FREEPORT-
MCMORAN

FACILITATOR GUIDE

RIG FCX1001C
TECHNICAL RIGGING

SEPTEMBER 2016

VERSION 1.2

Proof of a passing knowledge assessment and required in-field assessments must be available for audit purposes.

TABLE OF CONTENTS

INTRODUCTION

This course is a not a new course, it is a standardized course. The course was built for the sites by the sites, and the following should be acknowledged for their work on this project:

ACKNOWLEDGEMENTS

The course content was gathered from Freeport-McMoRan sites across North America. A team of technical instructors then worked with the Mine Training Institute to build the course you are about to teach:

CONTENT GATHERING

The following gathered site content and collaborated to produce the initial plan for the course:

David Colville	Bagdad
Andre Garza	Bagdad
Steve Love	Bagdad
Freeman Myers	Bagdad
Thomas Owings	Bagdad
Lenny Dorr	Climax (Lead)
Ali Hammer	Climax
Ted Wall	Henderson
Megan Crawford	Miami
John Freeman	Miami
Marcos Franco	Miami
Lavar Holyoak Jr.	Miami
Rickey Kissel	Miami
Kurtis Knauss	Miami
Rick Green	Morenci
Dusty Gatlin	Morenci
Raymond Barnes	NMO Chino
Steve Bencomo	NMO Chino
Wayne Capshaw	NMO Chino
David Marquez	NMO Chino
Dan Moseley	NMO Chino
Shad Burns	NMO Tyrone
Stanley Walkup	Oro Valley
Darrel Goad	Phoenix
Barry Johnson	Safford
Frank Martinez	Safford
Robert Perez	Safford
Robert Rogers	Safford
Jerry Burkett	San Carlos
Jayson Carpenter	San Carlos
Lloyd Keller	San Carlos
Tony Amaro	Sierrita
Bill Bufford	Sierrita
Astolfo Cota	Sierrita
Catherine Fontes	Sierrita
Dan Handt	Sierrita
Hector Rangel	Sierrita
Fredrick Siegert	Sierrita

COURSE BUILD

The following worked tirelessly to review drafts, revise and refine content, and build the course:

Thomas Owings	Bagdad
Dave Colville	Bagdad
Freeman Myers	Bagdad
Ali Hammer	Climax
John Freeman	Miami
Lavar Holyoak Jnr	Miami
Dusty Gatlin	Morenci
David Marquez	NMO
Raymond Barnes	NMO
Jarrod Johnson	NMO
Frank Martinez	Safford
Robert Rogers	Safford
Robert Perez	Safford
Steve Valdez	Safford
Jayson Carpenter	San Carlos
Lloyd Keller	San Carlos
Alfonso Cota	Sierrita
Bill Bufford	Sierrita
Jay Williams	Sierrita
Aldo Perazzone	Sierrita
Angela Johnson	MTI (Instructional Designer)

SPECIAL THANKS TO:

