps on the next page.

continued

Task 1 (*continued*)

Step 1:

Make a drawing on the sheet of paper provided that shows a rough picture of the scene. Write large and use the entire sheet of paper for your drawing. Label specific danger areas and equipment.

Step 2:

Mark the hazards with a color-coded circle on the map to show **WHAT and WHERE** the hazards are. Use colored dots, pencils or markers, whichever is provided. (*Refer to the codes on Factsheet 4.*)

Step 3:

Label each hazard with a number (1 to 4) to show the **LEVEL OF THE HAZARD** that is present. (*Refer to the codes on Factsheet 4.*)

Step 4:

Label each hazard with a **NAME OR BRIEF DESCRIPTION OF THE HAZARD**. (*See an example on the sample map in Factsheet 6a or 6b.*)

To best develop your Hazard map, you should proceed one step at a time (Steps 1-4). When you have finished your Hazard Map, you should place it on the wall and during report back your scribe will explain the map.

Task 2

Purpose Restated: To identify potential material handling hazards at our workplaces.

This Hazard Mapping Project was designed for workers to use to eliminate hazards in their workplace. Four important elements of the project are listed below.

1. Circulate the map so that all in the area can add to the map;
2. Make your recommendations to fix the hazards identified;
3. Present your Hazard Map to your employer; and
4. Follow up to make sure fixes are made.

Each of the above elements will probably require several steps by workers at your workplace in order for each element to be successful. To kick-start this Hazard Mapping Project, complete the questions on the next page and use it as a guide.

During report-back your facilitator will put one element per flipchart (four flipcharts) and will list the steps your group determines will be needed for each element.

continued

Task 2 (*continued*)

- 1. Who will circulate the map so that all in the area can add to the map? What steps need to be done to circulate the map and who is responsible for each step?**

- 2. Who will make your recommendations to fix the hazards identified? What steps need to be done to make your recommendations to fix the hazards and who is responsible for each step?**

- 3. Who will present your Hazard Map to your employer? What steps need to be done to present your hazard map to your employer and who is responsible for each step?**

- 4. Who will follow up to make sure fixes are made? What steps need to be done to follow-up to make sure fixes are made and who is responsible for each step?**

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Summary: Mapping Hazards at Work

1. In creating a Hazard Map, we are making a visual representation of workplace hazards that could lead to injury, illness or even death.
2. We can use Hazard Mapping to identify workplace hazards in order to eliminate them.
3. In Hazard mapping workers make valuable contributions to health and safety based on their collective skills, experience and know-how.
4. Using the hazard map in conjunction with a plan involves more workers and advises us of the actions we need to take to eliminate material handling hazards at work.

EVALUATION

Activity 2: Material Handling Hazard Identification

1. How important is this Activity for workers? Please circle one number.

Activity Is Not Important			Activity Is Very Important	
1	2	3	4	5

2. Which factsheets are the most important to distribute to the workers? (Please list the page numbers.)

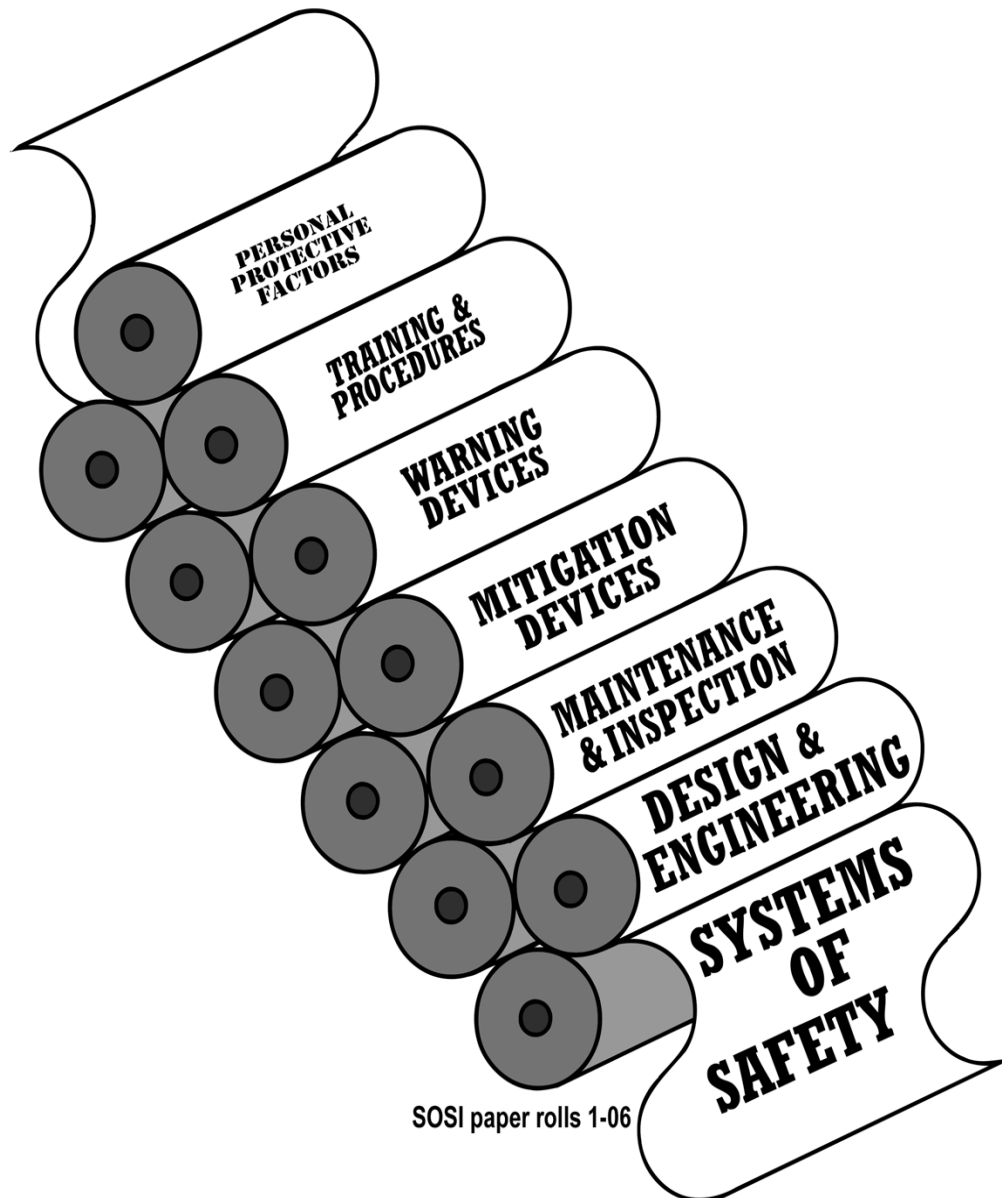
3. What would you suggest be done to improve this Activity?

Activity 3: Systems of Safety

Purpose

To introduce the concept of Systems of Safety and accident prevention.

This Activity has three tasks.



Task 1

Factsheet Reading Method for Task 1:

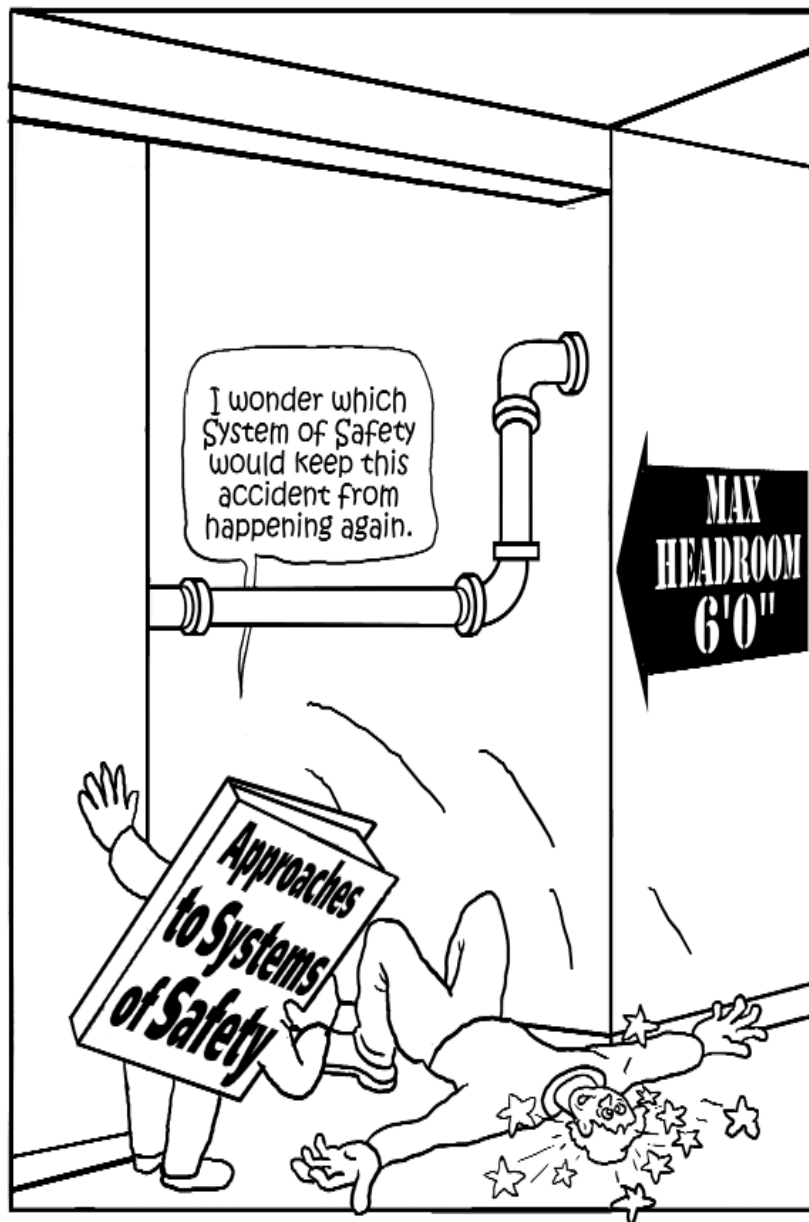
Factsheets will be assigned as follows:

Once everyone has read their assigned factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need be taken during this discussion. The factsheets should be explained in order as they were assigned (1 through 8), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Starting with the scribe and moving to the left, count out loud from 1 to 8. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5, the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 8 on the following pages.

1. What Are Systems of Safety?

Systems of Safety are proactive systems that actively seek to identify, control and/or eliminate workplace hazards.



Let's look at an incident where a worker bumped his head on a low pipe. How could this hazard be addressed by each of our Systems of Safety? (See the next six Factsheets.)

2. The Personal Protective Factors System

1. Personal Decision-making and Actions

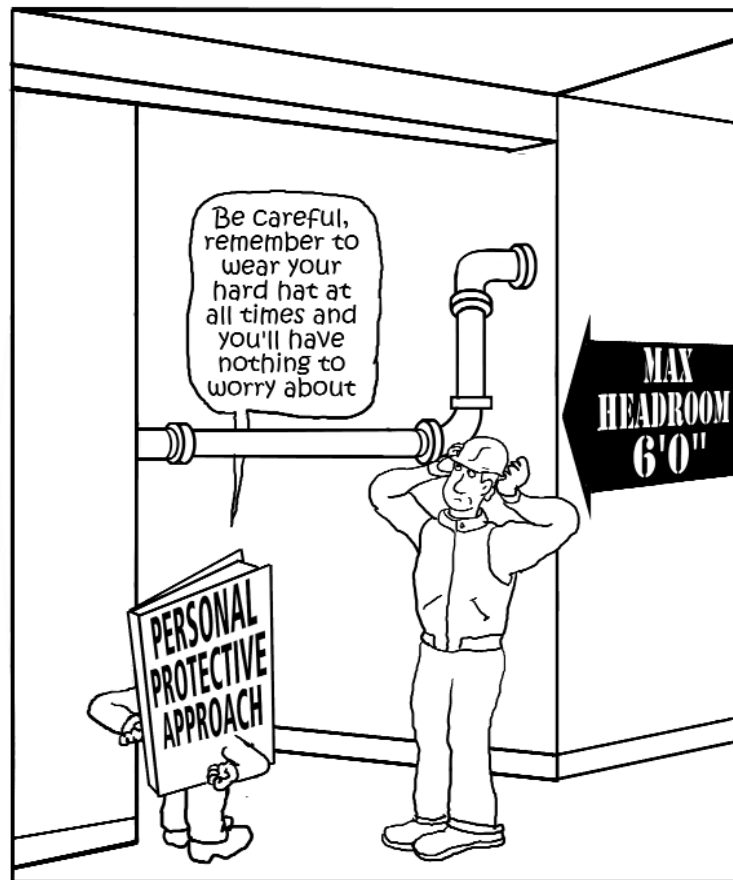
- Look and think critically at the workplace;
- Work collectively to identify hazards; and
- Contribute ideas, experience and know-how that will lead to correcting the systems flaws.

2. Personal Protective Equipment (PPE) and Devices

- Wear PPE as necessary and required when higher levels of protection are not feasible.

3. Stop Work Authority

- Authority is given to all individuals, and they are encouraged, to stop work, equipment or processes due to unsafe conditions until a thorough Hazard Analysis can be performed.



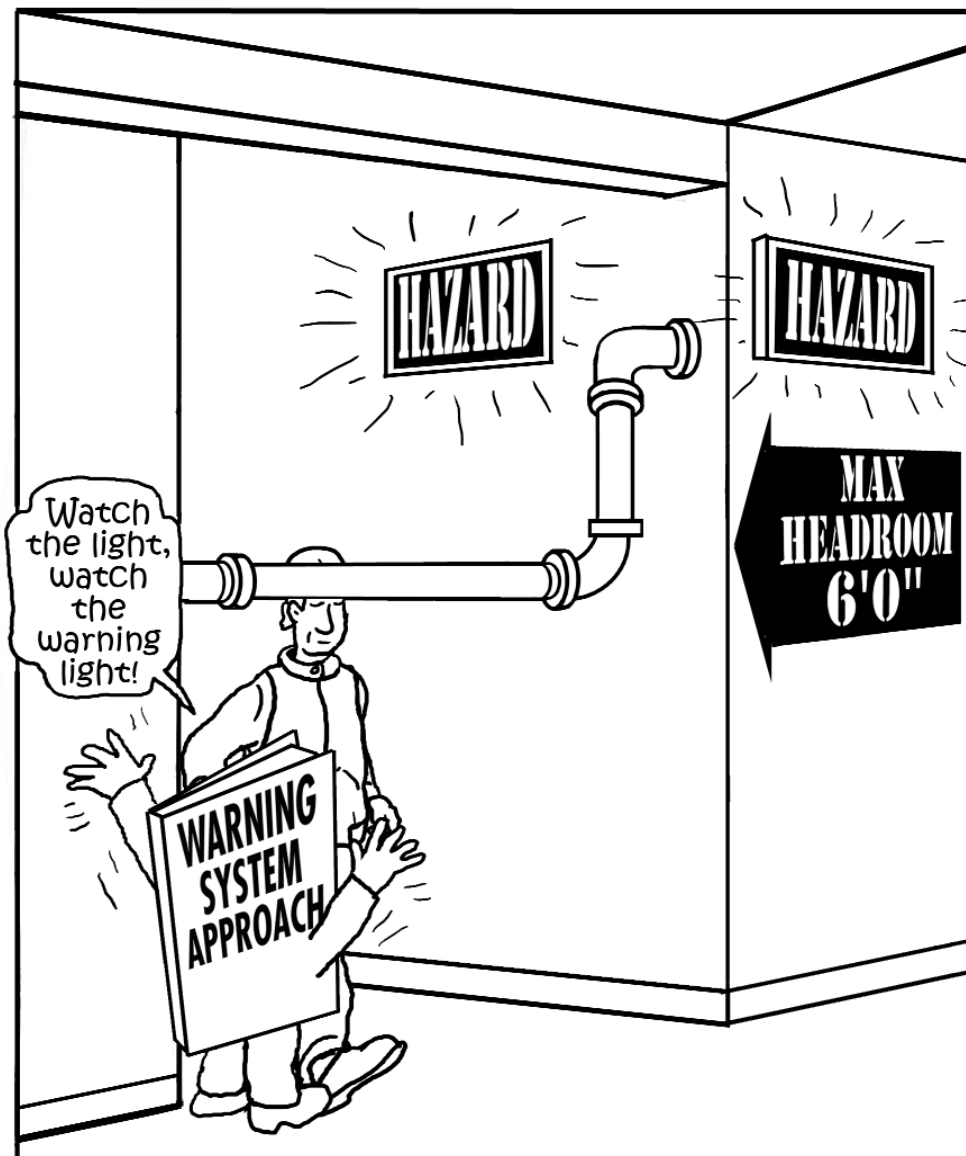
3. The Procedures and Training System

The operation and maintenance of processes that are dangerous require a system of written procedures and training. The greater the hazard, the greater is the need for Procedures and Training.



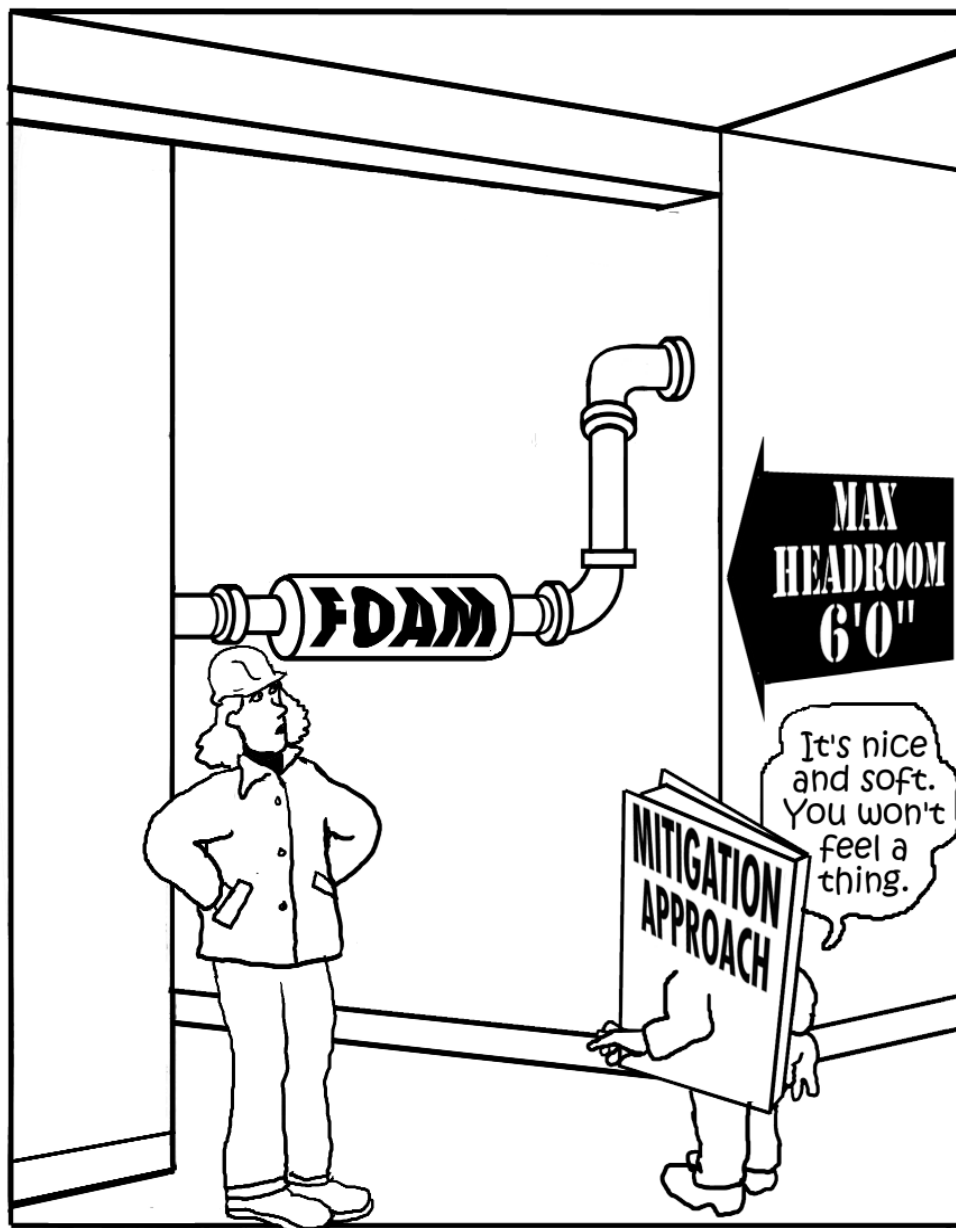
4. The Warning System

The Warning System of Safety includes the use of devices that warn of a dangerous or potentially dangerous situation. These devices require a person's intervention to control or mitigate the hazardous situation.



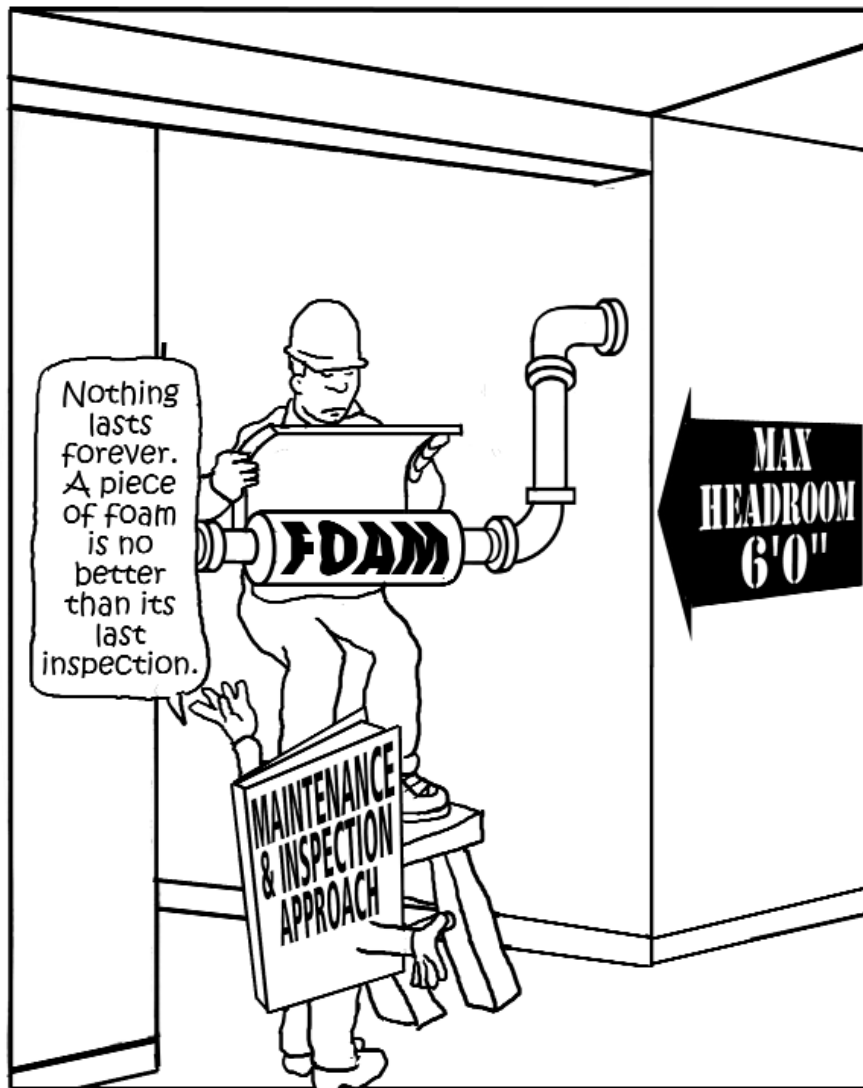
5. The Mitigation System

The Mitigation System of Safety involves the use of equipment that automatically acts to control or reduce the harmful consequences of hazardous incidents. Mitigation should be automatic and reliable.



6. The Maintenance and Inspection System

Properly designed equipment can turn into unsafe junk if it isn't properly maintained, inspected, and repaired. If the phrase "if it ain't broke, don't fix it" is used within a plant, the Maintenance and Inspection System is a failure. If you don't use preventive maintenance, then you end up doing breakdown maintenance.



7. Design and Engineering System of Safety

A central purpose of the Design System of Safety is to eliminate hazards through the selection of safe or low-risk processes and chemicals whenever possible.

One example of good design safety is the substitution of a less hazardous chemical such as sodium hypo-chlorite (bleach), for chlorine in treating cooling water. A release of toxic chlorine gas can travel in the wind for miles, whereas a spill of bleach is inherently less dangerous.



8. Systems and Sub-Systems (Examples)

Major Safety System	Design and Engineering	Maintenance and Inspection	Mitigation Devices	Warning Devices	Training and Procedures	Personal Protective Factors
Level of Prevention	Highest—the first line of defense	Middle—the second line of defense				Lowest—the last line of defense
Effectiveness	Most Effective					Least Effective
Goal	To eliminate hazards	To further minimize and control hazards				To protect when higher level systems fail
EXAMPLES OF SAFETY SUB-SYSTEMS**	Technical	Preventive Maintenance	Enclosures, Barriers Dikes and Containment	Monitors	Operating Manuals and Procedures	Personal Decision-making and Actions HF
	Design and Engineering of Equipment, Processes and Software	Inspection and Testing	Relief and Check Valves	Process Alarms	Process Safety Information	Personal Protective Equipment and Devices HF
	Management of Change (MOC)**	Maintenance	Shutdown and Isolation Devices	Facility Alarms	Process, Job and Other Types of Hazard Assessment and Analysis	Stop Work Authority
	Chemical Selection and Substitution	Quality Control	Fire and Chemical Suppression Devices	Community Alarms	Permit Programs	
	Safe Siting	Turnarounds and Overhauls	Machine Guarding	Emergency Notification Systems	Emergency Preparedness and Response Training	
	Work Environment HF	Mechanical Integrity			Refresher Training	
	Organizational (must address a root cause)				Information Resources	
	Staffing HF				Communications	
	Skills and Qualifications HF				Investigations and Lessons Learned	
	Management of Personnel Change (MOPC)				Maintenance Procedures	
	Work Organization and SchedulingHF Workload				Pre-Startup Safety Review	
	Allocation of Resources					
	Buddy System					
	Codes, Standards, and Policies**					

HF - Indicates that this subsystem is often included in a category called **Human Factors**.

* There may be additional subsystems that are not included in this chart. Also, in the workplace many subsystems are interrelated. It may not always be clear that an issue belongs to one subsystem rather than another.

** The Codes, Standards and Policies and Management of Change subsystems listed here are related to Design and Engineering. These subsystems may also be relevant to other systems; for example, Mitigation Devices. When these subsystems relate to systems other than Design and Engineering, they should be considered as part of those other systems, not Design and Engineering.

Revised October 2006

Task 1 *(continued)*

Purpose Restated: To introduce the concept of Systems of Safety and accident prevention.

Task:

Please begin by reading the following scenario:

At XYZ plant, forklift operators use the aisle between the finishing department and number one Machine Room as they collect drums for proper disposal. Employees also use the same aisle to access their work area.

This incident occurred five minutes prior to the start of first shift. Mary, an operator, was walking from the women's locker room in the finishing department to her work station. She was at the rear of a group of 10 employees going to their work stations. A third shift forklift operator was delivering an empty drum to the site. This was his last assignment before the end of his shift. After he had made his delivery he stopped to talk with the third shift machine foreman. Mary saw the forklift operator stop to talk with the foreman and assumed that the operator saw her so she proceeded to walk behind the forklift.

The forklift operator finished talking with the foreman and looked behind him. He saw the large group of people who had walked past him, but he didn't see anyone behind him. He put the forklift in reverse and backed up. He had gone about a foot when he heard screaming. That is when he realized that someone was behind him. He stopped and pulled the forklift forward and parked it.

Mary sustained major trauma to both of her legs and feet and required months of treatment and therapy to recover from her injuries. The forklift operator said that he looked but didn't see anyone behind him. His ability to see directly behind the forklift was hampered by the placement of the propane fuel tank and the design of the roll cage. He had completed his last assignment and was going to drop his forklift off at the rear of the plant.

continued

Task 1 (continued)

The injured employee said that she had always taken the same route to her work station. She walked behind the same forklift operator on numerous occasions and that he had always seen her before.

Listed below are summaries of the root causes from the accident in the previous scenario in the left column. In the right column are Systems of Safety that could contain these root causes. Using Systems of Safety Factsheets 1 through 8, chose which Systems of Safety contains the root causes listed below. Your group should choose one System of Safety (SOS) for each root cause. You should circle the selected SOS to indicate your group's answer.

Root Causes	Systems of Safety
A. Forklift designed with driver's visibility obstructed.	Personal Protective Factors Design and Engineering
B. No communication occurred between driver and pedestrian.	Training and Procedures Warning Devices
C. There was no warning that the forklift was going to back up.	Warning Devices Design and Engineering
D. Aisles are commonly used for both forklift and pedestrian traffic.	Design and Engineering Personal Protective Factors

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Task 2

Purpose Restated: To introduce the concept of Systems of Safety and accident prevention.

Using Factsheets 1 through 8 on pages 47 through 54, discuss the following questions with members of your group. Select a scribe to report your answers back to the class.

1. Below are the fixes in the left column. Please pick the Systems of Safety targeted by the fix from the right column.

Fixes	SOS Targeted (one for each action)
1. Install backup alarm on all forklifts.	Warning Devices Mitigation Devices
2. Designate aisle between finishing room and number one machine room for forklift traffic only.	Design and Engineering Training and Procedures
3. Contact forklift manufacturer to redesign propane tank and roll cage to increase visibility in the rear.	Design and Engineering Training and Procedures
4. Eliminate forklift use for last 20 and first 20 minutes of shift.	Mitigation Devices Training and Procedures
5. Include in training the importance of communications between a forklift driver and pedestrians.	Warning Devices Training and Procedures
6. Install convex mirrors on forklift to make full rear area visible to driver.	Mitigation Devices Warning Devices
7. Change procedure for forklift operation to include sounding horn before beginning to back up.	Training and Procedures Personal Protective Factors

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Task 3

Purpose Restated: To introduce the concept of Systems of Safety and accident prevention.

The real test of a system “fix” is determined by whether the root causes are corrected.

In your group review the fixes listed below:

1. **Install backup alarm on all forklifts.**
2. **Designate aisle between finishing room and number one machine room for forklift traffic only.**
3. **Contact forklift manufacturer to redesign propane tank and roll cage to increase driver’s visibility in rear.**
4. **Eliminate scheduled forklift use the last 20 minutes of the shift and the first 20 minutes of the shift.**
5. **Include section in forklift training and in general plant safety training on importance of communications between a forklift driver and pedestrians.**
6. **Install convex mirrors on forklift to make full rear area visible to driver.**
7. **Change procedure for forklift operation to include sounding horn before beginning to back up.**

In the first column in the chart on the next page are the root causes, A through D, from Task 1.

If the **root cause** would be adequately corrected by one or more of the fixes listed above (1 through 8), then answer “yes” in the second column and list the number or numbers of the fixes that would have accomplished this in the third column. You may list more than one fix per root cause.

If the **root cause** would not be adequately corrected, then answer “no” in the second column and make recommendations that would completely correct the root cause. These recommendations should be recorded on the chart below.

Root Causes	Adequately Fixed (Yes/No)	Recommendations
A. The forklift was designed with visibility obstructed.		
B. There was no communication between driver and pedestrian.		
C. There was no warning that the forklift was backing up.		
D. The aisles were commonly used for both forklift and pedestrian traffic.		

1. In your group’s opinion, would any of the proposed fixes completely eliminate the hazard.

a) If yes, what was the fix?

b) If no, what would your recommendation(s) be?

Summary: Systems of Safety

1. Proactive Systems of Safety are the key to preventing disasters and injuries.
2. Major Systems of Safety include:
 - Design and Engineering;
 - Maintenance and Inspection;
 - Mitigation Devices;
 - Warning Devices;
 - Procedures and Training; and
 - Personal Protective Factors.
3. The Design and Engineering System can provide primary prevention by eliminating the possibility of a serious accident. The other Systems of Safety provide secondary prevention by reducing the probability or severity of an accident.
4. Each plant may have different structures and names for its Systems of Safety, but all plants have Systems of Safety.
5. Active worker, union and community involvement in Systems of Safety are essential for these systems to be effective.

EVALUATION

Activity 3: Systems of Safety

1. How important is this Activity for workers? Please circle one number.

Activity Is Not Important			Activity Is Very Important	
1	2	3	4	5

2. Which factsheets are the most important to distribute to the workers? (Please list the page numbers.)

3. What would you suggest be done to improve this Activity?

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Activity 4: Near Misses and Prevention

Purpose

To apply the concept of near miss reporting to achieve the highest level of prevention possible.

To practice identifying the root causes of a near miss as early in the chain of events as possible.

This Activity has two tasks.

Task 1

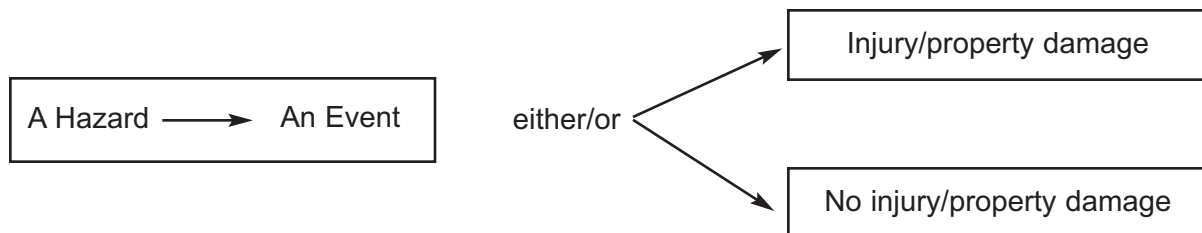
Purposes Restated:

To apply the concept of near miss reporting to achieve the highest level of prevention possible.

To practice identifying the root causes of a near miss as early in the chain of events as possible.

Below we have sketched out a simple chain of events. A material handler picks up a pallet of drums with a pallet truck. The improperly installed metal band around the drums breaks because there is no training program on how to band drums. The drums fall and almost strikes someone working in the area.

So a chain of events can be drawn as follows:



Task

1. What do you think prevented the worker from getting hurt?

2. What do you believe the root cause of the accident was?

Task 2

Factsheet Reading Method for Task 2:

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: 1) The knowledge and experiences workers bring into the room and 2) the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows: Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table. The idea is for each of you to take ownership and responsibility for the information contained in your factsheets and to describe it to the others in your group.

Factsheets will be assigned as follows:

Once everyone has read their assigned factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in order as they were assigned (1 through 10), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Starting with the scribe and moving to the left, count out loud from 1 to 10. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1, 5 and 9, the person to their left will be responsible for Factsheets 2, 6 and 10, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 10.

1. Near Miss, the Standard Definition

The standard definition of a near miss is:

“Any event that could have caused an injury or damage property.”

Near miss = Event - injury/damage

Generally, this is the definition used almost universally for near miss programs.

2. What is an Accident?

Webster's dictionary describes an accident as:

- An unfortunate mishap; especially one causing damage or injury.
- Anything that happens suddenly or by chance without an apparent cause.

The legal definition includes the following:

- Any unexpected personal injury resulting from any unlooked for mishap or occurrence; any unpleasant or unfortunate occurrence that causes injury, loss, suffering or death.
- Some untoward occurrence aside from the usual course of events.
- An event that takes place without one's foresight or expectation; an un-designed, sudden and unexpected event.

3. What is a Hazard?

A hazard is defined as:

A hazard is any source of potential damage, harm or adverse health effects on something or someone under certain conditions at work.

Basically, a hazard can cause harm or adverse affects to:

- Individuals as health effects or
- Organizations as property or equipment losses.

4. Hazards Cause Accidents

In the chain of events that cause accidents leading to death, injury or property damage, the existence of a work place hazard is always the starting point, therefore:

Hazards = Accidents

And since: A near miss is an accident that has already occurred.

Hazards = Near Miss

Understanding the root causes of accidents is important but by calling an accident a near miss, we miss the opportunity for real prevention.

5. Near Misses are Existing Hazards

A new definition:

“A near miss is an existing hazard, a trap waiting to be sprung. “

The hose lying across the dark path that no one trips on is a near miss.

The ungraded machine, the un-serviced safety valve and the uninspected sling are all near misses.

6. Near Miss Early Detection

The chain of events leading to an accident always contains multiple near misses. As we move backwards from the accident there are numerous opportunities to interrupt the causal chain of events, therefore preventing the accident.

The earlier we intervene in the chain of events the greater the level of protection and prevention achieved.

And as the causes of all accidents reside in the failure of site safety systems:

- The ungraded machine is a failure of the site mitigation safety system.
- The faulty safety valve and uninspected sling are failures of the site preventative maintenance and inspection systems.

**Early Near Miss Identification + Safety Systems =
Accident Prevention.**

7. The Blame Game

Traditional near miss programs look to events that could have caused an accident, illness or injury. Something in the sequence of actions didn't quite come together in these events to turn them into an accident, so it is referred to as a near miss.

Because of this view, someone is engaged in some activity or lack of activity that made these things happen; someone didn't inspect, report or do something in the right way, but we're lucky that no one got hurt or that nothing was broken. Someone is to blame.

Pointing a finger at someone is built into the system by the traditional definition of a near miss and in turn where the investigation and corrective action is likely to fall. Intentionally or not, by design and the misdefinition of a near miss, traditional programs are blame the worker programs.

8. Barriers to Reporting Near Misses

According to a study of near miss programs by the Wharton School of Business at the University of Pennsylvania, the failure to report near misses is the main reason that programs don't work

Potential barriers to reporting near misses are:

1. Peer Pressure

- Employees may feel pressure from colleagues not to report.

2. Direct disciplinary action

- Concern of receiving a verbal warning, addition of an incident to the employee's record, up to and including job dismissal discourage reporting.

3. Unintended disciplinary action

- As a result of incident investigation recommendations, additional job tasks or wearing cumbersome PPE may be perceived as punishment for reporting.

Source: <http://opim.wharton.upenn.edu/risk/downloads/01-03-JP.pdf>.

9. Near miss Programs can be Valuable to Workers.

Benefits of a functional near miss program can be valuable to workers.

- A near miss program that involves workers who are intimately familiar with daily system operations; therefore, potential problems are easily and quickly detected.
- Near miss programs keep workers from getting hurt.
- A near miss program can empower workers.
- Workers have an increased awareness of hazards in their work area.
- Workers should own their near miss program.
- Near miss programs should find resolutions to problems in a timely manner.

10. Program Problems According to Wharton—Lack of Management Commitment

Failure of management to remain committed to near miss programs:

- Can, in turn decrease employee reporting and
- Can result in employee accusations that near miss programs are 'a flavor of the month.'

Commitment failure can be both:

- Passive, where management stops emphasizing program participation due to inattention, or
- Active, where management seeks to reduce program participation.

Source: <http://opim.wharton.upenn.edu/risk/downloads/01-03-JP.pdf>.

Task 2 (*continued*)

Purposes Restated:

To apply the concept of near miss reporting to achieve the highest level of prevention possible.

To practice identifying the root causes of a near miss as early in the chain of events as possible.

The purpose of a near miss reporting program is to identify the cause of a near miss and eliminate or fix these causes in order to prevent accidents. Using Factsheets 1 through 10 and your experience, please answer the questions below.

1. Do you believe that identifying the root cause(s) of near misses at the earliest point in the event chain possible would lead to greater participation of workers at your site in a near miss reporting program? If so, please give your three top reasons why.
 - a.
 - b.
 - c.
2. Would increased worker participation be important at your site? Why or why not?

Summary: Near Misses and Prevention

1. A near miss is the existence of a hazard. It is a trap waiting to be sprung.
2. There are numerous identifiable hazards in the chain of events leading up to an accident. Hazards = Accidents.
3. The earlier we identify hazards as near misses the more prevention we are able to achieve.
4. It is universally recognized that the identifying and remediation of near-misses remains the greatest untapped recourse of prevention in the American workplaces today.
5. Removing barriers to reporting of near misses is key to a successful program.

EVALUATION

Activity 4: Near Misses and Prevention

1. How important is this Activity for workers? Please circle one number.

Activity Is Not Important			Activity Is Very Important	
1	2	3	4	5

2. Which factsheets are the most important to distribute to the workers? (Please list the page numbers.)

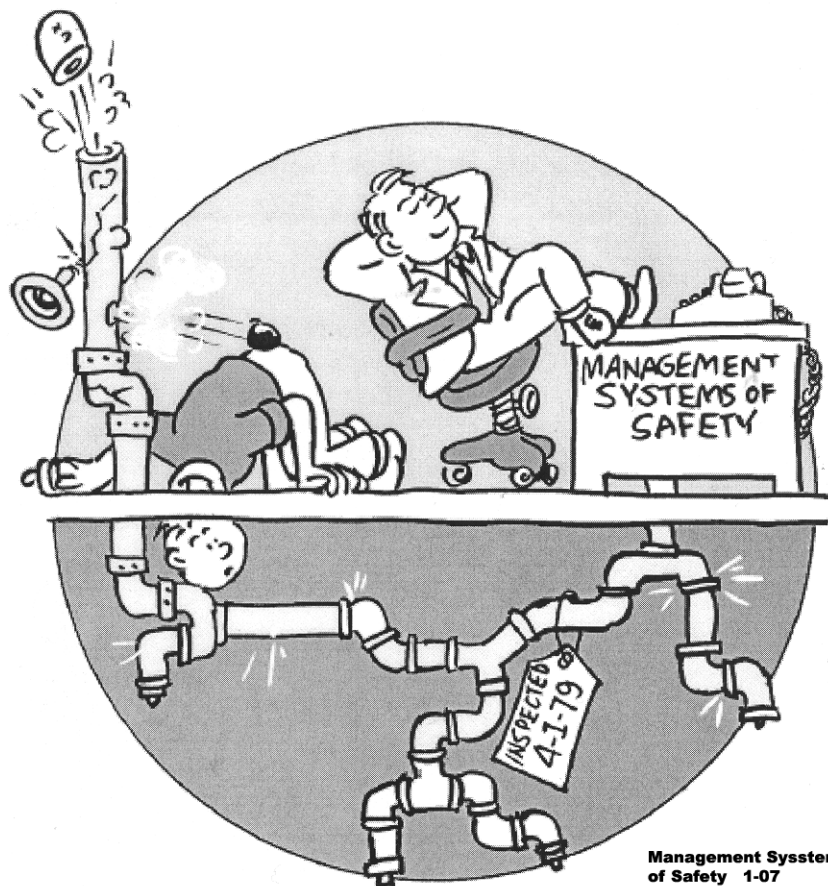
3. What would you suggest be done to improve this Activity?

Activity 5: Incident Investigation using Root Cause Analysis

Purpose

To understand the differences between the preliminary factors of incidents and accidents and the root causes.

This Activity has two tasks.



Task 1

Factsheet Reading Method for the Task 1.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: The knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows: Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table. The idea is for each of you to take ownership and responsibility for the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in the order they were assigned (1 through 7), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Starting with the scribe and moving to the left, count out loud from 1 to 7. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5, the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 7 on the following pages.

1. Systems vs. Symptoms

When focusing attention on worker injuries, we only see the tip of the safety iceberg. Changing the unsafe behaviors of an injured worker does not take us very far down the road to prevention.

Unsafe acts, unsafe conditions and accidents are symptoms that something is wrong in management's systems of safety.

The root causes of accidents are management system failures. For example, faulty design or inadequate training are responsible for unsafe conditions and unsafe acts.

The use of systems of safety to control hazards and reduce the number and degree of work-related incidents and accidents.

Prevention of accidents requires making changes in systems of safety.

Source: *Guidelines for Investigating Chemical Process Incidents*, Center for Chemical Process Safety, New York: American Institute of Chemical Engineers, 1992.

2. Finding the Root Cause

Experts in the field of process safety like The Center for Chemical Process Safety defines “root causes” as:

“Management systems failures; such as faulty design or inadequate training, that led to an unsafe act or condition that resulted in an accident; underlying cause. If the root causes were removed, the particular incident would not have occurred.”

The Environmental Protection Agency also emphasizes “root causes”:

“. . . an operator’s mistake may be the result of poor training, inappropriate standard operating procedures (SOPs) or poor design of control systems; equipment failure may result from improper maintenance, misuse of equipment (operating at too high a temperature) or use of incompatible materials. Without a thorough investigation, facilities may miss the opportunity to identify and solve the root problems.”

The reasons for apparent mistakes, accidents and equipment failure may be hidden from view.

Sources: *Guidelines for Auditing Process Safety Management Systems*, American Institute of Chemical Engineers, Environmental Protection Agency Proposed Rule, Risk Management Programs for Chemical Accidental Release Prevention.

3. What Are Preliminary Factors?

Most investigations only address the preliminary factors involved in an incident. Preliminary factors include things such as a sling failure, a worker not following a procedure or making a mistake. Preliminary factors are the symptoms of problems in management safety systems. They are relatively easy to identify and are never the final step in an investigation. They only lead to the real root causes.

Examples of Preliminary Factors

- Releases of hazardous materials or energy;
- Fires or explosions;
- Not using personal protective equipment or use of the wrong PPE;
- Improper lifting or body position;
- Not following a procedure;
- Bypassing safety devices or alarms;
- Using defective or wrong equipment or tools; and
- Poor housekeeping.

Source: *Accident Prevention*, Mine Safety and Health Administration, 1990, pp. 35-38.

4. What Are Root Causes?

The root causes of incidents are the prime factors that underlie the preliminary factors of an accident. Root causes are sometimes referred to as “basic” causes. There are almost always several root causes involved in an incident, accident or near-miss. For example, the root causes of an electrocution might include improperly designed or maintained equipment, poor lockout procedures or inadequate training. Root causes are always found in management safety systems.