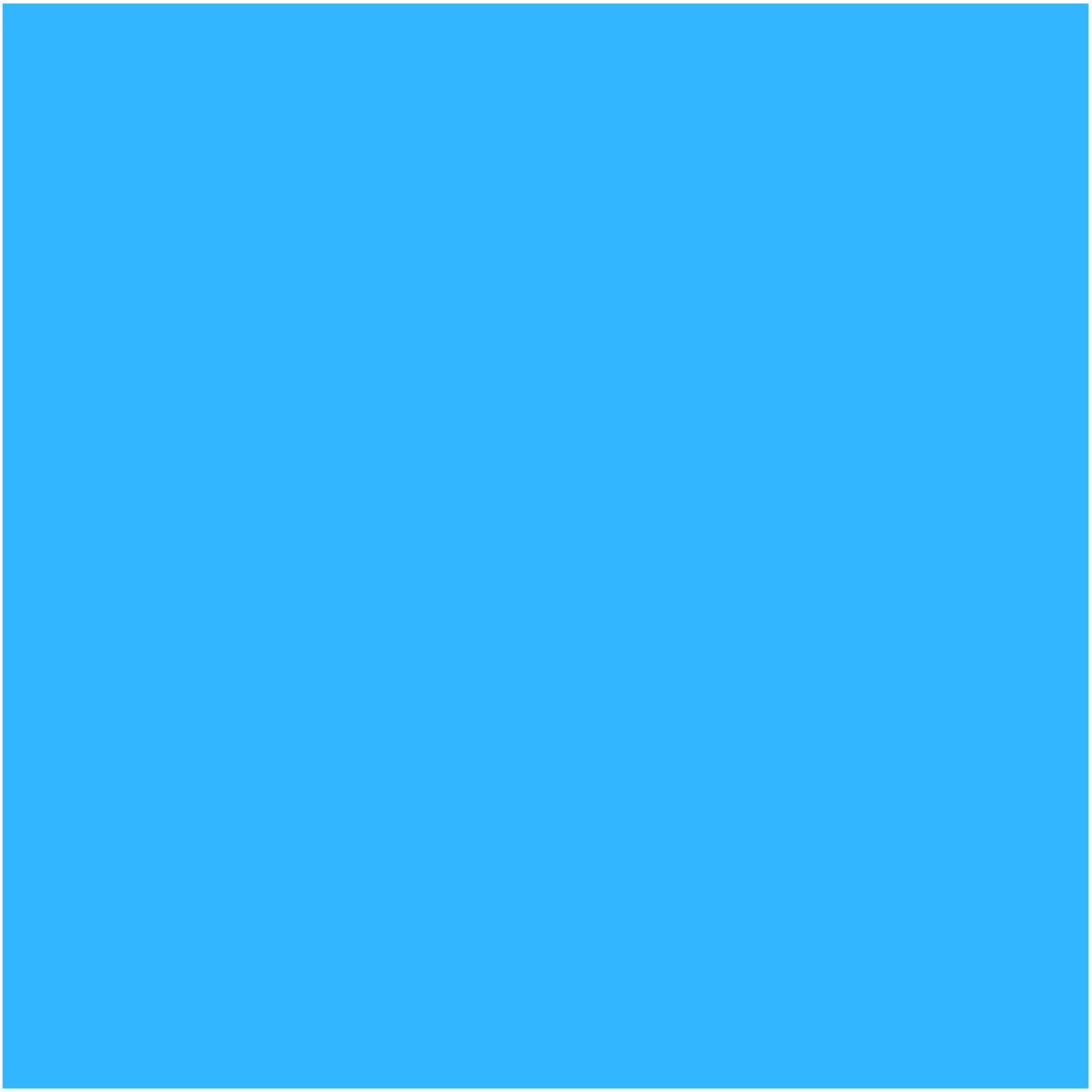
Dusty Gatlin for help with revised content for the Hardware, Slings and Hands Signals modules.

Ali Hammer for help with revised content for the Hitches, Hoists & Lifters, COG & Load Angle Factors, and the Exercises modules.

John Freeman for photographs and the Mechanical Advantage content.

Dusty Gatlin for hosting the pilot at Morenci. Mark Lozano for teaching the course, and thanks also to Elton Babb and Victor Goodman for the help with facilitation of assessments.

Course Overview



INTRODUCTION

This course is a not a new course, it is a standardized course.

STANDARDIZATION

Technical Rigging has always been taught at our North American mine sites. The purpose of this 'new' course is to standardize how it is taught at each site.

The course does not contain new content, it is standardized content. The content has been gathered from all of our sites, and agreed by all of the sites. It is therefore important that the course is taught as designed, and as agreed by all of the sites.

All content must be covered. When an employee transfers to a new site, their supervisor needs to know that they have the same Technical Rigging skills and knowledge as existing employees.

FLEXIBILITY

It is important that the course is taught as designed, however; facilitators have the flexibility to elaborate on content, and must also discuss site specific procedures where appropriate.

SITE SPECIFIC NOTES

Sites have very different procedures for some items. Facilitators need to research and record their own site specific procedure on; Taglines, Slings, and Hoist Maintenance.

Where site specific policy is to be discussed:

- Notes pages have been placed in the Facilitator Guide for facilitator preparation.
- Notes pages also appear in the Student Guide for employees to record their site specific policy.

STORIES / EXAMPLES / ELABORATION

Stories and examples aid understanding and student recall of information. Personal anecdotes add meaning to content. If you have personal knowledge of rigging incidences and PFE's it is important that you add your stories to the course.

You may also wish to elaborate on items, or stress content by adding further examples. In the sections of the course that includes math, you may have another way to calculate an equation. Always use the formula in the course, but adding another example aids understanding.

REGULATIONS / POLICIES / PROCEDURES

Rigging is heavily regulated. Regulations are referenced throughout the course: Hardware, Slings, Hoists & Lifters, and the Signals modules all contain multiple references to regulations.

Student Guide: All specific regulations are numbered in the text, and listed in the back of the student guide in the 'references' section pages 160 - 162. There is also a general list of OSHA and ASME regulations in the appendices of the student guide, (see 'Appendix 1: Federal Regulations', page 156.)