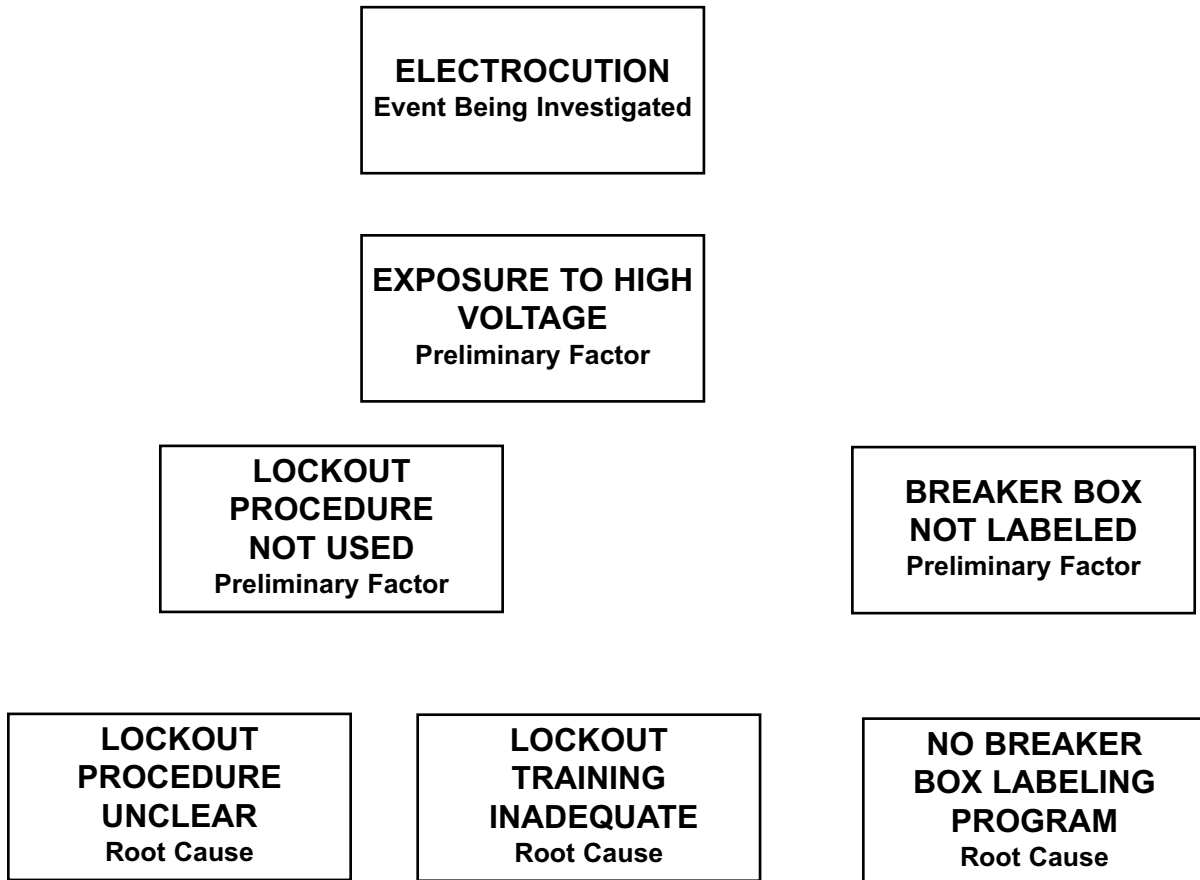
Examples of Root Causes

- Poor design of units and equipment;
- Poor layout of control room indicators and controls;
- Difficult access to equipment;
- Unsafe siting and spacing of units and equipment;
- Lack of preventive maintenance or inspection;
- Inadequate procedures or training for both normal and emergency situations;
- Excessive overtime; and
- Inadequate staffing levels.

Sources: *Accident Prevention*, Mine Safety and Health Administration, 1990, pp. 35-38; and *Guidelines for Investigating Chemical Process Incidents*, Center for Chemical Process Safety, 1992, pp. 129-131.

5. Preliminary Factors vs. Root Causes

The chart on this page uses an electrocution example to depict the differences between preliminary factors and root causes. Root causes are always found beneath preliminary factors.



Major Safety System	Design & Engineering	Maintenance & Inspection	Mitigation Devices	Warning Devices	Training & Procedures	Personal Protective Factors
Level of Prevention	Highest—the first line of defense	Middle—the second line of defense				Lowest—the last line of defense
Effectiveness	Most Effective					Least Effective
Goal	To eliminate hazards	To further minimize and control hazards				To protect when higher level systems fail
EXAMPLES OF SAFETY SUB-SYSTEMS**	Technical	Inspection and Testing	Enclosures, Barriers Dikes and Containment	Monitors	Operating Manuals and Procedures	Personal Decision-making and Actions HF
	Design and Engineering of Equipment, Processes and Software	Maintenance	Relief and Check Valves	Process Alarms	Process Safety Information	Personal Protective Equipment and Devices HF
	Management of Change (MOC)**	Quality Control	Shutdown and Isolation Devices	Facility Alarms	Process, Job and Other Types of Hazard Assessment and Analysis	Stop Work Authority
	Chemical Selection and Substitution	Turnarounds and Overhauls	Fire and Chemical Suppression Devices	Community Alarms	Permit Programs	
	Safe Siting	Mechanical Integrity	Machine Guarding	Emergency Notification Systems	Emergency Preparedness and Response Training	
	Work Environment HF				Refresher Training	
	Organizational (must address a root cause)				Information Resources	
	Staffing HF				Communications	
	Skills and Qualifications HF				Investigations and Lessons Learned	
	Management of Personnel Change (MOPC)				Maintenance Procedures	
	Work Organization and Scheduling HF				Pre-Startup Safety Review	
	Workload					
	Allocation of Resources					
	Buddy System					
	Codes, Standards, and Policies**					

HF - Indicates that this subsystem is often included in a category called **Human Factors**.

* There may be additional subsystems that are not included in this chart. Also, in the workplace many subsystems are interrelated. It may not always be clear that an issue belongs to one subsystem rather than another.

** The Codes, Standards and Policies and Management of Change subsystems listed here are related to Design and Engineering. These subsystems may also be relevant to other systems; for example, Mitigation Devices. When these subsystems relate to systems other than Design and Engineering, they should be considered as part of those other systems, not Design and Engineering.

Revised October 2006

7. The Problems with Procedures

Many incident and injury investigations end when it is concluded that an injured worker did not follow the procedure for a job task. A good investigation team digs deeper to discover the underlying reasons that the procedure was not followed. This further examination almost always reveals problems in the procedures system. To prevent similar incidents in the future, the root causes in the procedure system must be fixed, rather than the immediate causes, such as the behavior of the injured worker.

The investigation team should ask questions such as these when a procedure was not followed. (This is not a complete list.)

- Does a written procedure exist and is it readily available?
- Was the written procedure confusing, incomplete or difficult to use?
- Was the procedure specific to the job or was it a generic procedure?
- Has adequate training been conducted on the use of the procedure?
- Was the procedure written by someone who has actually performed the job?
- Was the procedure up-to-date with equipment and process changes?

Sources: *Guidelines for Investigating Chemical Process Incidents*, Center for Chemical Process Safety, 1992, p. 131.

Task 1 (*continued*)

Purpose Restated: To understand the differences between the preliminary factors of incidents and accidents and the root causes.

Scenario:

Millard Smith, a material handler, was killed when crushed by a 16,000 lb. load that was being moved by an overhead crane. The load was secured by an alloy chain sling when the load shifted and fell crushing Smith between it and a piece of stationary equipment. Although a synthetic sling was more appropriate for the job only alloy slings were available on site due to budget constraints.

Rescuers were unable to extract Smith in a timely manner and he died on the way to the hospital. Initial investigation by a management/labor team revealed the following facts.

The site was short handed that day due to a flu infection that had caused significant absenteeism at the site. There had been no preplanning on how to handle a possible pandemic flu outbreak and continue safe operations. Smith had been pressed into service as a crane operator at the end of his ninth in a row 16-hour shift. He had some training on the crane but had not completed it. A supervisor had been assigned to oversee his work but was distracted by a production upset in another area of the plant. Production was running behind due to the flu outbreak and there was serious pressure from above to keep things moving. Additionally:

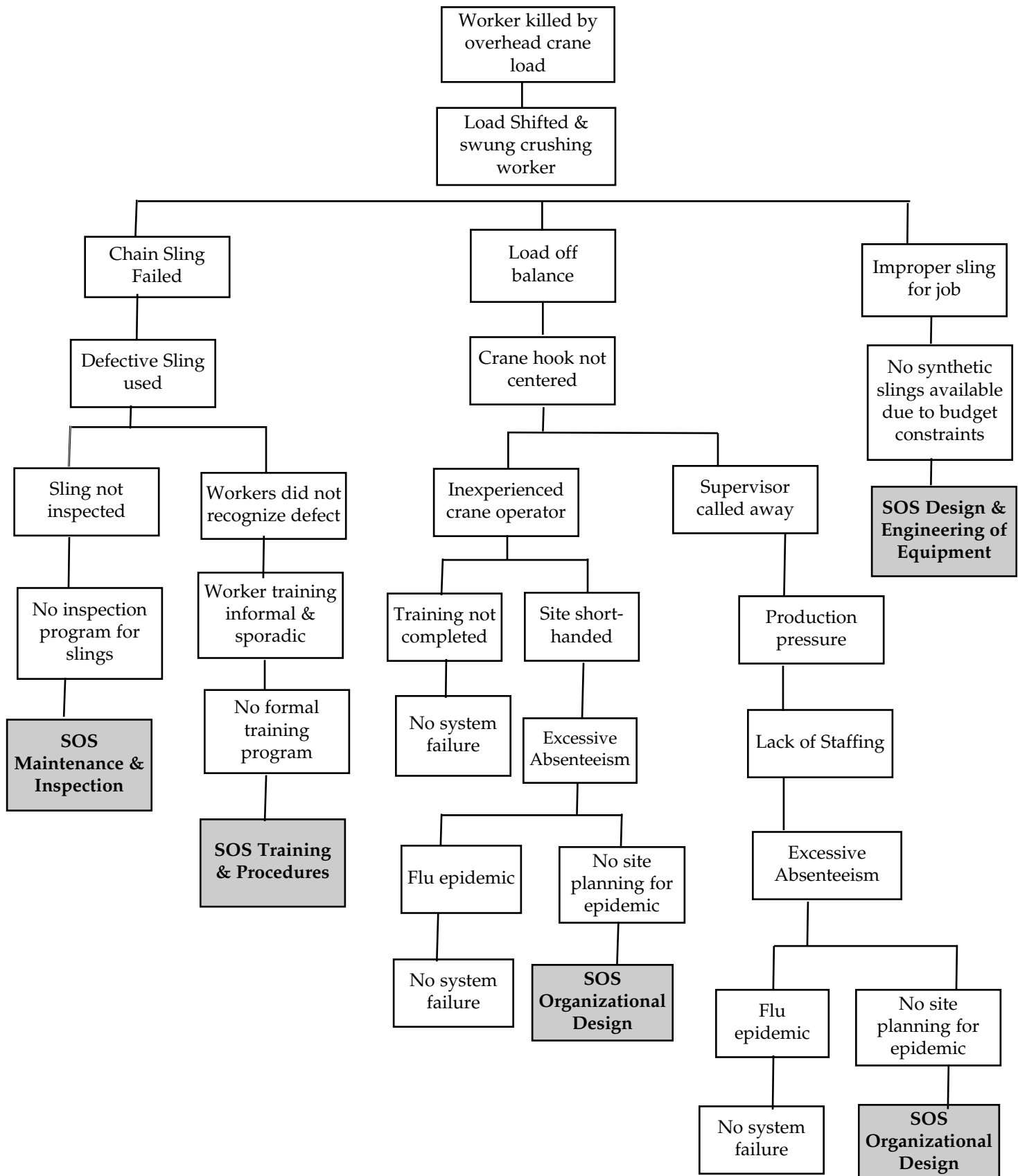
- The sling showed signs of excessive use including stretching of links, gouges and nicks.
- There was no formalized procedure in place requiring daily inspection or cleaning of slings prior to use.
- There were several different types of alloy slings used from different manufacturers and specs for each had been misplaced or were not available to workers.
- Training on sling inspection was sporadic and informal.
- The load was outside the rated capacity of the sling.
- The tool bin had been recently moved and there were no systems in place for storing slings according to load capacity.

-
- There was no procedure for tracking the history, care and usage of slings.
 - The crane hook was slightly off the center of gravity therefore causing an angle on one of the legs.
 - One of the legs of the sling failed causing the load to swing widely and out of control.
 - The sling was beyond its rated time of use.
 - There was slack in the line which caused the load to jerk when first lifted.
 - There were several people attempting to direct the crane operator.
 - Once the load shifted, it was left hanging while the operator tried to determine what to do.

Task:

The joint management/labor investigation produced the following logic tree. You are the local's health and safety committee and you have been asked to review the logic tree (on the next page), its conclusions and to make recommendations to management. When making your recommendations you should consider which fixes that would have the greatest possibility of assuring that an accident like this does not happen again. Your recommendations are going to be developed into a lessons learned and distributed to all sites in the corporation.

1. What are your group's top recommendations?

Task 1 (continued)

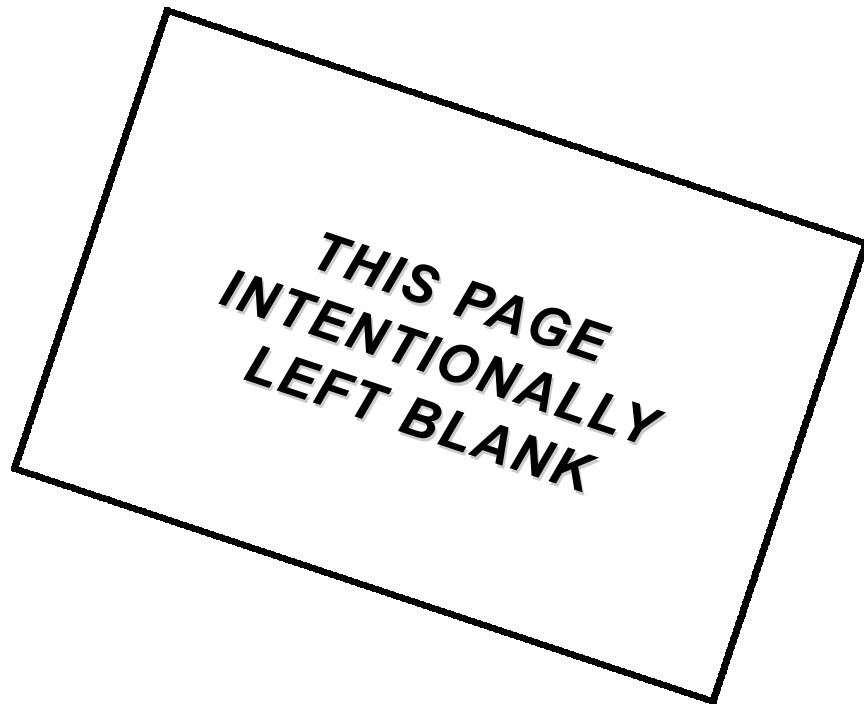
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Task 2

Purpose Restated: To understand the differences between the preliminary factors of incidents and accidents and the root causes.

Your group has also been asked to review the investigation committee's report. Are there any other recommendations you would make to management based on facts that were not used in the logic tree? Please give at least one and explain why.

Recommendation	Why



Summary: Understanding Root Causes

1. The idea that incidents and accidents are caused by unthinking or accident-prone workers is not only outdated, but inaccurate.
2. Most investigations only address the preliminary factors of incidents. Preliminary factors include things such as sling failure or a worker not following a procedure. Preliminary factors are the symptoms of problems in management safety systems.
3. The root causes of incidents are the factors which underlie preliminary factors. Examples of root causes include inadequate sling inspection and unclear, outdated or unavailable procedures.
4. Many incidents and near-misses are repeated because previous fixes only addressed the preliminary factors.

EVALUATION

Activity 5: Incident Investigation using Root Cause Analysis

1. How important is this Activity for workers? Please circle one number.

Activity Is Not Important			Activity Is Very Important	
1	2	3	4	5

2. Which factsheets are the most important to distribute to the workers? (Please list the page numbers.)

3. What would you suggest be done to improve this Activity?

Activity 6: Applying the OSHA Standards for Prevention

Purpose

To gain a general understanding of the OSHA standard 1910.179, 1910.180 and 1910.184.

To learn how to reference these standards.

This Activity has one task.

Task

Purposes Restated:

To gain a general understanding of the OSHA standard 1910.179, 1910.180 and 1910.184.

To learn how to reference these standards.

Scenario:

Millard Smith, a material handler, was killed when crushed by a 16,000 lb. load that was being moved by an overhead crane. The load was secured by an alloy chain sling when the load shifted and fell crushing Smith between it and a piece of stationary equipment. Although a synthetic sling was more appropriate for the job only alloy slings were available on site due to budget constraints.

Rescuers were unable to extract Smith in a timely manner and he died on the way to the hospital. Initial investigation by a management/labor team revealed the following facts.

The site was short handed that day due to a flu infection that had caused significant absenteeism at the site. There had been no preplanning on how to handle a possible pandemic flu outbreak and continue safe operations. Smith had been pressed into service as a crane operator at the end of his ninth in a row 16-hour shift. He had some training on the crane but had not completed it. A supervisor had been assigned to oversee his work but was distracted by a production upset in another area of the plant. Production was running behind due to the flu outbreak and there was serious pressure from above to keep things moving. Additionally:

- The sling showed signs of excessive use including stretching of links, gouges and nicks.
- There was no formalized procedure in place requiring daily inspection or cleaning of slings prior to use.
- There were several different types of alloy slings used from different manufacturers and specs for each had been misplaced or were not available to workers.
- Training on sling inspection was sporadic and informal.
- The load was outside the rated capacity of the sling.

-
- The tool bin had been recently moved and there were no systems in place for storing slings according to load capacity.
 - There was no procedure for tracking the history, care and usage of slings.
 - The crane hook was slightly off the center of gravity, therefore causing an angle on one of the legs.
 - One of the legs of the sling failed causing the load to swing widely and out of control.
 - The sling was beyond its rated time of use.
 - There was slack in the line which caused the load to jerk when first lifted.
 - There were several people attempting to direct the crane operator.
 - Once the load shifted it was left hanging while the operator tried to determine what to do.

Task

After reading this case, determine what parts of OSHA standards 1910.179 (starting on page 104) and 1910.184 (starting on page 129) were violated and identify the specific section(s). (Divide the small group at each table into half to read the two standards.) The standards are included starting on the next page.

Overhead and gantry cranes. - 1910.179-----
Regulations (Standards - 29 CFR) - Table of Contents

• Part Number:	1910
• Part Title:	Occupational Safety and Health Standards
• Subpart:	N
• Subpart Title:	Materials Handling and Storage
• Standard Number:	1910.179
• Title:	Overhead and gantry cranes.

1910.179(a)

Definitions applicable to this section.

1910.179(a)(1)

A “crane” is a machine for lifting and lowering a load and moving it horizontally, with the hoisting mechanism an integral part of the machine. Cranes whether fixed or mobile are driven manually or by power.

1910.179(a)(2)

An “automatic crane” is a crane which when activated operates through a preset cycle or cycles.

1910.179(a)(3)

A “cab-operated crane” is a crane controlled by an operator in a cab located on the bridge or trolley.

1910.179(a)(4)

“Cantilever gantry crane” means a gantry or semigantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.

1910.179(a)(5)

“Floor-operated crane” means a crane which is pendant or nonconductive rope controlled by an operator on the floor or an independent platform.

1910.179(a)(6)

“Gantry crane” means a crane similar to an overhead crane except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.

1910.179(a)(7)

“Hot metal handling crane” means an overhead crane used for transporting or pouring molten material.

1910.179(a)(8)

“Overhead crane” means a crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed runway structure.

1910.179(a)(9)

“Power-operated crane” means a crane whose mechanism is driven by electric, air, hydraulic, or internal combustion means.

1910.179(a)(10)

A “pulpit-operated crane” is a crane operated from a fixed operator station not attached to the crane.

1910.179(a)(11)

A “remote-operated crane” is a crane controlled by an operator not in a pulpit or in the cab attached to the crane, by any method other than pendant or rope control.

1910.179(a)(12)

A “semigantry crane” is a gantry crane with one end of the bridge rigidly supported on one or more legs that run on a fixed rail or runway, the other end of the bridge being supported by a truck running on an elevated rail or runway.

1910.179(a)(13)

“Storage bridge crane” means a gantry type crane of long span usually used for bulk storage of material; the bridge girders or trusses are rigidly or nonrigidly supported on one or more legs. It may have one or more fixed or hinged cantilever ends.

1910.179(a)(14)

“Wall crane” means a crane having a jib with or without trolley and supported from a side wall or line of columns of a building. It is a traveling type and operates on a runway attached to the side wall or columns.

1910.179(a)(15)

“Appointed” means assigned specific responsibilities by the employer or the employer's representative.

1910.179(a)(16)

“ANSI” means the American National Standards Institute.

1910.179(a)(17)

An “auxiliary hoist” is a supplemental hoisting unit of lighter capacity and usually higher speed than provided for the main hoist.

1910.179(a)(18)

A “brake” is a device used for retarding or stopping motion by friction or power means.

1910.179(a)(19)

A “drag brake” is a brake which provides retarding force without external control.

1910.179(a)(20)

A “holding brake” is a brake that automatically prevents motion when power is off.

1910.179(a)(21)

“Bridge” means that part of a crane consisting of girders, trucks, end ties, footwalks, and drive mechanism which carries the trolley or trolleys.

1910.179(a)(22)

“Bridge travel” means the crane movement in a direction parallel to the crane runway.

1910.179(a)(23)

A “bumper” [buffer] is an energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel; or when two moving cranes or trolleys come in contact.

1910.179(a)(24)

The “cab” is the operator's compartment on a crane.

1910.179(a)(25)

“Clearance” means the distance from any part of the crane to a point of the nearest obstruction.

1910.179(a)(26)

“Collectors current” are contacting devices for collecting current from runway or bridge conductors.

1910.179(a)(27)

“Conductors, bridge” are the electrical conductors located along the bridge structure of a crane to provide power to the trolley.

1910.179(a)(28)

“Conductors, runway” [main] are the electrical conductors located along a crane runway to provide power to the crane.

1910.179(a)(29)

The “control braking means” is a method of controlling crane motor speed when in an overhauling condition.

1910.179(a)(30)

“Countertorque” means a method of control by which the power to the motor is reversed to develop torque in the opposite direction.

1910.179(a)(31)

“Dynamic” means a method of controlling crane motor speeds when in the overhauling condition to provide a retarding force.

1910.179(a)(32)

“Regenerative” means a form of dynamic braking in which the electrical energy generated is fed back into the power system.

1910.179(a)(33)

“Mechanical” means a method of control by friction.

1910.179(a)(34)

“Controller, spring return” means a controller which when released will return automatically to a neutral position.

1910.179(a)(35)

“Designated” means selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

1910.179(a)(36)

A “drift point” means a point on a travel motion controller which releases the brake while the motor is not energized. This allows for coasting before the brake is set.

1910.179(a)(37)

The “drum” is the cylindrical member around which the ropes are wound for raising or lowering the load.

1910.179(a)(38)

An “equalizer” is a device which compensates for unequal length or stretch of a rope.

1910.179(a)(39)

“Exposed” means capable of being contacted inadvertently. Applied to hazardous objects not adequately guarded or isolated.

1910.179(a)(40)

“Fail-safe” means a provision designed to automatically stop or safely control any motion in which a malfunction occurs.

1910.179(a)(41)

“Footwalk” means the walkway with handrail, attached to the bridge or trolley for access purposes.

1910.179(a)(42)

A “hoist” is an apparatus which may be a part of a crane, exerting a force for lifting or lowering.

1910.179(a)(43)

“Hoist chain” means the load bearing chain in a hoist.

NOTE: Chain properties do not conform to those shown in ANSI B30.9-1971, Safety Code for Slings.

1910.179(a)(44)

“Hoist motion” means that motion of a crane which raises and lowers a load.

1910.179(a)(45)

“Load” means the total superimposed weight on the load block or hook.

1910.179(a)(46)

The “load block” is the assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoisting rope.

1910.179(a)(47)

“Magnet” means an electromagnetic device carried on a crane hook to pick up loads magnetically.

1910.179(a)(48)

“Main hoist” means the hoist mechanism provided for lifting the maximum rated load.

1910.179(a)(49)

A “man trolley” is a trolley having an operator's cab attached thereto.

1910.179(a)(50)

“Rated load” means the maximum load for which a crane or individual hoist is designed and built by the manufacturer and shown on the equipment nameplate(s).

1910.179(a)(51)

“Rope” refers to wire rope, unless otherwise specified.

1910.179(a)(52)

“Running sheave” means a sheave which rotates as the load block is raised or lowered.

1910.179(a)(53)

“Runway” means an assembly of rails, beams, girders, brackets, and framework on which the crane or trolley travels.

1910.179(a)(54)

“Side pull” means that portion of the hoist pull acting horizontally when the hoist lines are not operated vertically.

1910.179(a)(55)

“Span” means the horizontal distance center to center of runway rails.

1910.179(a)(56)

“Standby crane” means a crane which is not in regular service but which is used occasionally or intermittently as required.

1910.179(a)(57)

A “stop” is a device to limit travel of a trolley or crane bridge. This device normally is attached to a fixed structure and normally does not have energy absorbing ability.

1910.179(a)(58)

A “switch” is a device for making, breaking, or for changing the connections in an electric circuit.

1910.179(a)(59)

An “emergency stop switch” is a manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

1910.179(a)(60)

A “limit switch” is a switch which is operated by some part or motion of a power-driven machine or equipment to alter the electric circuit associated with the machine or equipment.

1910.179(a)(61)

A “main switch” is a switch controlling the entire power supply to the crane.

1910.179(a)(62)

A “master switch” is a switch which dominates the operation of contactors, relays, or other remotely operated devices.

1910.179(a)(63)

The “trolley” is the unit which travels on the bridge rails and carries the hoisting mechanism.

1910.179(a)(64)

“Trolley travel” means the trolley movement at right angles to the crane runway.

1910.179(a)(65)

“Truck” means the unit consisting of a frame, wheels, bearings, and axles which supports the bridge girders or trolleys.

1910.179(b)

General requirements -

1910.179(b)(1)

Application. This section applies to overhead and gantry cranes, including semigantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics. These cranes are grouped because they all have trolleys and similar travel characteristics.

1910.179(b)(2)

New and existing equipment. All new overhead and gantry cranes constructed and installed on or after August 31, 1971, shall meet the design specifications of the American National Standard Safety Code for Overhead and Gantry Cranes, ANSI B30.2.0-1967, which is incorporated by reference as specified in Sec. 1910.6.

1910.179(b)(3)

Modifications. Cranes may be modified and rerated provided such modifications and the supporting structure are checked thoroughly for the new rated load by a qualified engineer or the equipment manufacturer. The crane shall be tested in accordance with paragraph (k) (2) of this section. New rated load shall be displayed in accordance with subparagraph (5) of this paragraph.

1910.179(b)(4)

Wind indicators and rail clamps. Outdoor storage bridges shall be provided with automatic rail clamps. A wind-indicating device shall be provided which will give a visible or audible alarm to the bridge operator at a predetermined wind velocity. If the clamps act on the rail heads, any beads or weld flash on the rail heads shall be ground off.

1910.179(b)(5)

Rated load marking. The rated load of the crane shall be plainly marked on each side of the crane, and if the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block and this marking shall be clearly legible from the ground or floor.

1910.179(b)(6)

Clearance from obstruction.

1910.179(b)(6)(i)

Minimum clearance of 3 inches overhead and 2 inches laterally shall be provided and maintained between crane and obstructions in conformity with Crane Manufacturers Association of America, Inc, Specification No. 61, which is incorporated by reference as specified in Sec. 1910.6, (formerly the Electric Overhead Crane Institute, Inc).

1910.179(b)(6)(ii)

Where passageways or walkways are provided obstructions shall not be placed so that safety of personnel will be jeopardized by movements of the crane.

1910.179(b)(7)

Clearance between parallel cranes. If the runways of two cranes are parallel, and there are no intervening walls or structure, there shall be adequate clearance provided and maintained between the two bridges.

1910.179(b)(8)

Designated personnel - Only designated personnel shall be permitted to operate a crane covered by this section.

1910.179(c)

Cabs -

1910.179(c)(1)

Cab location.

1910.179(c)(1)(i)

The general arrangement of the cab and the location of control and protective equipment shall be such that all operating handles are within convenient reach of the operator when facing the area to be served by the load hook, or while facing the direction of travel of the cab. The arrangement shall allow the operator a full view of the load hook in all positions.

1910.179(c)(1)(ii)

The cab shall be located to afford a minimum of 3 inches clearance from all fixed structures within its area of possible movement.

1910.179(c)(2)

Access to crane. Access to the cab and/or bridge walkway shall be by a conveniently placed fixed ladder, stairs, or platform requiring no step over any gap exceeding 12 inches. Fixed ladders shall be in conformance with the American National Standard Safety Code for Fixed Ladders, ANSI A14.3-1956, which is incorporated by reference as specified in Sec. 1910.6.

1910.179(c)(3)

Fire extinguisher. Carbon tetrachloride extinguishers shall not be used.

1910.179(c)(4)

Lighting. Light in the cab shall be sufficient to enable the operator to see clearly enough to perform his work.

1910.179(d)

Footwalks and ladders -

1910.179(d)(1)

Location of footwalks.

1910.179(d)(1)(i)

If sufficient headroom is available on cab-operated cranes, a footwalk shall be provided on the drive side along the entire length of the bridge of all cranes having the trolley running on the top of the girders.

1910.179(d)(1)(ii)

Where footwalks are located in no case shall less than 48 inches of headroom be provided.

1910.179(d)(2)

Construction of footwalks.

1910.179(d)(2)(i)

Footwalks shall be of rigid construction and designed to sustain a distributed load of at least 50 pounds per square foot.

1910.179(d)(2)(ii)

Footwalks shall have a walking surface of antislip type.

NOTE: Wood will meet this requirement.

1910.179(d)(2)(iii)

[Reserved]

1910.179(d)(2)(iv)

The inner edge shall extend at least to the line of the outside edge of the lower cover plate or flange of the girder.

1910.179(d)(3)

Toeboards and handrails for footwalks. Toeboards and handrails shall be in compliance with section 1910.23 of this part.

1910.179(d)(4)

Ladders and stairways.

1910.179(d)(4)(i)

Gantry cranes shall be provided with ladders or stairways extending from the ground to the footwalk or cab platform.

1910.179(d)(4)(ii)

Stairways shall be equipped with rigid and substantial metal handrails. Walking surfaces shall be of an antislip type.

1910.179(d)(4)(iii)

Ladders shall be permanently and securely fastened in place and shall be constructed in compliance with 1910.27.

1910.179(e)

Stops, bumpers, rail sweeps, and guards -

1910.179(e)(1)

Trolley stops.

1910.179(e)(1)(i)

Stops shall be provided at the limits of travel of the trolley.

1910.179(e)(1)(ii)

Stops shall be fastened to resist forces applied when contacted.

1910.179(e)(1)(iii)

A stop engaging the tread of the wheel shall be of a height at least equal to the radius of the wheel.

1910.179(e)(2)

Bridge bumpers -

1910.179(e)(2)(i)

A crane shall be provided with bumpers or other automatic means providing equivalent effect, unless the crane travels at a slow rate of speed and has a faster deceleration rate due to the use of sleeve bearings, or is not operated near the ends of bridge and trolley travel, or is restricted to a limited distance by the nature of the crane operation and there is no hazard of striking any object in this limited distance, or is used in similar operating conditions. The bumpers shall be capable of stopping the crane (not including the lifted load) at an average rate of deceleration not to exceed 3 ft/s/s when traveling in either direction at 20 percent of the rated load speed.

1910.179(e)(2)(i)(a)

The bumpers shall have sufficient energy absorbing capacity to stop the crane when traveling at a speed of at least 40 percent of rated load speed.

1910.179(e)(2)(i)(b)

The bumper shall be so mounted that there is no direct shear on bolts.

1910.179(e)(2)(ii)

Bumpers shall be so designed and installed as to minimize parts falling from the crane in case of breakage.

1910.179(e)(3)

Trolley bumpers -

1910.179(e)(3)(i)

A trolley shall be provided with bumpers or other automatic means of equivalent effect, unless the trolley travels at a slow rate of speed, or is not operated near the ends of bridge and trolley travel, or is restricted to a limited distance of the runway and there is no hazard of striking any object in this limited distance, or is used in similar operating conditions. The bumpers shall be capable of stopping the trolley (not including the lifted load) at an average rate of deceleration not to exceed 4.7 ft/s/s when traveling in either direction at one-third of the rated load speed.

1910.179(e)(3)(ii)

When more than one trolley is operated on the same bridge, each shall be equipped with bumpers or equivalent on their adjacent ends.

1910.179(e)(3)(iii)

Bumpers or equivalent shall be designed and installed to minimize parts falling from the trolley in case of age.

1910.179(e)(4)

Rail sweeps. Bridge trucks shall be equipped with sweeps which extend below the top of the rail and project in front of the truck wheels.

1910.179(e)(5)

Guards for hoisting ropes.

1910.179(e)(5)(i)

If hoisting ropes run near enough to other parts to make fouling or chafing possible, guards shall be installed to prevent this condition.

1910.179(e)(5)(ii)

A guard shall be provided to prevent contact between bridge conductors and hoisting ropes if they could come into contact.

1910.179(e)(6)

Guards for moving parts.

1910.179(e)(6)(i)

Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating components which might constitute a hazard under normal operating conditions shall be guarded.

1910.179(e)(6)(ii)

Guards shall be securely fastened.

1910.179(e)(6)(iii)

Each guard shall be capable of supporting without permanent distortion the weight of a 200-pound person unless the guard is located where it is impossible for a person to step on it.

1910.179(f)

Brakes -

1910.179(f)(1)

Brakes for hoists.

1910.179(f)(1)(i)

Each independent hoisting unit of a crane shall be equipped with at least one self-setting brake, hereafter referred to as a holding brake, applied directly to the motor shaft or some part of the gear train.

1910.179(f)(1)(ii)

Each independent hoisting unit of a crane, except worm-gear hoists, the angle of whose worm is such as to prevent the load from accelerating in the lowering direction shall, in addition to a holding brake, be equipped with control braking means to prevent overspeeding.

1910.179(f)(2)

Holding brakes.

1910.179(f)(2)(i)

Holding brakes for hoist motors shall have not less than the following percentage of the full load hoisting torque at the point where the brake is applied.

1910.179(f)(2)(i)(a)

125 percent when used with a control braking means other than mechanical.

1910.179(f)(2)(i)(b)

100 percent when used in conjunction with a mechanical control braking means.

1910.179(f)(2)(i)(c)

100 percent each if two holding brakes are provided.

1910.179(f)(2)(ii)

Holding brakes on hoists shall have ample thermal capacity for the frequency of operation required by the service.

1910.179(f)(2)(iii)

Holding brakes on hoists shall be applied automatically when power is removed.

1910.179(f)(2)(iv)

Where necessary holding brakes shall be provided with adjustment means to compensate for wear.

1910.179(f)(2)(v)

The wearing surface of all holding-brake drums or discs shall be smooth.

1910.179(f)(2)(vi)

Each independent hoisting unit of a crane handling hot metal and having power control braking means shall be equipped with at least two holding brakes.

1910.179(f)(3)

Control braking means.

1910.179(f)(3)(i)

A power control braking means such as regenerative, dynamic or countertorque braking, or a mechanically controlled braking means shall be capable of maintaining safe lowering speeds of rated loads.

1910.179(f)(3)(ii)

The control braking means shall have ample thermal capacity for the frequency of operation required by service.

1910.179(f)(4)

Brakes for trolleys and bridges.

1910.179(f)(4)(i)

Foot-operated brakes shall not require an applied force of more than 70 pounds to develop manufacturer's rated brake torque.

1910.179(f)(4)(ii)

Brakes may be applied by mechanical, electrical, pneumatic, hydraulic, or gravity means.

1910.179(f)(4)(iii)

Where necessary brakes shall be provided with adjustment means to compensate for wear.

1910.179(f)(4)(iv)

The wearing surface of all brakedrums or discs shall be smooth.

1910.179(f)(4)(v)

All foot-brake pedals shall be constructed so that the operator's foot will not easily slip off the pedal.

1910.179(f)(4)(vi)

Foot-operated brakes shall be equipped with automatic means for positive release when pressure is released from the pedal.

1910.179(f)(4)(vii)

Brakes for stopping the motion of the trolley or bridge shall be of sufficient size to stop the trolley or bridge within a distance in feet equal to 10 percent of full load speed in feet per minute when traveling at full speed with full load.

1910.179(f)(4)(viii)

If holding brakes are provided on the bridge or trolleys, they shall not prohibit the use of a drift point in the control circuit.

1910.179(f)(4)(ix)

Brakes on trolleys and bridges shall have ample thermal capacity for the frequency of operation required by the service to prevent impairment of functions from overheating.

1910.179(f)(5)

Application of trolley brakes.

1910.179(f)(5)(i)

On cab-operated cranes with cab on trolley, a trolley brake shall be required as specified under paragraph (f)(4) of this section.

1910.179(f)(5)(ii)

A drag brake may be applied to hold the trolley in a desired position on the bridge and to eliminate creep with the power off.

1910.179(f)(6)

Application of bridge brakes.

1910.179(f)(6)(i)

On cab-operated cranes with cab on bridge, a bridge brake is required as specified under paragraph (f)(4) of this section.

1910.179(f)(6)(ii)

On cab-operated cranes with cab on trolley, a bridge brake of the holding type shall be required.

1910.179(f)(6)(iii)

On all floor, remote and pulpit-operated crane bridge drives, a brake of noncoasting mechanical drive shall be provided.

1910.179(g)

Electric equipment -

1910.179(g)(1)

General.

1910.179(g)(1)(i)

Wiring and equipment shall comply with subpart S of this part.

1910.179(g)(1)(ii)

The control circuit voltage shall not exceed 600 volts for a.c. or d.c. current.

1910.179(g)(1)(iii)

The voltage at pendant push-buttons shall not exceed 150 volts for a.c. and 300 volts for d.c.

1910.179(g)(1)(iv)

Where multiple conductor cable is used with a suspended pushbutton station, the station must be supported in some satisfactory manner that will protect the electrical conductors against strain.

1910.179(g)(1)(v)

Pendant control boxes shall be constructed to prevent electrical shock and shall be clearly marked for identification of functions.

1910.179(g)(2)

Equipment.

1910.179(g)(2)(i)

Electrical equipment shall be so located or enclosed that live parts will not be exposed to accidental contact under normal operating conditions.

1910.179(g)(2)(ii)

Electric equipment shall be protected from dirt, grease, oil, and moisture.

1910.179(g)(2)(iii)

Guards for live parts shall be substantial and so located that they cannot be accidentally deformed so as to make contact with the live parts.

1910.179(g)(3)

Controllers.

1910.179(g)(3)(i)

Cranes not equipped with spring-return controllers or momentary contact pushbuttons shall be provided with a device which will disconnect all motors from the line on failure of power and will not permit any motor to be restarted until the controller handle is brought to the "off" position, or a reset switch or button is operated.

1910.179(g)(3)(ii)

Lever operated controllers shall be provided with a notch or latch which in the "off" position prevents the handle from being inadvertently moved to the "on" position. An "off" detent or spring return arrangement is acceptable.

1910.179(g)(3)(iii)

The controller operating handle shall be located within convenient reach of the operator.

1910.179(g)(3)(iv)

As far as practicable, the movement of each controller handle shall be in the same general directions as the resultant movements of the load.

1910.179(g)(3)(v)

The control for the bridge and trolley travel shall be so located that the operator can readily face the direction of travel.

1910.179(g)(3)(vi)

For floor-operated cranes, the controller or controllers if rope operated, shall automatically return to the "off" position when released by the operator.

1910.179(g)(3)(vii)

Pushbuttons in pendant stations shall return to the "off" position when pressure is released by the crane operator.

1910.179(g)(3)(viii)

Automatic cranes shall be so designed that all motions shall fail-safe if any malfunction of operation occurs.

1910.179(g)(3)(ix)

Remote-operated cranes shall function so that if the control signal for any crane motion becomes ineffective the crane motion shall stop.

1910.179(g)(4)

Resistors.

1910.179(g)(4)(i)

Enclosures for resistors shall have openings to provide adequate ventilation, and shall be installed to prevent the accumulation of combustible matter too near to hot parts.

1910.179(g)(4)(ii)

Resistor units shall be supported so as to be as free as possible from vibration.

1910.179(g)(4)(iii)

Provision shall be made to prevent broken parts or molten metal falling upon the operator or from the crane.

1910.179(g)(5)

Switches.

1910.179(g)(5)(i)

The power supply to the runway conductors shall be controlled by a switch or circuit breaker located on a fixed structure, accessible from the floor, and arranged to be locked in the open position.

1910.179(g)(5)(ii)

On cab-operated cranes a switch or circuit breaker of the enclosed type, with provision for locking in the open position, shall be provided in the leads from the runway conductors. A means of opening this switch or circuit breaker shall be located within easy reach of the operator.

1910.179(g)(5)(iii)

On floor-operated cranes, a switch or circuit breaker of the enclosed type, with provision for locking in the open position, shall be provided in the leads from the runway conductors. This disconnect shall be mounted on the bridge or footwalk near the runway collectors. One of the following types of floor-operated disconnects shall be provided:

1910.179(g)(5)(iii)(a)

Nonconductive rope attached to the main disconnect switch.

1910.179(g)(5)(iii)(b)

An undervoltage trip for the main circuit breaker operated by an emergency stop button in the pendant pushbutton in the pendant pushbutton station.

1910.179(g)(5)(iii)(c)

A main line contactor operated by a switch or pushbutton in the pendant pushbutton station.

1910.179(g)(5)(iv)

The hoisting motion of all electric traveling cranes shall be provided with an overtravel limit switch in the hoisting direction.

1910.179(g)(5)(v)

All cranes using a lifting magnet shall have a magnet circuit switch of the enclosed type with provision for locking in the open position. Means for discharging the inductive load of the magnet shall be provided.

1910.179(g)(6)

Runway conductors. Conductors of the open type mounted on the crane runway beams or overhead shall be so located or so guarded that persons entering or leaving the cab or crane footwalk normally could not come into contact with them.

1910.179(g)(7)

Extension lamps. If a service receptacle is provided in the cab or on the bridge of cab-operated cranes, it shall be a grounded three-prong type permanent receptacle, not exceeding 300 volts.

1910.179(h)

Hoisting equipment -

1910.179(h)(1)

Sheaves.

1910.179(h)(1)(i)

Sheave grooves shall be smooth and free from surface defects which could cause rope damage.

1910.179(h)(1)(ii)

Sheaves carrying ropes which can be momentarily unloaded shall be provided with close-fitting guards or other suitable devices to guide the rope back into the groove when the load is applied again.

1910.179(h)(1)(iii)

The sheaves in the bottom block shall be equipped with close-fitting guards that will prevent ropes from becoming fouled when the block is lying on the ground with ropes loose.

1910.179(h)(1)(iv)

Pockets and flanges of sheaves used with hoist chains shall be of such dimensions that the chain does not catch or bind during operation.

1910.179(h)(1)(v)

All running sheaves shall be equipped with means for lubrication. Permanently lubricated, sealed and/or shielded bearings meet this requirement.

1910.179(h)(2)

Ropes.

1910.179(h)(2)(i)

In using hoisting ropes, the crane manufacturer's recommendation shall be followed. The rated load divided by the number of parts of rope shall not exceed 20 percent of the nominal breaking strength of the rope.

1910.179(h)(2)(ii)

Socketing shall be done in the manner specified by the manufacturer of the assembly.

1910.179(h)(2)(iii)

Rope shall be secured to the drum as follows:

1910.179(h)(2)(iii)(a)

No less than two wraps of rope shall remain on the drum when the hook is in its extreme low position.

1910.179(h)(2)(iii)(b)

Rope end shall be anchored by a clamp securely attached to the drum, or by a socket arrangement approved by the crane or rope manufacturer.

1910.179(h)(2)(iv)

Eye splices. [Reserved]

1910.179(h)(2)(v)

Rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope. Spacing and number of all types of clips shall be in accordance with the clip manufacturer's recommendation. Clips shall be drop-forged steel in all sizes manufactured commercially. When a newly installed rope has been in operation for an hour, all nuts on the clip bolts shall be retightened.

1910.179(h)(2)(vi)

Swaged or compressed fittings shall be applied as recommended by the rope or crane manufacturer.

1910.179(h)(2)(vii)

Wherever exposed to temperatures, at which fiber cores would be damaged, rope having an independent wire rope or wire-strand core, or other temperature-damage resistant core shall be used.

1910.179(h)(2)(viii)

Replacement rope shall be the same size, grade, and construction as the original rope furnished by the crane manufacturer, unless otherwise recommended by a wire rope manufacturer due to actual working condition requirements.

1910.179(h)(3)

Equalizers. If a load is supported by more than one part of rope, the tension in the parts shall be equalized.

1910.179(h)(4)

Hooks. Hooks shall meet the manufacturer's recommendations and shall not be overloaded.

1910.179(i)

Warning device. Except for floor-operated cranes a gong or other effective warning signal shall be provided for each crane equipped with a power traveling mechanism.

1910.179(j)

Inspection -

1910.179(j)(1)

Inspection classification.

1910.179(j)(1)(i)

Initial inspection. Prior to initial use all new and altered cranes shall be inspected to insure compliance with the provisions of this section.

1910.179(j)(1)(ii)

Inspection procedure for cranes in regular service is divided into two general classifications based upon the intervals at which inspection should be performed. The intervals in turn are dependent upon the nature of the critical components of the crane and the degree of their exposure to wear, deterioration, or malfunction. The two general classifications are herein designated as "frequent" and "periodic" with respective intervals between inspections as defined below:

1910.179(j)(1)(ii)(a)

Frequent inspection - Daily to monthly intervals.

1910.179(j)(1)(ii)(b)

Periodic inspection - 1 to 12-month intervals.

1910.179(j)(2)

Frequent inspection. The following items shall be inspected for defects at intervals as defined in paragraph (j)(1)(ii) of this section or as specifically indicated, including observation during operation for any defects which might appear between regular inspections. All deficiencies such as listed shall be carefully examined and determination made as to whether they constitute a safety hazard:

1910.179(j)(2)(i)

All functional operating mechanisms for maladjustment interfering with proper operation. Daily.

1910.179(j)(2)(ii)

Deterioration or leakage in lines, tanks, valves, drain pumps, and other parts of air or hydraulic systems. Daily.

1910.179(j)(2)(iii)

Hooks with deformation or cracks. Visual inspection daily; monthly inspection with a certification record which includes the date of inspection, the signature of the person who performed the inspection and the serial number, or other identifier, of the hook inspected. For hooks with cracks or having more than 15 percent in excess of normal throat opening or more than 10° twist from the plane of the unbent hook refer to paragraph (l)(3)(iii)(a) of this section.

1910.179(j)(2)(iv)

Hoist chains, including end connections, for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations. Visual inspection daily; monthly inspection with a certification record which includes the date of inspection, the signature of the person who performed the inspection and an identifier of the chain which was inspected.

1910.179(j)(2)(v)

[Reserved]

1910.179(j)(2)(vi)

All functional operating mechanisms for excessive wear of components.

1910.179(j)(2)(vii)

Rope reeving for noncompliance with manufacturer's recommendations.