Facilitator Guide: All specific regulations are in the notes for each individual slide in the Facilitator Guide. Note: The references are for information only, the actual content of the regulation is quoted in the course.

COURSE OVERVIEW

Through this course, employees will be trained to identify different types of rigging equipment and hardware. They will be able to conduct equipment inspections and recognize defects, calculate load angles and weights, for safe rigging practice.

Learning objectives have been identified to provide guidance and focus to students throughout the course and individual modules.

TARGET AUDIENCE

This course is a basic rigging course, intended to teach employees basic safe rigging practice.

Any time there is a suspended load; there is risk. The course teaches employees how to manage that risk, and is for any employee who will EVER encounter a suspended load

This course is essential to any employee who operates cranes, and is a pre-requisite to their crane training.

COURSE OBJECTIVES

Upon completion of this course, students will be able to:

- Identify different types of rigging equipment.
- Conduct rigging equipment inspections, and recognize defects.
- Recall safety regulations and apply safe rigging practices.

MODULE 1: BEST PRACTICE

Upon completion of this module, students will be able to:

- Understand the risks of rigging.
- Relate to rigging failure / fatality examples.
- Apply best practice to ensure safe rigging practices.

MODULE 2: HARDWARE

Upon completion of this module, students will be able to:

- Identify different types of rigging hardware, and their components.
- Conduct hardware inspections, and recognize defects.
- Recall hardware regulations and apply safe rigging practices.

MODULE 3: SLINGS

Upon completion of module, students will be able to:

- Identify different types of slings, and their components.
- Conduct sling inspections, and recognize defects.
- Recall sling regulations and apply safe rigging practices.

MODULE 4: HITCHES

Upon completion of module, students will be able to:

- Identify the different types of hitches and their uses.
- Recall hitch capacity reductions and apply safe rigging practices.

MODULE 5: HOISTS & LIFTERS

Upon completion of module, students will be able to:

- Identify the different types of hoists and lifters and their uses.
- Conduct hoist inspections, recognize defects, and understand maintenance requirements.
- Recall hoist regulations and apply safe rigging practices.

MODULE 6: SIGNALS

Upon completion of module, students will be able to:

- Understand the responsibilities of a signaler.
- Identify and recall the different crane hand signals.
- Recall signal regulations and apply safe rigging practices.
- Understand crane dynamics.

MODULE 7: WEIGHTS

Upon completion of module, students will be able to:

- Calculate the area and volume of loads.
- Use weight tables to calculate the weight of loads.

MODULE 8: CENTER OF GRAVITY & LOAD ANGLE FACTORS

Upon completion of module, students will be able to:

- Understand the effect the Center of Gravity and sling angles have on loads.
- Calculate sling angle tension and load angle factors, and apply safe rigging practices.
- Calculate Center of Gravity and sling tension, and apply safe rigging practices.

MODULE 9: RIGGING EXERCISES

Upon completion of this module, students will be able to:

- Use Rigging Reference Guides to calculate the correct rigging equipment for a lift.

ASSESSMENT

The course contains four items of assessment: A pre-course test, module quizzes, the post-course test and practical assessment.

- The pre-course test is not actually a test, it is to find out what they already know about rigging, to highlight any gaps in their knowledge, and areas they may need to pay particular attention to.
- Module quizzes check student understanding throughout the course.

Most of the pre course test questions are also used as module quizzes. This gives the facilitator an opportunity to discuss the question, and explain the answer to the class.

- The post-course test is a test of knowledge. Students must pass 80% of all questions before a 5000-23 can be issued. Remediation can be provided if appropriate.
- The practical assessment is a test of skill. Students must pass all items to receive their 5000-23. Remediation can be provided if appropriate.

COURSE LOGISTICS

The course materials do not contain a schedule. How you schedule the course, breaks / lunch and allocate time for assessments, ultimately depends on class size, and the number of facilitators available to assist with the post course assessments.

COURSE LENGTH

The course content and assessment take approximately 16 hours to teach, over 2 days.

CLASS SIZE

This course has no maximum or minimum number of students. However, class size will affect your schedule. The following should be considered:

PRE-COURSE MATH TEST

Modules 7, 8 and 9 are math based content. Students need to demonstrate math skill to pass course assessments. Sites with large class sizes may choose to have students take a basic math test before attending Technical Rigging. Sites with smaller class sizes will have more time to spend with students on math remediation.