1910.179(j)(3)

Periodic inspection. Complete inspections of the crane shall be performed at intervals as generally defined in paragraph (j)(1)(ii)(b) of this section, depending upon its activity, severity of service, and environment, or as specifically indicated below. These inspections shall include the requirements of paragraph (j)(2) of this section and in addition, the following items. Any deficiencies such as listed shall be carefully examined and determination made as to whether they constitute a safety hazard:

- 1910.179(j)(3)(i)
Deformed, cracked, or corroded members.
- 1910.179(j)(3)(ii)
Loose bolts or rivets.
- 1910.179(j)(3)(iii)
Cracked or worn sheaves and drums.
- 1910.179(j)(3)(iv)
Worn, cracked or distorted parts such as pins, bearings, shafts, gears, rollers, locking and clamping devices.
- 1910.179(j)(3)(v)
Excessive wear on brake system parts, linings, pawls, and ratchets.
- 1910.179(j)(3)(vi)
Load, wind, and other indicators over their full range, for any significant inaccuracies.
- 1910.179(j)(3)(vii)
Gasoline, diesel, electric, or other powerplants for improper performance or noncompliance with applicable safety requirements.
- 1910.179(j)(3)(viii)
Excessive wear of chain drive sprockets and excessive chain stretch.
- 1910.179(j)(3)(ix)
[Reserved]
- 1910.179(j)(3)(x)
Electrical apparatus, for signs of pitting or any deterioration of controller contactors, limit switches and pushbutton stations.
- 1910.179(j)(4)
Cranes not in regular use.
- 1910.179(j)(4)(i)
A crane which has been idle for a period of 1 month or more, but less than 6 months, shall be given an inspection conforming with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section before placing in service.
- 1910.179(j)(4)(ii)
A crane which has been idle for a period of over 6 months shall be given a complete inspection conforming with requirements of paragraphs (j)(2) and (3) of this section and paragraph (m)(2) of this section before placing in service.
- 1910.179(j)(4)(iii)
Standby cranes shall be inspected at least semi-annually in accordance with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section.

1910.179(k)
Testing -

1910.179(k)(1)
Operational tests.

1910.179(k)(1)(i)
Prior to initial use all new and altered cranes shall be tested to insure compliance with this section including the following functions:

1910.179(k)(1)(i)(a)
Hoisting and lowering.

1910.179(k)(1)(i)(b)
Trolley travel.

1910.179(k)(1)(i)(c)
Bridge travel.

1910.179(k)(1)(i)(d)
Limit switches, locking and safety devices.

1910.179(k)(1)(ii)

The trip setting of hoist limit switches shall be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch shall be located so that it will trip the switch, under all conditions, in sufficient time to prevent contact of the hook or hook block with any part of the trolley.

1910.179(k)(2)

Rated load test. Test loads shall not be more than 125 percent of the rated load unless otherwise recommended by the manufacturer. The test reports shall be placed on file where readily available to appointed personnel.

1910.179(l)
Maintenance -

1910.179(l)(1)
Preventive maintenance. A preventive maintenance program based on the crane manufacturer's recommendations shall be established.

1910.179(l)(2)
Maintenance procedure.

1910.179(l)(2)(i)
Before adjustments and repairs are started on a crane the following precautions shall be taken:

1910.179(l)(2)(i)(a)
The crane to be repaired shall be run to a location where it will cause the least interference with other cranes and operations in the area.

1910.179(l)(2)(i)(b)

All controllers shall be at the off position.

1910.179(l)(2)(i)(c)

The main or emergency switch shall be open and locked in the open position.

1910.179(l)(2)(i)(d)

Warning or “out of order” signs shall be placed on the crane, also on the floor beneath or on the hook where visible from the floor.

1910.179(l)(2)(i)(e)

Where other cranes are in operation on the same runway, rail stops or other suitable means shall be provided to prevent interference with the idle crane.

1910.179(l)(2)(ii)

After adjustments and repairs have been made the crane shall not be operated until all guards have been reinstalled, safety devices reactivated and maintenance equipment removed.

1910.179(l)(3)

Adjustments and repairs.

1910.179(l)(3)(i)

Any unsafe conditions disclosed by the inspection requirements of paragraph (j) of this section shall be corrected before operation of the crane is resumed. Adjustments and repairs shall be done only by designated personnel.

1910.179(l)(3)(ii)

Adjustments shall be maintained to assure correct functioning of components. The following are examples:

1910.179(l)(3)(ii)(a)

All functional operating mechanisms.

1910.179(l)(3)(ii)(b)

Limit switches.

1910.179(l)(3)(ii)(c)

Control systems.

1910.179(l)(3)(ii)(d)

Brakes.

1910.179(l)(3)(ii)(e)

Power plants.

1910.179(l)(3)(iii)

Repairs or replacements shall be provided promptly as needed for safe operation. The following are examples:

1910.179(l)(3)(iii)(a)

Crane hooks showing defects described in paragraph (j)(2)(iii) of this section shall be

discarded. Repairs by welding or reshaping are not generally recommended. If such repairs are attempted they shall only be done under competent supervision and the hook shall be tested to the load requirements of paragraph (k)(2) of this section before further use.

1910.179(l)(3)(iii)(b)

Load attachment chains and rope slings showing defects described in paragraph (j)(2)(iv) and (v) of this section respectively.

1910.179(l)(3)(iii)(c)

All critical parts which are cracked, broken, bent, or excessively worn.

1910.179(l)(3)(iii)(d)

Pendant control stations shall be kept clean and function labels kept legible.

1910.179(m)

Rope inspection. -

1910.179(m)(1)

Running ropes. A thorough inspection of all ropes shall be made at least once a month and a certification record which includes the date of inspection, the signature of the person who performed the inspection and an identifier for the ropes which were inspected shall be kept on file where readily available to appointed personnel. Any deterioration, resulting in appreciable loss of original strength, shall be carefully observed and determination made as to whether further use of the rope would constitute a safety hazard. Some of the conditions that could result in an appreciable loss of strength are the following:

1910.179(m)(1)(i)

Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires.

1910.179(m)(1)(ii)

A number of broken outside wires and the degree of distribution or concentration of such broken wires.

1910.179(m)(1)(iii)

Worn outside wires.

1910.179(m)(1)(iv)

Corroded or broken wires at end connections.

1910.179(m)(1)(v)

Corroded, cracked, bent, worn, or improperly applied end connections.

1910.179(m)(1)(vi)

Severe kinking, crushing, cutting, or unstranding.

1910.179(m)(2)

Other ropes. All rope which has been idle for a period of a month or more due to shutdown or storage of a crane on which it is installed shall be given a thorough

inspection before it is used. This inspection shall be for all types of deterioration and shall be performed by an appointed person whose approval shall be required for further use of the rope. A certification record shall be available for inspection which includes the date of inspection, the signature of the person who performed the inspection and an identifier for the rope which was inspected.

1910.179(n)

Handling the load -

1910.179(n)(1)

Size of load. The crane shall not be loaded beyond its rated load except for test purposes as provided in paragraph (k) of this section.

1910.179(n)(2)

Attaching the load.

1910.179(n)(2)(i)

The hoist chain or hoist rope shall be free from kinks or twists and shall not be wrapped around the load.

1910.179(n)(2)(ii)

The load shall be attached to the load block hook by means of slings or other approved devices.

1910.179(n)(2)(iii)

Care shall be taken to make certain that the sling clears all obstacles.

1910.179(n)(3)

Moving the load.

1910.179(n)(3)(i)

The load shall be well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

1910.179(n)(3)(ii)

Before starting to hoist the following conditions shall be noted:

1910.179(n)(3)(ii)(a)

Hoist rope shall not be kinked.

1910.179(n)(3)(ii)(b)

Multiple part lines shall not be twisted around each other.

1910.179(n)(3)(ii)(c)

The hook shall be brought over the load in such a manner as to prevent swinging.

1910.179(n)(3)(iii)

During hoisting care shall be taken that:

1910.179(n)(3)(iii)(a)

There is no sudden acceleration or deceleration of the moving load.

1910.179(n)(3)(iii)(b)

The load does not contact any obstructions.

1910.179(n)(3)(iv)

Cranes shall not be used for side pulls except when specifically authorized by a responsible person who has determined that the stability of the crane is not thereby endangered and that various parts of the crane will not be overstressed.

1910.179(n)(3)(v)

While any employee is on the load or hook, there shall be no hoisting, lowering, or traveling.

1910.179(n)(3)(vi)

The employer shall require that the operator avoid carrying loads over people.

1910.179(n)(3)(vii)

The operator shall test the brakes each time a load approaching the rated load is handled. The brakes shall be tested by raising the load a few inches and applying the brakes.

1910.179(n)(3)(viii)

The load shall not be lowered below the point where less than two full wraps of rope remain on the hoisting drum.

1910.179(n)(3)(ix)

When two or more cranes are used to lift a load one qualified responsible person shall be in charge of the operation. He shall analyze the operation and instruct all personnel involved in the proper positioning, rigging of the load, and the movements to be made.

1910.179(n)(3)(x)

The employer shall insure that the operator does not leave his position at the controls while the load is suspended.

1910.179(n)(3)(xi)

When starting the bridge and when the load or hook approaches near or over personnel the warning signal shall be sounded.

1910.179(n)(4)

Hoist limit switch.

1910.179(n)(4)(i)

At the beginning of each operator's shift, the upper limit switch of each hoist shall be tried out under no load. Extreme care shall be exercised; the block shall be "inched" into the limit or run in at slow speed. If the switch does not operate properly, the appointed person shall be immediately notified.

1910.179(n)(4)(ii)

The hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control.

1910.179(o)

Other requirements, general -

1910.179(o)(1)
Ladders.

1910.179(o)(1)(i)
The employer shall insure that hands are free from encumbrances while personnel are using ladders.

1910.179(o)(1)(ii)
Articles which are too large to be carried in pockets or belts shall be lifted and lowered by hand line.

1910.179(o)(2)
Cabs.

1910.179(o)(2)(i)
Necessary clothing and personal belongings shall be stored in such a manner as not to interfere with access or operation.

1910.179(o)(2)(ii)
Tools, oil cans, waste, extra fuses, and other necessary articles shall be stored in the tool box, and shall not be permitted to lie loose in or about the cab.

1910.179(o)(3)
Fire extinguishers. The employer shall insure that operators are familiar with the operation and care of fire extinguishers provided.

[39 FR 23502, June 27, 1974, as amended at 40 FR 27400, June 27, 1975; 49 FR 5322, Feb. 10, 1984; 51 FR 34560, Sept. 29, 1986; 55 FR 32015, Aug. 6, 1990; 61 FR 9227, March 7, 1996]

Slings. - 1910.184

Part Number:	1910
• Part Title:	Occupational Safety and Health Standards
• Subpart:	N
• Subpart Title:	Materials Handling and Storage
• Standard Number:	1910.184
• Title:	Slings.

1910.184(a)

Scope. This section applies to slings used in conjunction with other material handling equipment for the movement of material by hoisting, in employments covered by this part. The types of slings covered are those made from alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (nylon, polyester, and polypropylene).

1910.184(b)

Definitions.

Angle of loading is the inclination of a leg or branch of a sling measured from the horizontal or vertical plane as shown in Fig. N-184-5; provided that an angle of loading of five degrees or less from the vertical may be considered a vertical angle of loading.

Basket hitch is a sling configuration whereby the sling is passed under the load and has both ends, end attachments, eyes or handles on the hook or a single master link.

Braided wire rope is a wire rope formed by plaiting component wire ropes.

Bridle wire rope sling is a sling composed of multiple wire rope legs with the top ends gathered in a fitting that goes over the lifting hook.

Cable laid endless sling-mechanical joint is a wire rope sling made endless by joining the ends of a single length of cable laid rope with one or more metallic fittings.

Cable laid grommet-hand tucked is an endless wire rope sling made from one length of rope wrapped six times around a core formed by hand tucking the ends of the rope inside the six wraps.

Cable laid rope is a wire rope composed of six wire ropes wrapped around a fiber or wire rope core.

Cable laid rope sling-mechanical joint is a wire rope sling made from a cable laid rope with eyes fabricated by pressing or swaging one or more metal sleeves over the rope junction.

Choker hitch is a sling configuration with one end of the sling passing under the load and through an end attachment, handle or eye on the other end of the sling.

Coating is an elastomer or other suitable material applied to a sling or to a sling component to impart desirable properties.

Cross rod is a wire used to join spirals of metal mesh to form a complete fabric. (See Fig. N-184-2.)

Designated means selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

Equivalent entity is a person or organization (including an employer) which, by possession of equipment, technical knowledge and skills, can perform with equal competence the same repairs and tests as the person or organization with which it is equated.

Fabric (metal mesh) is the flexible portion of a metal mesh sling consisting of a series of transverse coils and cross rods.

Female handle (choker) is a handle with a handle eye and a slot of such dimension as to permit passage of a male handle thereby allowing the use of a metal mesh sling in a choker hitch. (See Fig. N-184-1.)

Handle is a terminal fitting to which metal mesh fabric is attached. (See Fig. N-184-1.)

Handle eye is an opening in a handle of a metal mesh sling shaped to accept a hook, shackle or other lifting device. (See Fig. N-184-1.)

Hitch is a sling configuration whereby the sling is fastened to an object or load, either directly to it or around it.

Link is a single ring of a chain.

Male handle (triangle) is a handle with a handle eye.

Master coupling link is an alloy steel welded coupling link used as an intermediate link to join alloy steel chain to master links. (See Fig. N-184-3.)

Master link or gathering ring is a forged or welded steel link used to support all members (legs) of an alloy steel chain sling or wire rope sling. (See Fig. N-184-3.)

Mechanical coupling link is a nonwelded, mechanically closed steel link used to attach master links, hooks, etc., to alloy steel chain.

FIGURE N-184-1 METAL MESH SLING (TYPICAL) (For Figure N-184-1, see page)

FIGURE N-184-2 METAL MESH CONSTRUCTION (For Figure N-184-2, see page)

FIGURE N-184-3 MAJOR COMPONENTS OF A QUADRUPLE SLING (For Figure N-184-3, see page)

Proof load is the load applied in performance of a proof test.

Proof test is a nondestructive tension test performed by the sling manufacturer or an equivalent entity to verify construction and workmanship of a sling.

Rated capacity or working load limit is the maximum working load permitted by the provisions of this section.

Reach is the effective length of an alloy steel chain sling measured from the top bearing surface of the upper terminal component to the bottom bearing surface of the lower terminal component.

Selvage edge is the finished edge of synthetic webbing designed to prevent unraveling.

Sling is an assembly which connects the load to the material handling equipment.

Sling manufacturer is a person or organization that assembles sling components into their final form for sale to users.

Spiral is a single transverse coil that is the basic element from which metal mesh is fabricated. (See Fig. N-184-2.)

Strand laid endless sling-mechanical joint is a wire rope sling made endless from one length of rope with the ends joined by one or more metallic fittings.

Strand laid grommet-hand tucked is an endless wire rope sling made from one length of strand wrapped six times around a core formed by hand tucking the ends of the strand inside the six wraps.

Strand laid rope is a wire rope made with strands (usually six or eight) wrapped around a fiber core, wire strand core, or independent wire rope core (IWRC).

Vertical hitch is a method of supporting a load by a single, vertical part or leg of the sling. (See Fig. N-184-4.)

1910.184(c)

Safe operating practices. Whenever any sling is used, the following practices shall be observed:

1910.184(c)(1)

Slings that are damaged or defective shall not be used.

1910.184(c)(2)

Slings shall not be shortened with knots or bolts or other makeshift devices.

1910.184(c)(3)

Sling legs shall not be kinked.

1910.184(c)(4)

Slings shall not be loaded in excess of their rated capacities.

..1910.184(c)(5)

1910.184(c)(5)

Slings used in a basket hitch shall have the loads balanced to prevent slippage.

1910.184(c)(6)

Slings shall be securely attached to their loads.

1910.184(c)(7)

Slings shall be padded or protected from the sharp edges of their loads.

1910.184(c)(8)

Suspended loads shall be kept clear of all obstructions.

1910.184(c)(9)

All employees shall be kept clear of loads about to be lifted and of suspended loads.

1910.184(c)(10)

Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.

1910.184(c)(11)

Shock loading is prohibited.

1910.184(c)(12)

A sling shall not be pulled from under a load when the load is resting on the sling.

..1910.184(d)**1910.184(d)**

Inspections. Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use, where service conditions warrant. Damaged or defective slings shall be immediately removed from service.

1910.184(e)

Alloy steel chain slings.

1910.184(e)(1)

Sling identification. Alloy steel chain slings shall have permanently affixed durable identification stating size, grade, rated capacity, and reach.

1910.184(e)(2)

Attachments.

1910.184(e)(2)(i)

Hooks, rings, oblong links, pear shaped links, welded or mechanical coupling links or other attachments shall have a rated capacity at least equal to that of the alloy steel chain with which they are used or the sling shall not be used in excess of the rated capacity of the weakest component.

1910.184(e)(2)(ii)

Makeshift links or fasteners formed from bolts or rods, or other such attachments, shall not be used.

1910.184(e)(3)

Inspections.

1910.184(e)(3)(i)

In addition to the inspection required by paragraph (d) of this section, a thorough periodic inspection of alloy steel chain slings in use shall be made on a regular basis, to be determined on the basis of (A) frequency of sling use; (B) severity of service conditions; (C) nature of lifts being made; and (D) experience gained on the service life of slings used in similar circumstances. Such inspections shall in no event be at intervals greater than once every 12 months.

..1910.184(e)(3)(ii)

1910.184(e)(3)(ii)

The employer shall make and maintain a record of the most recent month in which each alloy steel chain sling was thoroughly inspected, and shall make such record available for examination.

1910.184(e)(3)(iii)

The thorough inspection of alloy steel chain slings shall be performed by a competent person designated by the employer, and shall include a thorough inspection for wear, defective welds, deformation and increase in length. Where such defects or deterioration are present, the sling shall be immediately removed from service.

1910.184(e)(4)

Proof testing. The employer shall ensure that before use, each new, repaired, or reconditioned alloy steel chain sling, including all welded components in the sling assembly, shall be proof tested by the sling manufacturer or equivalent entity, in accordance with paragraph 5.2 of the American Society of Testing and Materials Specification A391-65, which is incorporated by reference as specified in Sec. 1910.6 (ANSI G61.1-1968). The employer shall retain a certificate of the proof test and shall make it available for examination.

1910.184(e)(5)

Sling use. Alloy steel chain slings shall not be used with loads in excess of the rated capacities prescribed in Table N-184-1. Slings not included in this table shall be used only in accordance with the manufacturer's recommendations.

..1910.184(e)(6)

1910.184(e)(6)

Safe operating temperatures. Alloy steel chain slings shall be permanently removed from service if they are heated above 1000 deg. F. When exposed to service temperatures in excess of 600 deg. F, maximum working load limits permitted in Table N-184-1 shall be reduced in accordance with the chain or sling manufacturer's recommendations.

1910.184(e)(7)

Repairing and reconditioning alloy steel chain slings.

1910.184(e)(7)(i)

Worn or damaged alloy steel chain slings or attachments shall not be used until repaired. When welding or heat testing is performed, slings shall not be used unless repaired, reconditioned and proof tested by the sling manufacturer or an equivalent entity.

1910.184(e)(7)(ii)

Mechanical coupling links or low carbon steel repair links shall not be used to repair broken lengths of chain.

1910.184(e)(8)

Effects of wear. If the chain size at any point of any link is less than that stated in Table N-184-2, the sling shall be removed from service.

1910.184(e)(9)

Deformed attachments.

1910.184(e)(9)(i)

Alloy steel chain slings with cracked or deformed master links, coupling links or other components shall be removed from service.

TABLE N-184-1 -- RATED CAPACITY (WORKING LOAD LIMIT), FOR ALLOY
STEEL CHAIN SLINGS

Rated Capacity (Working Load Limit), Pounds
[Horizontal angles shown in parentheses]

Chain size, inches	Single branch sling -- 90° loading	Double Sling vertical angle (1)			Triple and quadruple sling (3) vertical angle		
		30° (60°)	45° (45°)	60° (30°)	30° (60°)	45° (45°)	60° (30°)
1/4	3,250	5,650	4,550	3,250	8,400	6,800	4,900
3/8	6,600	11,400	9,300	6,600	17,000	14,000	9,000
1/2	11,250	19,500	15,900	11,250	29,000	24,000	17,000
5/8	16,500	28,500	23,000	16,500	43,000	35,000	24,500
3/4	23,000	39,800	32,500	23,000	59,500	48,500	34,500
7/8	28,750	49,800	40,600	28,750	74,500	61,000	43,000
1	38,750	67,100	5,800	38,750	101,000	82,000	58,000
1 1/8	44,500	77,000	63,000	44,500	115,500	94,500	66,500
1 1/4	57,500	99,500	61,000	57,500	149,000	121,500	86,000
1 3/8	67,000	116,000	94,000	67,000	174,000	141,000	100,500
1 1/2	80,000	138,000	112,900	80,000	207,000	169,000	119,500
1 3/4	100,000	172,000	140,000	100,000	258,000	210,000	150,000

(1) Rating of multileg slings adjusted for angle of loading measured as the included angle between the inclined leg and the vertical as shown in Figure N-184-5.

(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load, as shown in Figure N-184-5.

(3) Quadruple sling rating is same as triple sling because normal lifting practice may not distribute load uniformly to all 4 legs.

TABLE N-184-2. - MINIMUM ALLOWABLE CHAIN SIZE AT ANY POINT OF LINK

Chain size, inches	Minimum allowable chain size, inches
1/4	13/64
3/8	19/64
1/2	25/64
5/8	31/64
3/4	19/32
7/8	45/64
1	13/16
1 1/8	29/32
1 1/4	1
1 3/8	1 3/32
1 1/2	1 3/16
1 3/4	1 13/32

1910.184(e)(9)(ii)

Slings shall be removed from service if hooks are cracked, have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

..1910.184(f)

1910.184(f)

Wire rope slings.

1910.184(f)(1)

Sling use. Wire rope slings shall not be used with loads in excess of the rated capacities shown in Tables N-184-3 through N-184-14. Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

1910.184(f)(2)

Minimum sling lengths.

1910.184(f)(2)(i)

Cable laid and 6x19 and 6x37 slings shall have a minimum clear length of wire rope 10 times the component rope diameter between splices, sleeves or end fittings.

1910.184(f)(2)(ii)

Braided slings shall have a minimum clear length of wire rope 40 times the component rope diameter between the loops or end fittings.

1910.184(f)(2)(iii)

Cable laid grommets, strand laid grommets and endless slings shall have a minimum circumferential length of 96 times their body diameter.

1910.184(f)(3)

Safe operating temperatures. Fiber core wire rope slings of all grades shall be permanently removed from service if they are exposed to temperatures in excess of 200 deg. F. When nonfiber core wire rope slings of any grade are used at temperatures above 400 deg. F or below minus 60 deg. F, recommendations of the sling manufacturer regarding use at that temperature shall be followed.

1910.184(f)(4)

End attachments.

1910.184(f)(4)(i)

Welding of end attachments, except covers to thimbles, shall be performed prior to the assembly of the sling.

..1910.184(f)(4)(ii)

1910.184(f)(4)(ii)

All welded end attachments shall not be used unless proof tested by the manufacturer or equivalent entity at twice their rated capacity prior to initial use. The employer shall retain a certificate of the proof test, and make it available for examination.