POST-COURSE ASSESSMENTS

At the end of the course there is a post course test and a practical assessment. The practical assessment requires that each student be observed and assessed individually. Depending on the number of students and trainers available, you may wish to:

- Split the class into two groups, and have Group 1 take the Post Course Test, and Group 2 do the Practical Assessment.
- With a large group you may wish to split the class into three or four groups and have Group 1 take the test, Group 2 do the first part of the Practical Assessment (Identification), Group 3 do the second part of the test (Demonstration of Skill).
- Or you may choose to see students individually over the next few days / weeks, for them to take the Practical Assessment.

COURSE SCHEDULE

The course materials do not contain a daily schedule. This is suggestion of how it may run:

DAY 1

Introduction - Contains activities and pre course test

Best Practice

Hardware

Slings

Hitches

Hoists and Lifters

Signals

DAY 2

Weight

Center of Gravity & Load Angle Factors

Rigging Exercises

Assessment - Contains post course test and practical assessment

Day 1: Knowledge based content, (with knowledge quiz questions).

Day 2 Skills based content, (with practice quiz questions), and assessments.

BREAKS

Some sites break each hour on the hour, other may choose to break at the end of modules.

- Allow students regular 5 – 10 minute breaks throughout the course.
- Allow students a 30 – 60 minute lunch break.

Clearly communicate what time you expect students to return, and what time you will be resuming class.

END OF DAY 1 / START OF DAY 2

Whatever schedule you decide on, it is good practice to close out at the end of the day and recap the next.

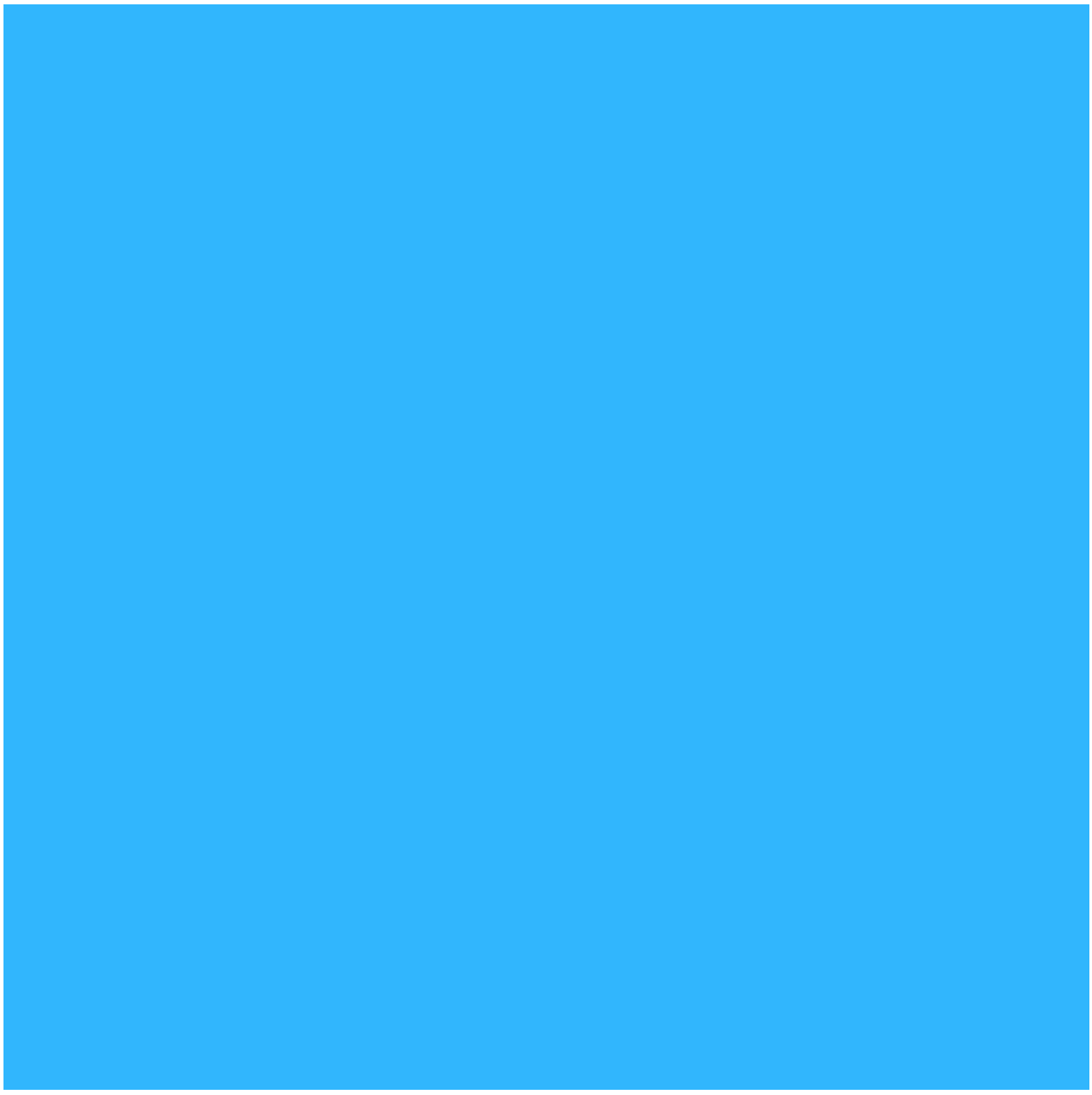
At the end of day 1:

- Ask them if there is anything they do not understand.
- Ask the students if they have any questions. Run through the modules / topics if necessary.
- Remind the students that they will have a post course test and practical assessment on Day 2. Ask them if there is anything they do not understand. Suggest that if they are unsure about specific content they make want to, for example,
    - look through hardware identification diagrams,
    - read through the sling inspection lists,
    - or practice hand signals.
- Clearly communicate what time class will start tomorrow.

At the beginning of Day 2:

- Recap day one. Run through the modules / topics.
- Ask the students if they have any questions.

Facilitator Preparation



FACILITATOR PREPARATION

The following information will help the facilitator prepare for the course.

FACILITATOR QUALIFICATIONS

Facilitators shall be well versed with rigging equipment, inspections and defects, and the correct use of rigging equipment. Facilitators should have a thorough understanding of calculating weights and load angles, and the selection of equipment.

Most sites ensure that their technical rigging instructors are vendor trained. These are qualified or master riggers trained by the CIA (Crane Institute of America) or NACB (North America Crane Bureau). Facilitator training is site specific, talk to your supervisor if you have any concerns about your suitability to facilitate this course.

PREPARATION

Ensure that you are familiar with the flow and design of the PowerPoint Presentation before teaching the class. The order and layout may be different to how you have taught Technical Rigging in the past.

The PowerPoint slides contain only bullet points. The facilitator will expand on the bullet points from their rigging knowledge, and notes in the Facilitator Guide and PowerPoint.

Study the Facilitator Guide before teaching the class. The guide contains facilitation information and tips, and notes for each individual slide. (The notes also appear in the notes section on each PowerPoint slide.)

You should also ensure that you are familiar with the Student Guide, and how the students' book relates to the PowerPoint Presentation.

PLANNING

As discussed in the previous section; you will need to plan the course schedule and assessment logistics in advance. You will also need to prepare Site Specific Notes.

COURSE SCHEDULE

Plan how you are going to run the course:

- Do you have a large group and need students to take the pre course math test?
- How are you going to split the content over the 2 days?

ASSESSMENT LOGISTICS

Plan how you will run assessments:

- How will you run the multiple assessments?
- Do you need additional trainers to help facilitate the practical assessments?

SITE SPECIFIC NOTES

This is standardized course, however, sites have very different procedures for some items. Facilitators need to research and record their own site specific procedure on

- Slide 26, Introduction: Taglines
- Slide 94, Slings: Slings
- Slide 93, Hoists & Lifters: Hoist Maintenance

MATERIALS

Your classroom will probably be equipped with the general materials listed below. Module materials include copies of assessments (1 per student), and various items of rigging equipment. Plan ahead by gathering the necessary materials ahead of the class.

GENERAL MATERIALS

The following materials are consistently needed for courses:

- Computer, projector and sound system for the PowerPoint Presentation
- Attendance sign-in sheets
- Name cards – 1 per student
- Pens and/or pencils
- Easel and Flipchart
- Markers
- Appropriate Personal Protective Equipment (PPE)

COURSE MATERIALS

The following materials are needed for this course – 1 per student:

- Student Guide
- Pre Course Test Paper
- Post Course Test Paper
- Post Course Practical Assessment Sheet
- Rigging Reference Guide: ‘Crosby Users Guide for Lifting’
- Rigging Reference Guide: Crane Institute of America ‘Rigging Safety Reference’
- Calculators

MODULE MATERIALS

The following is a table of specific materials needed for each module:

MODULE	MATERIALS
Introduction	Activity 2: Slide 4, Course Icebreaker Easel and flipchart Markers Assessment 1: Slide 10, Pre Course Test Pre Course Test Papers Rigging Reference Guides (Crosby and CIA) Calculators
Module 1: Best Practice	Slide 17, Hardware Selection: Refer to Rigging Reference Guide (Crosby Card)
Module 2: Hardware	Pass examples of Hardware and B/O hardware around: Hooks Shackles Eye Bolts Hoist Rings Turnbuckles Master Links
Module 3: Slings	Pass examples of Slings and B/O Slings around: Alloy Steel Chain Wire Rope Synthetic Web Synthetic Round Examples of capacity tags Slide 125, Wire Rope Clip Installation: refer to Rigging Reference Guide (Crosby)
Module 4: Hitches	Demonstrate / pass examples of hitches around: Single Leg / Vertical Hitch Choker Hitches Basket Hitch Bridle Hitch

Module 5: Hoists & Lifters	Demonstrate / pass examples of portable hoists around: Lever Hoists / Come Alongs Chain Hoists
Module 7: Weights	Examples & Quizzes Calculators
Module 8: Center of Gravity & Load Angle Factors	Examples & Quizzes Calculators
Module 9: Rigging Exercises	Rigging Reference Guides (Crosby and CIA) Calculators
Conclusion	Assessment 2: Slide 285, Post Course Test Post Course Test Paper Rigging Reference Guides (Crosby and CIA) Calculators Review: Slide 286, Pre & Post Course Test Review Graded Pre Course Test Papers Graded Post Course Test Paper Feedback: Slide 287, Feedback Student end of course questionnaire (in the back of the Student Guide). *Continued on next page*

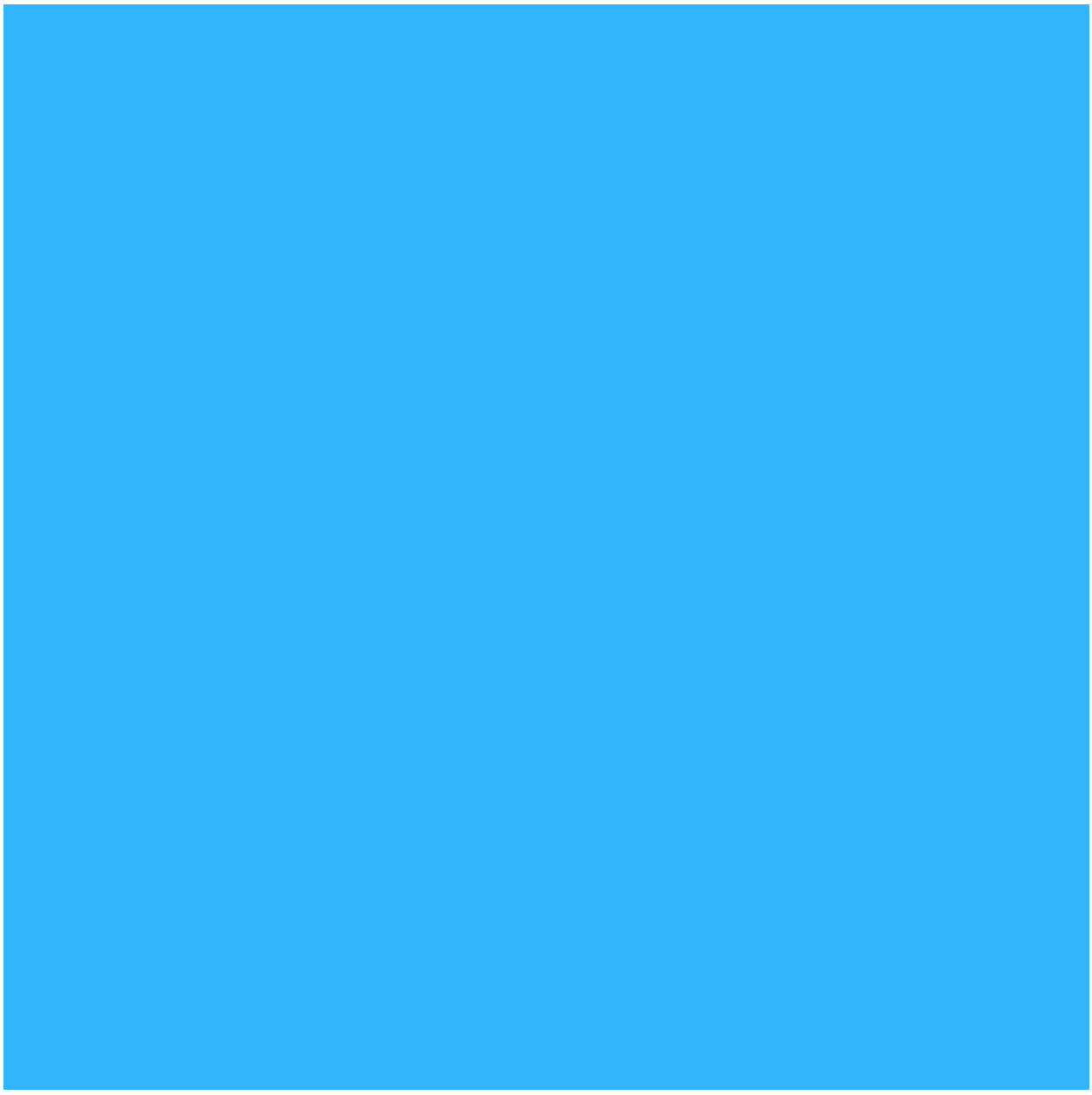
	Assessment 3: Slide 288, Practical Assessment. Practical Assessment Checklist Examples for assessment: Shackles Eye Bolts Hooks Hoist Rings Turnbuckles Master Links Makeshift Hardware Plate Clamps / Lifting Magnets Lifting Beams / Spreader Bars Wire Rope Clips / Thimbles Rigging Blocks Wire Rope Slings Synthetic Web Slings Synthetic Round Slings Alloy Steel Chain Sling Damaged / Defective Slings Manufacturers Capacity Tags Sling Storage Areas / Unused Slings Come Alongs Chain Hoists I Beams Beam Trolleys Hoists without Straight Line Pull Damaged Hoists Have a load / loads set up for students to demonstrate the following: Calculation of load weight, load angle factors, and COG. Selection of an appropriate hitch Correct use of softeners Ability to remain out of the line of fire when using a tag line