TABLE N-184-3. - RATED CAPACITIES FOR SINGLE LEG SLINGS

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Fiber Core (FC)

Rope		Rated capacities, tons (2,000 lb.)					
		Vertical			Choker		
Dia (inches)	Constr	HT	MS	S	HT	MS	S
1/4	6x19	0.49	0.51	0.55	0.37	0.38	0.41
5/16	6x19	0.76	0.79	0.85	0.57	0.59	0.64
3/8	6x19	1.1	1.1	1.2	0.80	0.85	0.91
7/16	6x19	1.4	1.5	1.6	1.1	1.1	1.2
1/2	6x19	1.8	2.0	2.1	1.4	1.5	12.6
9/16	6x19	2.3	2.5	2.7	1.7	1.9	2.0
5/8	6x19	2.8	3.1	3.3	2.1	2.3	2.5
3/4	6x19	3.9	4.4	4.8	2.9	3.3	3.6
7/8	6x19	5.1	5.9	6.4	3.9	4.5	4.8
1	6x19	6.7	7.7	8.4	5.0	5.8	6.3
1 1/8	6/19	8.4	9.5	10.0	6.3	7.1	7.9
1 1/4	6/37	9.8	11.0	12.0	7.4	8.3	9.2
1 3/8	6x37	12.0	13.0	15.0	8.9	10.0	11.0
1 1/2	6x37	14.0	16.0	15.0	10.0	12.0	13.0
1 5/8	6x37	16.0	18.0	21.0	12.0	14.0	15.0
1 3/4	6x37	19.0	21.0	24.0	14.0	16.0	18.0
2	6x37	25.0	28.0	31.0	18.0	21.0	23.0

TABLE N-184-3. - RATED CAPACITIES FOR SINGLE LEG SLINGS (CONTINUED)

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Fiber Core (FC)

Rope		Rated Capacities, tons (2,000 lb)		
		Vertical Basket (1)		
Dia (inches)	Constr	HT	MS	S
1/4	6x19	0.99	1.0	1.1
5/16	6x19	1.5	1.6	1.7
3/8	6x19	2.1	2.2	2.4
7/16	6x19	2.9	3.0	3.3
1/2	6x19	3.7	3.9	4.3
9/16	6x19	4.6	5.0	5.4
5/8	6x19	5.6	6.0	6.7
3/4	6x19	7.8	8.8	9.5
7/8	6x19	10.0	12.0	13.0
1	6x19	13.0	15.0	17.0
1 1/8	6/19	17.0	19.0	21.0
1 1/4	6/37	20.0	22.0	25.0
1 3/8	6x37	24.0	27.0	30.0
1 1/2	6x37	28.0	32.0	35.0
1 5/8	6x37	33.0	27.0	41.0
1 3/4	6x37	38.0	43.0	48.0
2	6x37	49.0	55.0	62.0

HT = Hand Tucked Splice and Hidden Tuck Splice.
For hidden tuck splice (IWRC) use values in HT
columns.

MS = Mechanical Splice.

S = Swaged or Zinc Poured Socket.

Footnote(1) These values only apply when the
D/d ratio for HT slings is 10 or greater, and for
MS and S slings is 20 or greater where:
D=Diameter of curvature around which the body of
the sling is bent; d=Diameter of rope.

TABLE N-184-4. - RATED CAPACITIES FOR SINGLE LEG SLINGS

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Independent Wire Rope Core (IWRC)

Rope		Rated capacities, tons (2,000 lb.)					
Dia (inches)	Constr	Vertical			Choker		
		HT	MS	S	HT	MS	S
1/4	6x19	0.53	0.56	0.59	0.40	0.42	0.44
5/16	6x19	0.81	0.87	0.92	0.61	0.65	0.69
3/8	6x19	1.1	1.2	1.3	0.86	0.93	0.98
7/16	6x19	1.5	1.7	1.8	1.2	1.3	1.3
1/2	6x19	2.0	2.2	2.3	1.5	1.6	1.7
9/16	6x19	2.5	2.7	2.9	1.8	2.1	2.2
5/8	6x19	3.0	3.4	3.6	2.2	2.5	2.7
3/4	6x19	4.2	4.9	5.1	3.1	3.6	3.8
7/8	6x19	5.5	6.6	6.9	4.1	4.9	5.2
1	6x19	7.2	8.5	9.0	5.4	6.4	6.7
1 1/8	6/19	9.0	10.0	11.0	6.8	7.8	8.5
1 1/4	6/37	10.0	12.0	13.0	7.9	9.2	9.9
1 3/8	6x37	13.0	15.0	16.0	9.6	11.0	12.0
1 1/2	6x37	15.0	17.0	19.0	11.0	13.0	14.0
1 5/8	6x37	18.0	20.0	22.0	13.0	15.0	17.0
1 3/4	6x37	20.0	24.0	26.0	15.0	18.0	19.0
2	6x37	26.0	30.0	33.0	20.0	23.0	25.0

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TABLE N-184-4. - RATED CAPACITIES FOR SINGLE LEG SLINGS
CONTINUED

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Independent Wire Rope Core (IWRC)

Rope		Rated Capacities, tons (2,000 lb)		
		Vertical Basket (1)		
Dia (inches)	Constr	HT	MS	S
1/4	6x19	1.0	1.1	1.2
5/16	6x19	1.6	1.7	1.8
3/8	7x7x7	2.3	2.5	2.6
7/16	7x7x7	3.1	3.4	3.5
1/2	7x7x7	3.9	4.4	4.6
9/16	7x7x7	4.9	5.5	5.8
5/8	7x7x7	6.0	6.8	7.2
3/4	7x7x7	8.4	9.7	10.0
7/8	7x7x7	11.0	13.0	14.0
1	7x7x7	14.0	17.0	18.0
1 1/8	6/19	18.0	21.0	23.0
1 1/4	6/37	21.0	24.0	26.0
1 3/8	6x37	25.0	29.0	32.0
1 1/2	6x37	30.0	35.0	38.0
1 5/8	6x37	35.0	41.0	44.0
1 3/4	6x37	41.0	47.0	51.0
2	6x37	53.0	61.0	66.0

HT = Hand Tucked Splice. For hidden tuck splice
(IWRC) use Table 1 values in HT column.

MS = Mechanical Splice.

S = Swaged or Zinc Poured Socket.

Footnote(1) These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S slings is 20 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of rope.

TABLE N-184-5. -- RATED CAPACITIES FOR SINGLE LEG SLINGS

Cable Laid Rope -- Mechanical Splice Only

7x7x7 & 7X19 Constructions Galvanized Aircraft Grade Rope

7x6x19 IWRC Construction Improved Plow Steel Grade Rope

Rope		Rated capacities, tone (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket (1)
1/4	7x7x7	0.50	0.38	1.0
3/8	7x7x7	1.1	0.81	2.0
1/2	7x7x7	1.8	1.4	3.7
5/8	7x7x7	2.8	2.1	5.5
3/4	7x7x7	3.8	2.9	7.6
5/8	7x7x7	2.9	2.2	5.8
3/4	7x7x19	4.1	3.0	8.1
7/8	7x7x19	5.4	4.0	11.0
1	7x7x19	5.4	5.1	14.0
1 1/8	7x7x19	6.9	6.2	16.0
1 1/4	7x7x19	8.2	7.4	20.0
3/4	7x7x19		2.8	7.6
7/8	7x6x19 IWRC	3.8	3.8	10.0
1	7x6x19 IWRC	5.0	4.8	13.0
1 1/8	7x6x19 IWRC	7.7	5.8	15.0
1 1/4	7x6x19 IWRC	9.2	6.9	18.0
1 5/16	7x6x19 IWRC	10.0	7.5	20.0
1 3/8	7x6x19 IWRC	11.0	8.2	22.0
1 1/2	7x6x19 IWRC	13.0	9.6	26.0

Footnote(1) These values only apply when the D/d ratio is 10 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of rope.

TABLE N-184-6. -- RATED CAPACITIES FOR SINGLE LEG SLINGS

8-Part and 6-Part Braided Rope
6x7 and 6x19 Construction Improved Plow Steel Grade Rope
7x7 Construction Galvanized Aircraft Grade Rope

Componet Ropes		Rated capacities, tons (2,000 lb)					
		Vertical		Choker		Basket vertical to 30 deg. (1)	
Diameter (inches)	Constr	8-part	6-part	8-part	6-part	8-part	6-part
3/32	6x7	0.42	0.32	0.32	0.24	0.74	0.55
1/8	6x7	0.75	0.57	0.57	0.42	1.3	0.98
3/16	6x7	1.7	1.3	1.3	0.94	2.9	2.2
3/32	7x7	0.51	0.39	0.38	0.29	0.89	0.67
1/8	7x7	0.95	0.7	0.71	0.53	1.6	1.2
3/16	7x7	2.1	1.5	1.5	1.2	3.6	2.7
3/16	6x19	1.7	1.3	1.3	0.98	3.0	2.2
1/4	6x19	3.1	2.3	2.3	1.7	5.3	4.0
5/16	6x19	4.8	3.6	3.6	2.7	8.3	6.2
3/8	6x19	3.8	5.1	5.1	3.8	12.0	8.9
7/16	6x19	9.3	6.9	6.9	5.2	16.0	12.0
1/2	6x19	12.0	9.0	9.0	6.7	21.0	15.0
9/16	6x19	15.0	11.0	11.0	8.5	26.0	20.0
5/8	6x19	19.0	14.0	14.0	10.0	32.0	24.0
3/4	6x19	27.0	20.0	20.0	15.0	46.0	35.0
7/8	6x19	36.0	27.0	27.0	20.0	62.0	47.0
1	6/19	47.0	35.0	35.0	26.0	81.0	61.0

Footnote(1) These values only apply when the D/d ratio is 20 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of component rope.

TABLE N-184-7.-- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BRIDLE SLINGS

6x19 and 6x37 Classification Improved Plow Steel
Grade Rope With Fiber Core (FC)
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
Dia [in.]	Constr	2-Leg bridle slings					
		30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	0.85	0.83	0.70	0.72	0.49	0.51
5/16	6x19	1.3	1.4	1.1	1.1	0.76	0.79
3/8	6x19	1.8	1.9	1.5	1.6	1.1	1.1
7/16	6x19	2.5	2.6	2.0	2.2	1.4	1.5
1/2	6x19	3.2	3.4	2.6	2.8	1.8	2.0
9/16	6x19	4.0	4.3	3.2	3.5	2.3	2.5
5/8	6x19	4.8	5.3	4.0	4.4	2.8	3.1
3/4	6x19	5.8	7.6	5.5	6.2	3.9	4.4
7/8	6x19	8.9	10.0	7.3	8.4	5.1	5.9
1	6x19	11.0	13.0	9.4	11.0	6.7	7.7
1 1/8	6x19	14.0	16.0	12.0	13.0	8.4	9.3
1 1/4	6x37	17.0	19.0	14.0	16.0	9.8	11.0
1 3/8	6x37	20.0	23.0	17.0	19.0	12.0	13.0
1 1/2	6x37	24.0	27.0	20.0	22.0	14.0	16.0
1 5/8	6x37	28.0	32.0	23.0	26.0	16.0	18.0
1 3/4	6x37	33.0	37.0	27.0	30.0	19.0	21.0
2	6x37	43.0	48.0	35.0	39.0	25.0	28.0

TABLE N-184-7.-- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BRIDLE SLINGS

[Continued]

6x19 and 6x37 Classification Improved Plow Steel
Grade Rope With Fiber Core (FC)
[Horizontal angles shown in parentheses]

Rope		Rated Capacities, tons (2,000 lb)					
Dia (inc.)	Const	2-leg bridle slings					
		30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6/19	0.92	0.97	0.75	0.79	0.53	0.56
5/16	6x19	1.4	1.5	1.1	1.2	0.81	0.87
3/8	6/19	2.0	2.1	1.6	1.8	1.1	1.2
7/16	6x19	2.7	2.9	2.2	2.4	1.5	1.7
1/2	6/19	3.4	3.8	2.8	3.1	2.0	2.2
9/16	6x19	4.3	4.8	3.5	3.9	2.5	2.7
5/8	6/19	5.2	5.9	4.2	4.8	3.0	3.4
3/4	6x19	7.3	8.4	5.9	6.9	4.2	4.9
7/8	6/19	9.6	11.0	7.8	9.3	5.5	6.6
1	6x19	12.0	15.0	10.0	12.0	7.2	8.5
1 1/8	6/19	16.0	18.0	13.0	15.0	9.0	10.0
1 1/4	6/37	18.0	21.0	15.0	17.0	10.0	12.0
1 3/8	6x37	22.0	25.0	18.0	21.0	13.0	15.0
1 1/2	6x37	26.0	30.0	21.0	25.0	15.0	17.0
1 5/8	6x37	31.0	35.0	25.0	29.0	18.0	20.0
1 3/4	6x37	35.0	41.0	29.0	33.0	20.0	24.0
2	6x37	46.0	53.0	37.0	43.0	26.0	30.0

= Hand Tucked Splice.

MS = Mechanical Splice.

TABLE N-184-8 -- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BIRDLE SLINGS6x17 and 6x37 Classification Improved Plow Steel
Grade Rope with Independent Wire Rope Core (IWRC)
(Horizontal angles shown in parentheses)

Rope		Rated capacities, tons (2,000 lb)					
Dia [in.]	Constr	2-Leg bridle slings					
		30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	0.92	0.97	0.75	0.79	0.53	0.56
5/16	6x19	1.4	1.5	1.1	1.2	0.81	0.87
3/8	6x19	2.0	2.1	1.6	1.8	1.1	1.2
7/16	6x19	2.7	2.9	2.2	2.4	1.5	1.7
1/2	6x19	3.4	3.8	2.8	3.1	2.0	2.2
9/16	6x19	4.3	4.8	3.5	3.9	2.5	2.7
5/8	6x19	5.2	5.9	4.2	4.8	3.0	3.4
3/4	6x19	7.3	8.4	5.9	6.9	4.2	4.9
7/8	6x19	9.6	11.0	7.8	9.3	5.5	6.6
1	6x19	12.0	15.0	10.0	12.0	7.2	8.5
1 1/8	6x19	16.0	18.0	13.0	15.0	9.0	10.0
1 1/4	6x37	18.0	21.0	15.0	17.0	10.0	12.0
1 3/8	6x37	22.0	25.0	18.0	21.0	13.0	15.0
1 1/2	6x37	26.0	30.0	21.0	25.0	15.0	17.0
1 5/8	6x37	31.0	35.0	25.0	29.0	18.0	20.0
1 3/4	6x37	35.0	41.0	29.0	33.0	20.0	24.0
2	6x37	46.0	53.0	37.0	43.0	26.0	30.0

TABLE N-184-8 -- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BRIDLE SLINGS
(CONTINUED)

6x17 and 6x37 Classification Improved Plow Steel
Grade Rope with Independent Wire Rope Core (IWRC)
(Horizontal angles shown in parentheses)

Rope		Rated capacities, tons (2,000 lb)					
Dia [in.]	Constr	3-Leg bridle slings					
		30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	1.4	1.4	1.1	1.2	0.79	0.84
5/16	6x19	2.1	2.3	1.7	1.8	1.2	1.3
3/8	6x19	3.0	3.2	2.4	2.6	1.7	1.9
7/16	6x19	4.0	4.4	3.3	3.6	2.3	2.5
1/2	6x19	5.1	5.7	4.2	4.6	3.0	3.3
9/16	6x19	6.4	7.1	5.2	5.8	3.7	4.1
5/8	6x19	7.8	8.8	6.4	7.2	4.5	5.1
3/4	6x19	11.0	13.0	8.9	10.0	6.3	7.3
7/8	6x19	14.0	17.0	12.0	14.0	8.3	9.9
1	6x19	19.0	22.0	15.0	18.0	11.0	13.0
1 1/8	6x19	23.0	27.0	19.0	22.0	13.0	16.0
1 1/4	6x37	27.0	32.0	22.0	26.0	16.0	18.0
1 3/8	6x37	33.0	38.0	27.0	31.0	19.0	22.0
1 1/2	6x37	39.0	45.0	32.0	37.0	23.0	26.0
1 5/8	6x37	46.0	53.0	38.0	43.0	27.0	31.0
1 3/4	6x37	53.0	61.0	43.0	50.0	31.0	35.0
2	6x37	68.0	79.0	56.0	65.0	40.0	46.0

HT = Hand Tucked Splice
MS = Mechanical Splice

TABLE N-184-9. -- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BRIDLE SLINGS

Cable Laid Rope - Mechanical Splice Only
7x7x7 and 7x7x19 Construction Galvanized Aircraft Grade Rope
7x6x19 IWRC Construction Improved Plow Steel Grade Rope
[Horizontal angles shown in parenthesis]

Rope		Rated Capacities, tons (2,000 lb)		
		2-leg bridle slings		
Dia (inc.)	Const	30 deg. (60 deg.)	45 deg. angle	60 deg. (30 deg.)
1/4	7x7x7	0.87	0.71	0.50
3/8	7x7x7	1.9	1.5	1.1
1/2	7x7x7	3.2	2.6	1.8
5/8	7x7x7	4.8	3.9	2.8
3/4	7x7x7	6.6	5.4	3.8
5/8	7x7x19	5.0	4.1	2.9
3/4	7x7x19	7.0	5.7	4.1
7/8	7x7x19	9.3	7.6	5.4
1	7x7x19	12.0	9.7	6.9
1 1/8	7x7x19	14.0	12.0	8.2
1 1/4	7x7x19	17.0	14.0	9.9
3/4	7x6x19 IWRC	6.6	5.4	3.8
7/8	7x6x19 IWRC	8.7	7.1	5.0
1	7x6x19 IWRC	11.0	9.0	6.4
1 1/8	7x6x19 IWRC	13.0	11.0	7.7
1 1/4	7x6x19 IWRC	16.0	13.0	9.2
1 5/16	7x6x19 IWRC	17.0	14.0	10.0
1 3/8	7x6x19 IWRC	19.0	15.0	11.0
1 1/2	7x6x19 IWRC	22.0	18.0	13.0

TABLE N-184-9. -- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BRIDLE SLINGS

[Continued]

Cable Laid Rope - Mechanical Splice Only
 7x7x7 and 7x7x19 Construction Galvanized Aircraft Grade Rope
 7x6x19 IWRC Construction Improved Plow Steel Grade Rope
 [Horizontal angles shown in parenthesis]

Rope		Rated capacities, tons (2,000 lb)		
Dia [in.]	Constr	3-Leg bridle slings		
		30 deg. (60 deg.)	45 deg. angle	60 deg. (30 deg.)
1/4.....	7x7x7	1.3	1.1	0.75
3/8.....	7x7x7.....	2.8	2.3	1.6
1/2.....	7x7x7.....	4.8	3.9	2.8
5/8.....	7x7x7.....	7.2	5.9	4.2
3/4.....	7x7x7.....	9.9	8.1	3.7
5/8.....	7x7x19.....	7.5	6.1	4.3
3/4.....	7x7x19.....	10.0	8.6	6.1
7/8.....	7x7x19.....	14.0	11.0	8.1
1.....	7x7x19.....	18.0	14.0	10.0
1 1/8....	7x7x19.....	21.0	17.0	12.0
1 1/4....	7x7x19.....	26.0	21.0	15.0
3/4.....	7x6x19 IWRC.	9.9	8.0	5.7
7/8.....	7x6x19 IWRC.	13.0	11.0	7.5
1.....	7x6x19 IWRC.	17.0	13.0	9.6
1 1/8....	7x6x19 IWRC.	20.0	16.0	11.0
1 1/4....	7x6x19 IWRC.	24.0	20.0	14.0
1 5/16...	7x6x19 IWRC.	26.0	21.0	15.0
1 3/8....	7x6x19 IWRC.	28.0	23.0	16.0
1 1/2....	7x6x19 IWRC.	33.0	27.0	19.0

TABLE N-184-10. -- RATED CAPACITIES FOR 2-LEG AND
3-LEG BRIDLE SLINGS

8-Part and 6-Part Braided Rope
 6x7 and 6x19 Construction Improved Plow Steel Grade Rope
 7x7 Construction Galvanized Aircraft Grade Rope
 [Horizontal angles shown in parentheses]

Dia (in.)	Constr	2-Leg bridle sling					
		30 deg (60 deg)		45 deg angle		60 deg (30 deg)	
		8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6x7	0.74	0.55	0.60	0.45	0.42	0.32
1/8	6x7	1.3	0.98	1.1	0.80	0.76	0.57
3/16	6x7	2.9	2.2	2.4	1.8	1.7	1.3
3/32	7x7	0.89	0.67	0.72	0.55	0.51	0.39
1/8	7x7	1.6	1.2	1.3	1.0	0.95	0.71
3/16	7x7	3.6	2.7	2.9	2.2	2.1	1.5
3/16	6x19	3.0	2.2	2.4	1.8	1.7	1.3
1/4	6x19	5.3	4.0	4.3	3.2	3.1	2.3
5/16	6x19	8.3	6.2	6.7	5.0	4.8	3.6
3/8	6x19	12.0	8.9	9.7	7.2	6.8	5.1
7/16	6x19	16.0	12.0	13.0	9.8	9.3	6.9
1/2	6x19	21.0	15.0	17.0	13.0	12.0	9.0
9/16	6x19	26.0	20.0	21.0	16.0	15.0	11.0
5/8	6x19	32.0	24.0	26.0	20.0	10.0	14.0
3/4	6x19	46.0	35.0	38.0	28.0	27.0	20.0
7/8	6x19	62.0	47.0	51.0	38.0	36.0	27.0
1	6x19	81.0	61.0	66.0	50.0	47.0	35.0

TABLE N-184-10. -- RATED CAPACITIES FOR 2-LEG AND
3-LEG BRIDLE SLINGS
[Continued]

8-Part and 6-Part Braided Rope
6x7 and 6x19 Construction Improved Plow Steel Grade Rope
7x7 Construction Galvanized Aircraft Grade Rope
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		3-Leg Bridle					
		30 deg. (60 deg)		45 deg angle		60 deg (30 deg)	
Diameter (inches)	Constr	8-part	6-part	8-part	6-part	8-part	6-part
3/32	6x7	1.1	0.83	0.90	0.68	0.64	0.48
1/8	6x7	2.0	1.5	1.6	1.2	1.1	0.85
3/16	6x7	4.4	3.3	3.6	2.7	2.5	1.9
3/32	7x7	1.3	1.0	1.1	0.82	0.77	0.58
1/8	7x7	2.5	1.8	2.0	1.5	1.4	1.1
3/16	7x7	5.4	4.0	4.4	3.3	3.1	2.3
3/16	6x19	4.5	3.4	3.7	2.8	2.6	1.9
1/4	6x19	8.0	6.0	6.5	4.9	4.6	3.4
5/16	6x19	12.0	9.3	10.0	7.6	7.1	5.4
3/8	6x19	18.0	13.0	14.0	11.0	10.0	7.7
7/16	6x19	24.0	18.0	20.0	15.0	14.0	10.0
1/2	6x19	31.0	23.0	25.0	19.0	18.0	13.0
9/16	6x19	39.0	29.0	32.0	24.0	23.0	17.0
5/8	6x19	48.0	36.0	56.0	30.0	28.0	21.0
3/4	6x19	69.0	52.0	56.0	42.0	40.0	30.0
7/8	6x19	94.0	70.0	76.0	57.0	54.0	40.0
1	6/19	122.0	91.0	99.0	74.0	70.0	53.0

TABLE N-184-11. -- RATED CAPACITIES FOR STRAND LAID GROMMET
-- HAND TUCKED

Improved Plow Steel Grade Rope

TABLE N-184-11. -- RATED CAPACITIES FOR STRAND LAID GROMMET
-- HAND TUCKED

Improved Plow Steel Grade Rope

Rope body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
1/4	7x19	0.85	0.64	1.7
5/16	7x19	1.3	1.0	2.6
3/8	7x19	1.9	1.4	3.8
7/16	7x19	2.6	1.9	5.2
1/2	7x19	3.3	2.5	6.7
9/16	7x19	4.2	3.1	8.4
5/8	7x19	5.2	3.9	10.0
3/4	7x19	7.4	5.6	15.0
7/8	7x19	10.0	7.5	20.0
1	7x19	13.0	9.7	26.0
1 1/8	7x19	16.0	12.0	32.0
1 1/4	7x37	18.0	14.0	37.0
1 3/8	7x37	22.0	16.0	44.0
1 1/2	7x37	26.0	19.0	52.0

Footnote(1) These values only apply when the D/d ratio is 5 or greater where: D=Diameter of curvature around which rope is bent. d=Diameter of rope body.