STUDENTS DO NOT NEED:

In the past, sites have had to spend large sums of money buying materials to supplement their course content. All of the content is now in the course materials.

- Students DO NOT NEED the CIA Rigging Book.
- Student DO NOT NEED the Hand Signals Cards.

Facilitation



USING THE FACILITATOR GUIDE

Throughout the FG, cues are used to help the facilitator quickly identify slides that have unusual but important features. The purpose of these symbols is explained below.

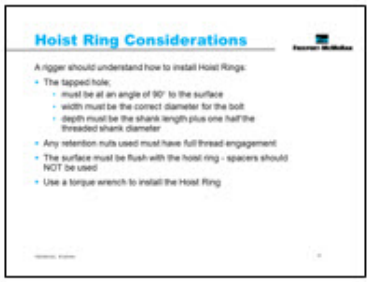
DESCRIPTION	SYMBOL	PURPOSE
Animated Slide		The star indicates when a PPT slide has an animation and requires more than one click to view all of the content.
Note		The paper and pencil indicate that students will need to take notes where site specific information is discussed. The facilitator will need to prepare their site specific notes in advance of the course.
Incidents		The first aid symbol indicates when a PFE, testimonial, or other safety related incident is addressed on a PPT slide or in the FG.
Flipchart		The marker indicates when the facilitator needs to write down answers given to them by the students. This is generally done on a flipchart or a whiteboard.
Discussion		The question mark indicates when students are expected to participate in a discussion.
Facilitation Tip		The podium indicates an instructional technique used to enhance the presentation.

Throughout the FG, notes for the facilitator are presented in italic font, and the actual slide text for the student is presented in normal font, as show below.

PPT slide 67, SG page 34

Instruction

- A rigger should be familiar with how to install and use hoist rings, including any manufacturer's instructions.
- *Run through bullet points.*
- *Explain that torque is the turning force of an object. The torque value is the amount of torque that can be applied to the bolt when installed.*



USING THE FACILITATOR GUIDE & POWERPOINT

There are several ways to facilitate the course:

- Project the presentation and use the paper copy of the Facilitator Guide to walk around the room.
- Use the PowerPoint in presentation mode. This displays only the slide to the class on the projection screen, but shows the facilitator notes and the next slide on the facilitator's screen. (Presentation mode also allows you to use the marker tools to write on slides and emphasize teaching points.)
- The facilitator can also choose to do both. This is the preferred method for facilitating this course. Moving around the room helps the facilitator engage more participants and keeps the students' brains stimulated, thus promoting learning.

NOTE: The Facilitator Guide follows the PowerPoint presentation slide by slide. Each page has an image of the slide, with extensive notes. The Facilitator Guide should be used as a roadmap to guide the facilitator through the course.