TABLE N-184-12. -- RATED CAPACITIES FOR CABLE LAID GROMMET
-- HAND TUCKED

7x6x7 and 7x6x19 Constructions Improved Plow Steel Grade Rope
7x7x7 Construction Galvanized Aircraft Grade Rope

Cable body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
3/8	7x6x7	1.3	0.95	2.5
9/16	7x6x7	2.8	2.1	5.6
5/8	7x6x7	3.8	2.8	7.6
3/8	7x7x7	1.6	1.2	3.2
9/16	7x7x7	3.5	2.6	6.9
5/8	7x7x7	4.5	3.4	9.0
5/8	7x6x19	3.9	3.0	7.9
3/4	7x6x19	5.1	3.8	10.0
15/16	7x6x19	7.9	5.9	16.0
1 1/8	7x6x19	11.0	8.4	22.0
1 5/16	7x6x19	15.0	11.0	30.0
1 1/2	7x6x19	19.0	14.0	39.0
1 11/16	7x6x19	24.0	18.0	49.0
1 7/8	7x6x19	30.0	22.0	60.0
2 1/4	7x6x19	42.0	31.0	84.0
2 5/8	7x6x19	56.0	42.0	112.0

Footnote(1)

These values only apply when the D/d ratio is 5 or greater where: D=Diameter of curvature around which cable body is bent., d=Diameter of cable body.

TABLE N-184-13. -- RATED CAPACITIES FOR STRAND LAID
ENDLESS SLINGS
-- MECHANICAL JOINT

Improved Plow Steel Grade Rope

Rope body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
1/4	(2) 6x19	0.92	0.69	1.8
3/8	(2) 6x19	2.0	1.5	4.1
1/2	(2) 6x19	3.6	2.7	7.2
5/8	(2) 6x19	5.6	4.2	11.0
3/4	(2) 6x19	8.0	6.0	16.0
7/8	(2) 6x19	11.0	8.1	21.0
1	(2) 6x19	14.0	10.0	28.0
1 1/8	(2) 6x19	18.0	13.0	35.0
1 1/4	(2) 6x37	21.0	15.0	41.0
1 3/8	(2) 6x37	25.0	19.0	50.0
1 1/2	(2) 6x37	29.0	22.0	59.0

Footnote(1) These values only apply when the D/d ratio is 5 or greater where: D=Diameter of curvature around which rope is bent. d=Diameter of rope body.

Footnote(2) IWRC.

TABLE N-184-14. -- RATED CAPACITIES FOR CABLE LAID
ENDLESS SLINGS
-- MECHANICAL JOINT

Cable body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket (1)
1/4	7x7x7	0.83	0.62	1.6
3/8	7x7x7	1.8	1.3	3.5
1/2	7x7x7	3.0	2.3	6.1
5/8	7x7x7	4.5	3.4	9.1
3/4	7x7x7	6.3	4.7	12.0
5/8	7x7x19	4.7	3.5	9.5
3/4	7x7x19	6.7	5.0	13.0
7/8	7x7x19	8.9	6.6	18.0
1	7x7x19	11.0	8.5	22.0
1 1/8	7x7x19	14.0	10.0	28.0
1 1/4	7x7x19	17.0	12.0	33.0
3/4	(2) 7x6x19	6.2	4.7	12.0
7/8	(2) 7x6x19	8.3	6.2	16.0
1	(2) 7x6x19	10.0	7.9	21.0
1 1/8	(2) 7x6x19	13.0	9.7	26.0
1 1/4	(2) 7x6x19	16.0	12.0	31.0
1 3/8	(2) 7x6x19	18.0	14.0	37.0
1 1/2	(2) 7x6x19	22.0	16.0	43.0

Footnote(1) These values only apply when the D/d value is 5 or greater where: D=Diameter of curvature around which cable body is bent. d=Diameter of cable body.

Footnote(2) IWRC.

1910.184(f)(5)

Removal from service. Wire rope slings shall be immediately removed from service if any of the following conditions are present:

1910.184(f)(5)(i)

Ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay.

1910.184(f)(5)(ii)

Wear or scraping of one-third the original diameter of outside individual wires.

1910.184(f)(5)(iii)

Kinking, crushing, bird caging or any other damage resulting in distortion of the wire rope structure.

1910.184(f)(5)(iv)

Evidence of heat damage.

1910.184(f)(5)(v)

End attachments that are cracked, deformed or worn.

1910.184(f)(5)(vi)

Hooks that have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

1910.184(f)(5)(vii)

Corrosion of the rope or end attachments.

..1910.184(g)

1910.184(g)

Metal mesh slings --

1910.184(g)(1)

Sling marking. Each metal mesh sling shall have permanently affixed to it a durable marking that states the rated capacity for vertical basket hitch and choker hitch loadings.

1910.184(g)(2)

Handles. Handles shall have a rated capacity at least equal to the metal fabric and exhibit no deformation after proof testing.

1910.184(g)(3)

Attachments of handles to fabric. The fabric and handles shall be joined so that:

1910.184(g)(3)(i)

The rated capacity of the sling is not reduced.

1910.184(g)(3)(ii)

The load is evenly distributed across the width of the fabric.

1910.184(g)(3)(iii)

Sharp edges will not damage the fabric.

1910.184(g)(4)

Sling coatings. Coatings which diminish the rated capacity of a sling shall not be applied.

1910.184(g)(5)

Sling testing. All new and repaired metal mesh slings, including handles, shall not be used unless proof tested by the manufacturer or equivalent entity at a minimum of 1 1/2 times their rated capacity. Elastomer impregnated slings shall be proof tested before coating.

..1910.184(g)(6)

1910.184(g)(6)

Proper use of metal mesh slings. Metal mesh slings shall not be used to lift loads in excess of their rated capacities as prescribed in Table N-184-15. Slings not included in this table shall be used only in accordance with the manufacturer's recommendations.

1910.184(g)(7)

Safe operating temperatures. Metal mesh slings which are not impregnated with elastomers may be used in a temperature range from minus 20 deg. F to plus 550 deg. F without decreasing the working load limit. Metal mesh slings impregnated with polyvinyl chloride or neoprene may be used only in a temperature range from zero degrees to plus 200 deg. F. For operations outside these temperature ranges or for metal mesh slings impregnated with other materials, the sling manufacturer's recommendations shall be followed.

1910.184(g)(8)

Repairs.

1910.184(g)(8)(i)

Metal mesh slings which are repaired shall not be used unless repaired by a metal mesh sling manufacturer or an equivalent entity.

1910.184(g)(8)(ii)

Once repaired, each sling shall be permanently marked or tagged, or a written record maintained, to indicate the date and nature of the repairs and the person or organization that performed the repairs. Records of repairs shall be made available for examination.

1910.184(g)(9)

Removal from service. Metal mesh slings shall be immediately removed from service if any of the following conditions are present:

..1910.184(g)(9)(i)

1910.184(g)(9)(i)

A broken weld or broken brazed joint along the sling edge.

1910.184(g)(9)(ii)

Reduction in wire diameter of 25 per cent due to abrasion or 15 per cent due to corrosion.

1910.184(g)(9)(iii)

Lack of flexibility due to distortion of the fabric.

TABLE N-184-15 - RATED CAPACITIES
Carbon Steel and Stainless Steel Metal Mesh slings
[Horizontal angles shown in parentheses]

Sling width in inches	Vertical or choker	Vertical basket	Effect of angle on rated capacities in basket hitch		
			30 deg. (60 deg.)	45 deg. (45 deg.)	60 deg. (30 deg.)
Heavy Duty - 10 Ga 35 Spirals/Ft of sling width					
2	1,500	3,000	2,600	2,100	1,500
3	2,700	5,400	4,700	3,800	2,700
4	4,000	8,000	6,900	5,600	4,000
6	6,000	12,000	10,400	8,400	6,000
8	8,000	16,000	13,800	11,300	8,000
10	10,000	20,000	17,000	14,100	10,000
12	12,000	24,000	20,700	16,900	12,000
14	14,000	28,000	24,200	19,700	14,000
16	16,000	32,000	27,700	22,600	16,000
18	18,000	36,000	31,100	25,400	18,000
20	20,000	40,000	34,600	28,200	20,000
Medium Duty - 12 Ga 43 Spirals/Ft of sling width					
2	1,350	2,700	2,300	1,900	1,400
3	2,000	4,000	3,500	2,800	2,000
4	2,700	5,400	4,700	3,800	2,700
6	4,500	9,000	7,800	6,400	4,500
8	6,000	12,000	10,400	8,500	6,000
10	7,500	15,000	13,000	10,600	7,500
12	9,000	18,000	15,600	12,700	9,000
14	10,500	21,000	18,200	14,800	10,500
16	12,000	24,000	20,800	17,000	12,000
18	13,500	27,000	23,400	19,100	13,500
20	15,000	30,000	26,000	21,200	15,000
Light Duty - 14 Ga 59 Spirals/Ft of sling width					
2	900	1,800	1,600	1,300	900
3	1,400	2,800	2,400	2,000	1,400
4	2,000	4,000	3,500	2,800	2,000
6	3,000	6,000	5,200	4,200	3,000
8	4,000	8,000	6,900	5,700	4,000
10	5,000	10,000	8,600	7,100	5,000
12	6,000	12,000	10,400	8,500	6,000
14	7,000	14,000	12,100	9,900	7,000
16	8,000	16,000	13,900	11,300	8,000
18	9,000	18,000	15,600	12,700	9,000
20	10,000	20,000	17,300	14,100	10,000

1910.184(g)(9)(iv)

Distortion of the female handle so that the depth of the slot is increased more than 10 per cent.

1910.184(g)(9)(v)

Distortion of either handle so that the width of the eye is decreased more than 10 per cent.

1910.184(g)(9)(vi)

A 15 percent reduction of the original cross sectional area of metal at any point around the handle eye.

1910.184(g)(9)(vii)

Distortion of either handle out of its plane.

1910.184(h)

Natural and synthetic fiber rope slings --

1910.184(h)(1)

Sling use.

1910.184(h)(1)(i)

Fiber rope slings made from conventional three strand construction fiber rope shall not be used with loads in excess of the rated capacities prescribed in Tables N-184-16 through N-184-19.

..1910.184(h)(1)(ii)

1910.184(h)(1)(ii)

Fiber rope slings shall have a diameter of curvature meeting at least the minimums specified in Figs. N-184-4 and N-184-5.

1910.184(h)(1)(iii)

Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

FIGURE N-184-4 Basic Sling Configurations with Vertical Legs
(For Figure N-184-4, [Click Here](#))

FIGURE N-184-5 Basic Sling Configurations with Angled Legs
(For Figure N-184-5, [Click Here](#))

TABLE N-184-16. -- MANILA ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical Hitch	Choker Hitch	Basket Hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	7.5	480	240	960	830	680	480
9/16	10.4	620	310	1240	1070	875	620
5/8	13.3	790	395	1580	1370	1120	790
3/4	16.7	970	485	1940	1680	1370	970
13/16	19.5	1170	585	2340	2030	1650	1170
7/8	22.5	1390	1695	2780	2410	1970	1390
1	27.0	1620	810	3240	2810	2290	1620
1 1/16	31.3	1890	945	3780	3270	2670	1890
1 1/8	36.0	2160	1080	4320	3740	3050	2160
1 1/4	41.7	2430	1220	4860	4210	3440	2430
1 5/16	47.9	2700	1350	5400	4680	3820	2700
1 1/2	59.9	3330	1670	6660	5770	4710	3330
1 5/8	74.6	4050	2030	8100	7010	5730	4050
1 3/4	89.3	4770	2390	9540	8260	6740	4770
2	107.5	5580	2790	11200	9660	7890	5580
2 1/8	125.0	6480	3240	13000	11200	9160	6480
2 1/4	146.0	7380	3690	14800	12800	10400	7380
2 1/2	166.7	8370	4190	16700	14500	11800	8370
2 5/8	190.8	9360	4680	18700	16200	13200	9360

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-16. -- MANILA ROPE SLINGS
[Continued]
[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	7.5	865	430	1,730	1,500	1,220	865
9/16	10.4	1,120	560	2,230	1,930	1,580	1,120
5/8	13.3	1,420	710	2,840	2,460	2,010	1,420
3/4	16.7	1,750	875	3,490	3,020	2,470	1,750
13/16	19.5	2,110	1,050	4,210	3,650	2,980	2,110
7/8	22.5	2,500	1,250	5,000	4,330	3,540	2,500
1	27.0	2,920	1,460	5,830	5,050	4,120	2,920
1 1/16	31.3	3,400	1,700	6,800	5,890	4,810	3,400
1 1/8	36.0	3,890	1,940	7,780	6,730	5,500	3,890
1 1/4	41.7	4,370	2,190	8,750	7,580	6,190	4,370
1 5/16	47.9	4,860	2,430	9,720	8,420	6,870	4,860
1 1/2	59.9	5,990	3,000	12,000	10,400	8,480	5,990
1 5/8	74.6	7,290	3,650	14,600	12,600	10,300	7,290
1 3/4	89.3	8,590	4,290	17,200	14,900	12,100	8,590
2	107.5	10,000	5,020	20,100	17,400	14,200	10,000
2 1/8	125.0	11,700	5,830	23,300	20,200	16,500	11,700
2 1/4	146.0	13,300	6,640	26,600	23,000	18,800	13,300
2 1/2	166.7	15,100	7,530	30,100	26,100	21,300	15,100
2 5/8	190.8	16,800	8,420	33,700	29,200	23,800	16,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-17. -- NYLON ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical Hitch	Choker Hitch	Basket Hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	6.5	635	320	1270	1100	900	635
9/16	8.3	790	395	1580	1370	1120	790
5/8	10.5	1030	515	2060	1780	1460	1030
3/4	14.5	1410	705	2820	2440	1990	1410
13/16	17.0	1680	840	3360	2910	2380	1680
7/8	20.0	1980	990	3960	3430	2800	1980
1	26.0	2480	1240	4960	4300	3510	2480
1 1/16	29.0	2850	1430	5700	4940	4030	2850
1 1/8	34.0	3270	1640	6540	5660	4620	3270
1 1/4	40.0	3710	1860	7420	6430	5250	3710
1 5/16	45.0	4260	2130	8520	7380	6020	4260
1 1/2	55.0	5250	2630	10500	9090	7420	5250
1 5/8	68.0	6440	3220	12900	11200	9110	6440
1 3/4	83.0	7720	3860	15400	13400	10900	7720
2	95.0	9110	4560	18200	15800	12900	9110
2 1/8	109.0	10500	5250	21000	18200	14800	10500
2 1/4	129.0	12400	6200	24800	21500	17500	12400
2 1/2	149.0	13900	6950	27800	24100	19700	13900
2 5/8	168.0	16000	8000	32000	27700	22600	16000

TABLE N-184-17. -- NYLON ROPE SLINGS
[Continued]
[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	6.5	1,140	570	2,290	1,980	1,620	1,140
9/16	8.3	1,420	710	2,840	2,460	2,010	1,420
5/8	10.5	1,850	925	3,710	3,210	2,620	1,850
3/4	14.5	2,540	1,270	5,080	4,400	3,590	2,540
13/16	17.0	3,020	1,510	6,050	5,240	4,280	3,020
7/8	20.0	3,560	1,780	7,130	6,170	5,040	3,560
1	26.0	4,460	2,230	8,930	7,730	6,310	4,460
1 1/16	29.0	5,130	2,570	10,300	8,890	7,260	5,130
1 1/8	34.0	5,890	2,940	11,800	10,200	8,330	5,890
1 1/4	40.0	6,680	3,340	13,400	11,600	9,450	6,680
1 5/16	45.0	7,670	3,830	15,300	13,300	10,800	7,670
1 1/2	55.0	9,450	4,730	18,900	16,400	13,400	9,450
1 5/8	68.0	11,600	5,800	23,200	20,100	16,400	11,600
1 3/4	83.0	13,900	6,950	27,800	24,100	19,700	13,900
2	95.0	16,400	8,200	32,800	28,400	23,200	16,400
2 1/8	109.0	18,900	9,450	37,800	32,700	26,700	18,900
2 1/4	129.0	22,300	11,200	44,600	38,700	31,600	22,300
2 1/2	149.0	25,000	12,500	50,000	43,300	35,400	25,000
2 5/8	168.0	28,800	14,400	57,600	49,900	40,700	28,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-18. -- POLYESTER ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	8.0	635	320	1,270	1,100	900	635
9/16	10.2	790	395	1,580	1,370	1,120	790
5/8	13.0	990	495	1,980	1,710	1,400	990
3/4	17.5	1,240	620	2,480	2,150	1,750	1,240
13/16	21.0	1,540	770	3,080	2,670	2,180	1,540
7/8	25.0	1,780	890	3,560	3,080	2,520	1,780
1	30.5	2,180	1,090	4,360	3,780	3,080	2,180
1 1/16	34.5	2,530	1,270	5,060	4,380	3,580	2,530
1 1/8	40.0	2,920	1,460	5,840	5,060	4,130	2,920
1 1/4	46.3	3,290	1,650	6,580	5,700	4,650	3,290
1 5/16	52.5	3,710	1,860	7,420	6,430	5,250	3,710
1 1/2	66.8	4,630	2,320	9,260	8,020	6,550	4,630
1 5/8	82.0	5,640	2,820	11,300	9,770	7,980	5,640
1 3/4	98.0	6,710	3,360	13,400	11,600	9,490	6,710
2	118.0	7,920	3,960	15,800	13,700	11,200	7,920
2 1/8	135.0	9,110	4,460	18,200	15,800	12,900	9,110
2 1/4	157.0	10,600	5,300	21,200	18,400	15,000	10,600
2 1/2	181.0	12,100	6,050	24,200	21,000	17,100	12,100
2 5/8	205.0	13,600	6,800	27,200	23,600	19,200	13,600

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-18. -- POLYESTER ROPE SLINGS
[Continued]
[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling					
		Vertical Hitch	Choker Hitch	Basket Hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	8.0	1140	570	2290	1980	1620	1140
9/16	10.2	1420	710	2840	2460	2010	1420
5/8	13.0	1780	890	3570	3090	2520	1780
3/4	17.5	2230	1120	4470	3870	3160	2230
13/16	21.0	2770	1390	5540	4800	3920	2770
7/8	25.0	3200	1600	6410	5550	4530	3200
1	30.5	3920	2960	7850	6800	5550	3920
1 1/16	34.5	4550	2280	9110	7990	6440	4550
1 1/8	40.0	5260	2630	10500	9100	7440	5260
1 1/4	46.3	5920	2960	11800	10300	8380	5920
1 5/16	52.5	6680	3340	13400	11600	9450	6680
1 1/2	66.8	8330	4170	16700	14400	11800	8330
1 5/8	82.0	10200	5080	20300	17600	14400	10200
1 3/4	98.0	12100	6040	24200	20900	17100	12100
2	118.0	14300	7130	28500	24700	20200	14300
2 1/8	135.0	16400	8200	32800	28400	23200	16400
2 1/4	157.0	19100	9540	38200	33100	2700	19100
2 1/2	181.0	2180	10900	43600	37700	30800	21800
2 5/8	205.0	24500	12200	49000	42400	34600	24500

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-19. -- POLYPROPYLENE ROPE SLINGS
(Angel of rope to vertical shown in parentheses)

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	4.7	645	325	1,290	1,120	910	645
9/16	6.1	780	390	1,560	1,350	1,100	780
5/8	7.5	950	475	1,900	1,650	1,340	950
3/4	10.7	1,300	650	2,600	2,250	1,840	1,300
13/16	12.7	1,520	760	3,040	2,630	2,150	1,520
7/8	15.0	1,760	880	3,520	3,050	2,490	1,760
1	18.0	2,140	1,070	4,280	3,700	3,030	2,140
1 1/16	20.4	2,450	1,230	4,900	4,240	3,460	2,450
1 1/8	23.7	2,800	1,400	5,600	4,850	3,960	2,800
1 1/4	27.0	3,210	1,610	6,420	5,560	4,540	3,210
1 5/16	30.5	3,600	1,800	7,200	6,240	5,090	3,600
1 1/2	38.5	4,540	2,270	9,080	7,860	6,420	4,540
1 5/8	47.5	5,510	2,760	11,000	9,540	7,790	5,510
1 3/4	57.0	6,580	3,290	13,200	11,400	9,300	6,580
2	69.0	7,960	3,980	15,900	13,800	11,300	7,960
2 1/8	80.0	9,330	4,670	18,700	16,200	13,200	9,330
2 1/4	92.0	10,600	5,300	21,200	18,400	15,000	10,600
2 1/2	107.0	12,200	6,100	24,400	21,100	17,300	12,200
2 5/8	120.0	13,800	6,900	27,600	23,900	19,600	13,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-19. -- POLYPROPYLENE ROPE SLINGS
[Continued]
[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling					
		Vertical Hitch	Choker Hitch	Basket Hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	4.7	1160	580	2320	2010	1640	1160
9/16	6.1	1400	700	2810	2430	1990	1400
5/8	7.5	1710	855	3420	2960	2420	1710
3/4	10.7	2340	1170	4680	4050	3310	2340
13/16	12.7	2740	1370	5470	4740	3870	2740
7/8	15.0	3170	1580	6340	5490	4480	3170
1	18.0	3850	1930	7700	6670	5450	3860
1 1/16	20.4	4410	2210	8820	7640	6240	4410
1 1/8	23.7	5040	2520	10100	8730	7130	5040
1 1/4	27.0	5780	2890	11600	10000	8170	5780
1 5/16	30.5	6480	3240	13000	11200	9170	6480
1 1/2	38.5	8170	4090	16300	14200	11600	8170
1 5/8	47.5	9920	4960	19800	17200	14000	9920
1 3/4	57.0	1180	5920	23700	20300	16800	11800
2	69.0	14300	7160	28700	24800	20300	14300
2 1/8	80.0	16800	8400	33600	29100	23800	16800
2 1/4	92.0	19100	9540	38200	33100	27000	19100
2 1/2	107.0	22000	11000	43900	38000	31000	22000
2 5/8	120.0	24800	12400	49700	43000	35100	24800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

1910.184(h)(2)

Safe operating temperatures. Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from minus 20 deg. F to plus 180 deg. F without decreasing the working load limit. For operations outside this temperature range and for wet frozen slings, the sling manufacturer's recommendations shall be followed.

1910.184(h)(3)

Splicing. Spliced fiber rope slings shall not be used unless they have been spliced in accordance with the following minimum requirements and in accordance with any additional recommendations of the manufacturer:

1910.184(h)(3)(i)

In manila rope, eye splices shall consist of at least three full tucks, and short splices shall consist of at least six full tucks, three on each side of the splice center line.

1910.184(h)(3)(ii)

In synthetic fiber rope, eye splices shall consist of at least four full tucks, and short splices shall consist of at least eight full tucks, four on each side of the center line.

..1910.184(h)(3)(iii)

1910.184(h)(3)(iii)

Strand end tails shall not be trimmed flush with the surface of the rope immediately adjacent to the full tucks. This applies to all types of fiber rope and both eye and short splices. For fiber rope under one inch in diameter, the tail shall project at least six rope diameters beyond the last full tuck. For fiber rope one inch in diameter and larger, the tail shall project at least six inches beyond the last full tuck. Where a projecting tail interferes with the use of the sling, the tail shall be tapered and spliced into the body of the rope using at least two additional tucks (which will require a tail length of approximately six rope diameters beyond the last full tuck).

1910.184(h)(3)(iv)

Fiber rope slings shall have a minimum clear length of rope between eye splices equal to 10 times the rope diameter.

1910.184(h)(3)(v)

Knots shall not be used in lieu of splices.

1910.184(h)(3)(vi)

Clamps not designed specifically for fiber ropes shall not be used for splicing.

1910.184(h)(3)(vii)

For all eye splices, the eye shall be of such size to provide an included angle of not greater than 60 degrees at the splice when the eye is placed over the load or support.

1910.184(h)(4)

End attachments. Fiber rope slings shall not be used if end attachments in contact with the rope have sharp edges or projections.

1910.184(h)(5)

Removal from service. Natural and synthetic fiber rope slings shall be immediately removed from service if any of the following conditions are present:

1910.184(h)(5)(i)

Abnormal wear.

1910.184(h)(5)(ii)
Powdered fiber between strands.

..1910.184(h)(5)(iii)

1910.184(h)(5)(iii)
Broken or cut fibers.
1910.184(h)(5)(iv)
Variations in the size or roundness of strands.

1910.184(h)(5)(v)
Discoloration or rotting.

1910.184(h)(5)(vi)
Distortion of hardware in the sling.

1910.184(h)(6)
Repairs. Only fiber rope slings made from new rope shall be used. Use of repaired or reconditioned fiber rope slings is prohibited.

1910.184(i)
Synthetic web slings --

1910.184(i)(1)
Sling identification. Each sling shall be marked or coded to show the rated capacities for each type of hitch and type of synthetic web material.

1910.184(i)(2)
Webbing. Synthetic webbing shall be of uniform thickness and width and selvage edges shall not be split from the webbing's width.

1910.184(i)(3)
Fittings. Fittings shall be:

1910.184(i)(3)(i)
Of a minimum breaking strength equal to that of the sling; and

1910.184(i)(3)(ii)
Free of all sharp edges that could in any way damage the webbing.

..1910.184(i)(4)

1910.184(i)(4)
Attachment of end fittings to webbing and formation of eyes. Stitching shall be the only method used to attach end fittings to webbing and to form eyes. The thread shall be in an even pattern and contain a sufficient number of stitches to develop the full breaking strength of the sling.

1910.184(i)(5)

Sling use. Synthetic web slings illustrated in Fig. N-184-6 shall not be used with loads in excess of the rated capacities specified in Tables N-184-20 through N-184-22. Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

1910.184(i)(6)

Environmental conditions. When synthetic web slings are used, the following precautions shall be taken:

1910.184(i)(6)(i)

Nylon web slings shall not be used where fumes, vapors, sprays, mists or liquids of acids or phenolics are present.

1910.184(i)(6)(ii)

Polyester and polypropylene web slings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

1910.184(i)(6)(iii)

Web slings with aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

FIGURE N-184-6 Basic Synthetic Web Sling Constructions
(For Figure N-184-6,)

TABLE N-184-20. -- SYNTHETIC WEB SLINGS
-- 1,000 Pounds per Inch of Width
-- Single-Ply
[Rated capacity in pounds]

Sling body width, inches	Triangle -- Choker slings, type I: Triangle -- Triangle slings, type II; Eye and eye with flat eye slings, type III; Eye and eye with twisted eye slings, type IV					
	Vert.	Choker	Vert. Basket	30 deg basket	45 deg. basket	60 deg. basket
1	1000	750	2000	1700	1400	1000
2	2000	1500	4000	3500	2800	2000
3	3000	2200	6000	5200	4200	3000
4	4000	3000	8000	6900	5700	4000
5	5000	3700	10000	8700	7100	5000
6	6000	4500	12000	10400	8500	6000

TABLE N-184-20. -- SYNTHETIC WEB SLINGS

-- 1,000 Pounds per Inch of Width

-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Endless slings, type V					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	1,600	1,300	3,200	2,800	2,300	1,600
2.....	3,200	2,600	6,400	5,500	4,500	3,200
3.....	4,800	3,800	9,600	8,300	6,800	4,800
4.....	6,400	5,100	12,800	11,100	9,000	6,400
5.....	8,000	6,400	16,000	13,900	11,300	8,000
6.....	9,600	7,700	19,200	16,600	13,600	9,600

TABLE N-184-20. -- SYNTHETIC WEB SLINGS

-- 1,000 Pounds per Inch of Width

-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Return eye slings, type VI					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	800	650	1,600	1,400	1,150	800
2.....	1,600	1,300	3,200	2,800	2,300	1,600
3.....	2,400	1,950	4,800	4,150	3,400	2,400
4.....	3,200	2,600	6,400	5,500	4,500	3,200
5.....	4,000	3,250	8,000	6,900	5,650	4,000
6.....	4,800	3,800	9,600	8,300	6,800	4,800

NOTES: 1. All angles shown are measured from the vertical.

2. Capacities for intermediate widths not shown may be obtained by interpolation.

TABLE N-184-21. -- SYNTHETIC WEB SLINGS

-- 1,200 Pounds Per Inch of Width

-- Single-Ply

[Rated capacity in pounds]

Sling body width, inches	Triangle -- Choker slings, type I: Triangle -- Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	1,200	900	2,400	2,100	1,700	1,200
2.....	2,400	1,800	4,800	4,200	3,400	2,400
3.....	3,600	2,700	7,200	6,200	5,100	3,600
4.....	4,800	3,600	9,600	8,300	6,800	4,800
5.....	6,000	4,500	12,000	10,400	8,500	6,000
6.....	7,200	5,400	14,400	12,500	10,200	7,200

TABLE N-184-21. -- SYNTHETIC WEB SLINGS

-- 1,200 Pounds per Inch of Width

-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Endless slings, type V					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	1,900	1,500	3,800	3,300	2,700	1,900
2.....	3,800	3,000	7,600	6,600	5,400	3,800
3.....	5,800	4,600	11,600	10,000	8,200	5,800
4.....	7,700	6,200	15,400	13,300	10,900	7,700
5.....	9,600	7,700	19,200	16,600	13,600	9,600
6.....	11,500	9,200	23,000	19,900	16,300	11,500

TABLE N-184-21. -- SYNTHETIC WEB SLINGS
 -- 1,200 Pounds per Inch of Width
 -- Single-Ply
 [Rated capacity in pounds]
 (Continued)

Sling body width, inches	Return eye slings, type VI					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	950	750	1,900	1,650	1,350	950
2.....	1,900	1,500	3,800	3,300	2,700	1,900
3.....	2,850	2,250	5,700	4,950	4,050	2,850
4.....	3,800	3,000	7,600	6,600	5,400	3,800
5.....	4,750	3,750	9,500	8,250	6,750	4,750
6.....	5,800	4,600	11,600	10,000	8,200	5,800

NOTES: 1. All angles shown are measured from the vertical.
 2. Capacities for intermediate widths not shown may be obtained by interpolation.

TABLE N-184-22. -- SYNTHETIC WEB SLINGS
 -- 1,600 Pounds per Inch of Width
 -- Single-Ply

[Rated capacity in pounds]

Sling body width, inches	Triangle -- Choker slings, type I: Triangle -- Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	1,600	1,200	3,200	2,800	2,300	1,600
2.....	3,200	2,400	6,400	5,500	4,500	3,200
3.....	4,800	3,600	9,600	8,300	6,800	4,800
4.....	6,400	4,800	12,800	11,100	9,000	6,400
5.....	8,000	6,000	16,000	13,800	11,300	8,000
6.....	9,600	7,200	19,200	16,600	13,600	9,600

TABLE N-184-22. -- SYNTHETIC WEB SLINGS

-- 1,600 Pounds per Inch of Width

-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Endless slings, type V					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.....	2,600	2,100	5,200	4,500	3,700	2,600
2.....	5,100	4,100	10,200	8,800	7,200	5,100
3.....	7,700	6,200	15,400	13,300	10,900	7,700
4.....	10,100	8,200	20,400	17,700	14,400	10,200
5.....	12,800	10,200	25,600	22,200	18,100	12,800
6.....	15,400	12,300	30,800	26,700	21,800	15,400

TABLE N-184-22. -- SYNTHETIC WEB SLINGS

-- 1,600 Pounds per Inch of Width

-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Return eye slings, type VI					
	Vert.	Choker	Vert. Basket	30 deg basket	45 deg. basket	60 deg. basket
1	1050	1050	2600	2250	1850	1300
2	2600	2100	5200	4500	3700	2600
3	3900	3150	7800	6750	5500	3900
4	5100	4100	10200	8800	7200	5100
5	6400	5150	12800	11050	9050	6400
6	7700	6200	15400	13300	10900	7700

NOTES: 1. All angles shown are measured from the vertical.

2. Capacities for intermediate widths not shown may be obtained by interpolation.

1910.184(i)(7)

Safe operating temperatures. Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180 deg. F. Polypropylene web slings shall not be used at temperatures in excess of 200 deg. F.

..1910.184(i)(8)

1910.184(i)(8)

Repairs.

1910.184(i)(8)(i)

Synthetic web slings which are repaired shall not be used unless repaired by a sling manufacturer or an equivalent entity.

1910.184(i)(8)(ii)

Each repaired sling shall be proof tested by the manufacturer or equivalent entity to twice the rated capacity prior to its return to service. The employer shall retain a certificate of the proof test and make it available for examination.

1910.184(i)(8)(iii)

Slings, including webbing and fittings, which have been repaired in a temporary manner shall not be used.

1910.184(i)(9)

Removal from service. Synthetic web slings shall be immediately removed from service if any of the following conditions are present:

1910.184(i)(9)(i)

Acid or caustic burns;

1910.184(i)(9)(ii)

Melting or charring of any part of the sling surface;

1910.184(i)(9)(iii)

Snags, punctures, tears or cuts;

1910.184(i)(9)(iv)

Broken or worn stitches; or

1910.184(i)(9)(v)

Distortion of fittings.

[40 FR 27369, June 27, 1975, as amended at 40 FR 31598, July 28, 1975; 41 FR 13353, Mar. 30, 1976; 58 FR 35309, June 30, 1993; 61 FR 9227, March 7, 1996]

Summary: Applying the Standard

1. The OSHA standard is a tool than we can use for our protection by demanding that the law be enforced.
2. It is important to be familiar with the Material handling Standard for all workers, especially those working around or with material handling equipment such as cranes, derricks, helicopters and slings.
3. The OSHA standards are minimum requirements; every workplace is unique and lessons learned should include situations which are above and beyond OSHA standards to ensure that workers are safe.

EVALUATION

Activity 6: Applying the OSHA Standards

1. How important is this Activity for workers? Please circle one number.

Activity Is Not Important			Activity Is Very Important	
1	2	3	4	5

2. What would you suggest be done to improve this Activity?

Appendix:
Supplemental Information

1. Chains

Chains are commonly used because of their strength and ability to adapt to the shape of the load. They must have identification permanently affixed which has size, grade, rated capacity and reach.

Care should be taken when using alloy chain slings because they are subject to damage by sudden shocks.

Misuse of chain slings could damage the sling, resulting in sling failure and possible injury to an employee.

Chain slings are your best choice for lifting materials that are very hot. They can be heated to temperatures of up to 1000° F; however, when alloy chain slings are consistently exposed to service temperatures in excess of 600° F, operators must reduce the working load limits in accordance with the manufacturer's recommendations.

All sling types must be visually inspected by a competent person prior to use. In addition to frequent inspections, a thorough periodic inspection of chain slings must be conducted on a regular basis depending on usage, but at least yearly. This inspection should be documented.

When inspecting alloy steel chain slings, pay special attention to any:

- Stretching,
- Wear in excess of the allowances made by the manufacturer and
- Nicks and gouges.

These are all indications that the sling may be unsafe and is to be removed from service.

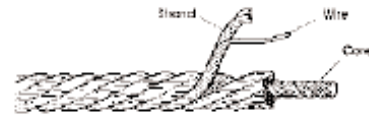


2. Wire Rope

Wire rope is composed of individual wires that have been twisted to form strands. The strands are then twisted to form a wire rope.

When wire rope has a fiber core, it is usually more flexible but is less resistant to environmental damage.

A core that is made of a wire rope strand tends to have greater strength and is more resistant to heat damage.



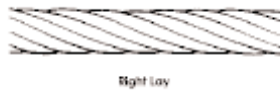
3. Rope Lay

Wire rope may be further defined by the “lay.” The lay of a wire rope can mean any of three things:

1. One complete wrap of a strand around the core: **One rope lay** is one complete wrap of a strand around the core.



2. The direction the strands are wound around the core: Wire rope is referred to as **right lay** or **left lay**. A right lay rope is one in which the strands are wound in a right-hand direction like a conventional screw thread. A left lay rope is just the opposite.



3. The direction the wires are wound in the strands in relation to the direction of the strands around the core: In **regular lay** rope, the wires in the strands are laid in one direction while the strands in the rope are laid in the opposite direction. In **lang lay** rope, the wires are twisted in the same direction as the strands.



Right lay, regular lay



Right lay, lang lay



Right lay, regular lay



Left lay, lang lay

continued

3. Rope Lay (*continued*)

Regular lay ropes, the wires in the strands are laid in one direction, while the strands in the rope are laid in the opposite direction. The result is that the wire crown runs approximately parallel to the longitudinal axis of the rope. These ropes have good resistance to kinking and twisting and are easy to handle. They are also able to withstand considerable crushing and distortion due to the short length of exposed wires. **This type of rope has the widest range of applications.**

Lang lay (where the wires are twisted in the same direction as the strands) is recommended for many excavating, construction and mining applications, including draglines, hoist lines, dredgelines and other similar lines.

Lang lay ropes are more flexible and have greater wearing surface per wire than regular lay ropes. In addition, since the outside wires in lang lay ropes lie at an angle to the rope axis, internal stress due to bending over sheaves and drums is reduced causing lang lay ropes to be more resistant to bending fatigue.

Left lay rope is one in which the strands form a left-hand helix similar to the threads of a left-hand screw thread. Left lay rope has its greatest usage in oil fields on rod and tubing lines, blast hole rigs, and spudders where rotation of right lay would loosen couplings. The rotation of a left lay rope tightens a standard coupling.

4. Wire Rope Sling Selection

When selecting a wire rope sling to give the best service, there are four characteristics to consider: strength, ability to bend without distortion, ability to withstand abrasive wear and ability to withstand abuse.

1. **Strength**—The strength of a wire rope is a function of its size, grade and construction. It must be sufficient to accommodate the maximum load that will be applied. The maximum load limit is determined by means of an appropriate multiplier. This multiplier is the number by which the ultimate strength of a wire rope is divided to determine the working load limit. Thus a wire rope sling with a strength of 10,000 pounds and a total working load of 2,000 pounds has a design factor (multiplier) of 5. New wire rope slings have a design factor of 5. As a sling suffers from the rigors of continued service, however, both the design factor and the sling's ultimate strength are proportionately reduced. If a sling is loaded beyond its ultimate strength, it will fail. For this reason, older slings must be more rigorously inspected to ensure that rope conditions adversely affecting the strength of the sling are considered in determining whether or not a wire rope sling should be allowed to continue in service.

2. **Fatigue**—A wire rope must have the ability to withstand repeated bending without the failure of the wires from fatigue. Fatigue failure of the wires in a wire rope is the result of the development of small cracks under repeated applications of bending loads. It occurs when ropes make small radius bends. The best means of preventing fatigue failure of wire rope slings is to use blocking or padding to increase the radius of the bend.



Wire Rope Fatigue Failure

continued

4. Wire Rope Sling Selection (*continued*)

Abrasive Wear—The ability of a wire rope to withstand abrasion is determined by the size, number of wires and construction of the rope. Smaller wires bend more readily and therefore offer greater flexibility but are less able to withstand abrasive wear. Conversely, the larger wires of less flexible ropes are better able to withstand abrasion than smaller wires of the more flexible ropes.



Wire Rope "Bird Cage"

Abuse—All other factors being equal, misuse or abuse of wire rope will cause a wire rope sling to become unsafe long before any other factor. Abusing a wire rope sling can cause serious structural damage to the wire rope, such as kinking or bird caging which reduces the strength of the wire rope. (In bird

caging, the wire rope strands are forcibly untwisted and become spread outward.) Therefore, in order to prolong the life of the sling and protect the lives of employees, the manufacturer's suggestion for safe and proper use of wire rope slings must be strictly adhered to.

5. Wire Rope Life

Many operating conditions affect wire rope life. They are:

- Bending,
- Stresses,
- Loading conditions,
- Speed of load application (jerking),
- Abrasion,
- Corrosion,
- Sling design,
- Materials handled,
- Environmental conditions and
- History of previous usage.

In addition to the above operating conditions, the:

- Weight,
- Size and
- Shape

of the loads to be handled also affect the service life of a wire rope sling.

Flexibility is also a factor. Generally, more flexible ropes are selected when smaller radius bending is required. Less flexible ropes should be used when the rope must move through or over abrasive materials.

6. Wire Rope Sling Inspection

Wire rope slings must be visually inspected before each use.

The operator should check the twists or lay of the sling.

- If ten randomly distributed wires in one lay are broken, or
- Five wires in one strand of a rope lay are damaged,

the sling must not be used.

It is not sufficient, however, to check only the condition of the wire rope.

- End fittings and other components should also be inspected for any damage that could make the sling unsafe.

To ensure safe sling usage between scheduled inspections a close watch must be kept on the slings in use.

If any accident involving the movement of materials occurs, the operator must immediately shut down the equipment and report the accident to a supervisor. The cause of the accident must be determined and corrected before resuming operations.

7. Discarding Slings

Wire rope slings can provide a margin of safety by showing early signs of failure. Factors requiring that a wire sling be discarded include the following:

- Severe corrosion;
- Localized wear (shiny worn spots) on the outside;
- A one-third reduction in outer wire diameter;
- Damage or displacement of end fittings - hooks, rings, links, or collars - by overload or misapplication;
- Distortion, kinking, bird caging or other evidence of damage to the wire rope structure; or
- Excessive broken wires.

8. Fiber Rope and Synthetic Web

Fiber rope and synthetic web slings are used primarily for temporary work, such as construction and painting jobs, and in marine operations.

They are also the best choice for use on expensive loads, highly finished parts, fragile parts and delicate equipment.

9. Fiber Rope

Fiber rope slings are preferred for some applications because:

- They are pliant;
- They grip the load well; and
- They do not mar the surface of the load.

They should be used only on light loads, and must not be used on objects that have sharp edges capable of cutting the rope or in applications where the sling will be exposed to high temperatures, severe abrasion or acids.

The choice of rope type and size will depend upon the application, the weight to be lifted and the sling angle. Before lifting any load with a fiber rope sling be sure to inspect the sling carefully because they deteriorate far more rapidly than wire rope slings and their actual strength is very difficult to estimate.

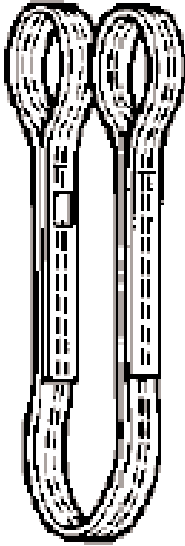
When inspecting a fiber rope sling prior to using it:

- **Look** at its surface. Look for dry, brittle, scorched or discolored fibers. If any of these conditions are found, a determination must be made regarding the safety of the sling. If the sling is found to be unsafe, it must be discarded.
- **Check** the interior of the sling. It should be as clean as when the rope was new. A build-up of powder-like sawdust on the inside of the fiber rope indicates excessive internal wear and is an indication that the sling is unsafe.
- **Scratch** the fibers with a fingernail. If the fibers come apart easily, the fiber sling has suffered some kind of chemical damage and must be discarded.



10. Synthetic Web Slings

Synthetic web slings offer a number of advantages for rigging purposes. The most commonly used synthetic web slings are made of nylon, dacron, and polyester. They have the following properties in common:



- **Strength**—some synthetic web slings may have a rated capacity of up to 300,000 lbs.
- **Convenience**— can conform to any shape.
- **Safety**—will adjust to the load contour and hold it with a tight, non-slip grip.
- **Load protection**—will not mar, deface or scratch highly polished or delicate surfaces.
- **Long life**—are unaffected by mildew, rot or bacteria; resist some chemical action; and have excellent abrasion resistance.
- **Economy**— have low initial cost plus long service life.
- **Shock absorbency**— can absorb heavy shocks without damage.
- **Temperature resistance**—are unaffected by temperatures up to 180° F.

11. Unique Properties and Possible Defects

Each synthetic material has its own unique properties.

- Nylon must be used wherever alkaline or greasy conditions exist. It is also preferable when neutral conditions prevail and when resistance to chemicals and solvents is important.
- Dacron must be used where high concentrations of acid solutions - such as sulfuric, hydrochloric, nitric and formic acids - and where high-temperature bleach solutions are prevalent. (Nylon will deteriorate under these conditions.) Do not use dacron in alkaline conditions because it will deteriorate; use nylon or polypropylene instead.
- Polyester must be used where acids or bleaching agents are present and is also ideal for applications where a minimum of stretching is important.
- When hazardous materials are present, manufacturer instructions should be consulted to ensure proper use of sling.

Synthetic web slings must be removed from service if any of the following defects exist:

- Acid or caustic burns,
- Melting or charring of any part of the surface,
- Snags, punctures, tears or cuts,
- Broken or worn stitches,
- Wear or elongation exceeding the amount recommended by the manufacturer or
- Distortion of fittings.

12. Derricks

OSHA 1910.181(a)(1) defines derricks as an apparatus consisting of a mast or equivalent member held at the head by guys or braces with or without a boom, for use with a hoisting mechanism and operating ropes.

Load ratings for permanently installed derricks with fixed lengths of boom, guy and mast shall have a rating chart securely affixed to where it is visible by the operator. The chart shall include:

- Manufacturer's approval load ratings at corresponding ranges of boom angle or operating radii;
- Specific lengths of components on which the load ratings are based; and
- Required parts for hoist revving.

For non-permanent installations, the manufacturer shall provide sufficient information from which capacity charts can be prepared for the particular installation. The capacity charts shall be located at the derricks or the job site office.

No derrick shall be loaded beyond the rated load.

Source: OSHA 29 CFR 1910.181.

13. Helicopters

If there is ever the need to use a helicopter crane, it shall comply with Federal Aviation Administration (FAA) regulations and **OSHA standard 1910.183**.

Hooking Loads

Workers will not perform work under a hovering craft except when necessary to hook or unhook loads.

Signal System

The employer shall instruct the air and ground crew on the signal system and shall review the systems with the workers before hoisting the load. This applies to both radio and hand signals.

Static Charge

Static charge on a suspended load shall be dissipated with a grounding device before ground crews touch the load.

Approach

No worker shall be permitted to approach within 50 feet of the helicopter when the rotor blades are turning, unless their work duties require otherwise.

Communications

There shall be constant, reliable communications between designated worker on the assigned ground crew and the pilot.

Source: OSHA 29 CFR 1910.183.

14. Other Crane Info

Some mobile cranes cannot operate with outriggers in the traveling position.

When used, the outriggers must rest:

- On firm ground,
- On timbers or
- Be sufficiently cribbed to spread the weight of the crane and the load over a large enough area.

This will prevent the crane from tipping during use.

Hoisting chains and ropes must always be free of kinks or twists and must never be wrapped around a load.

Loads should be attached to the load hook by slings, fixtures or other devices that have the capacity to support the load on the hook.

Sharp edges of loads should be padded to prevent cutting slings.

Proper sling angles shall be maintained so that slings are not loaded in excess of their capacity.

All rim wheels, multi and single piece, shall be removed from service if is showing any of the following defects:

- Crack at welds;
- Cracked or broken components;
- Bent or sprung components caused by mishandling, abuse, tire explosion or rim wheel separation; and
- Component pitted due to corrosion or other structural damage that would decrease its effectiveness.