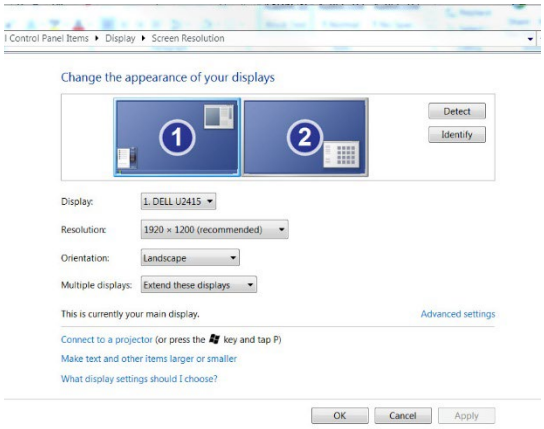
NOTE: The PowerPoint slides contain only bullet points. The facilitator will expand on the bullet points from the notes, and their rigging knowledge.

FACILITATION TIP

The PPT is a guide – do not read directly from the slides.

SETTING THE PRESENTATION MODE

Before setting the PowerPoint to presentation mode, you must "Extend the Screens" otherwise the student will see the facilitator presentation mode, rather than just the slide.



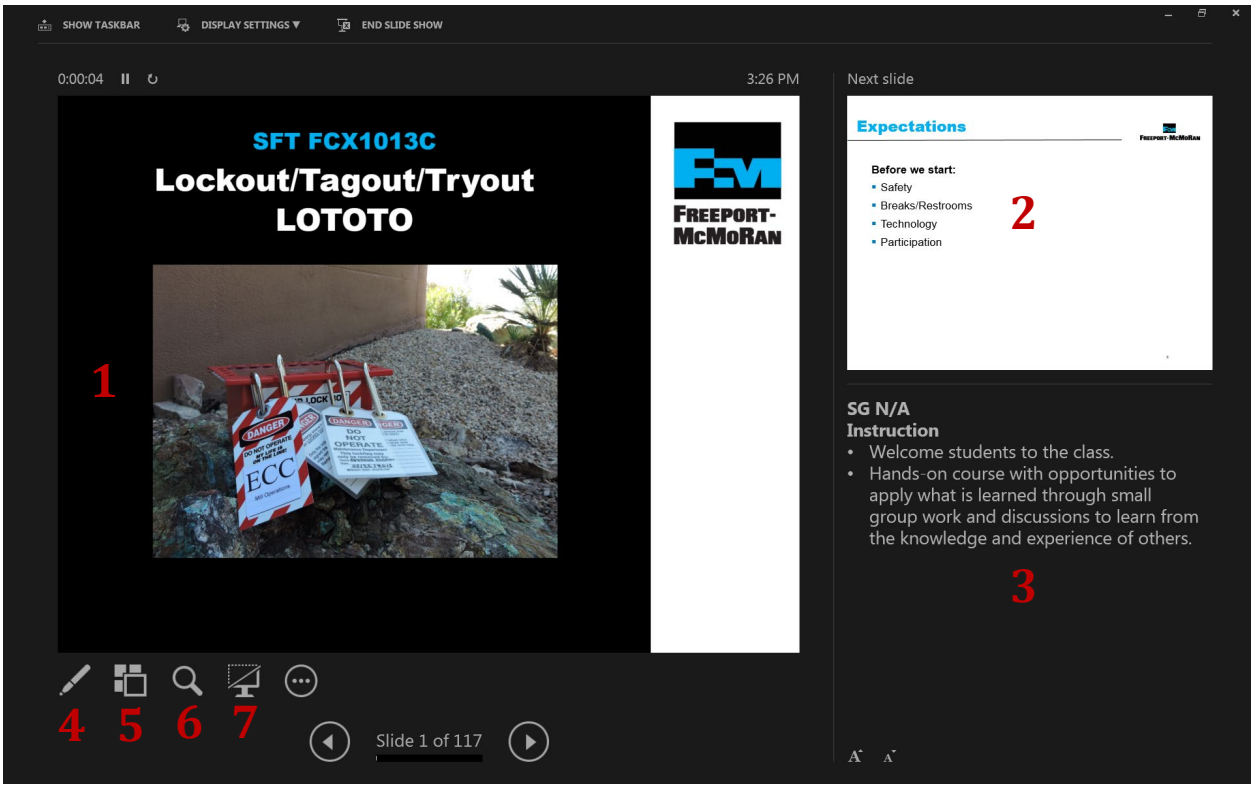
- In the bottom left hand corner of your screen, click on "Control Panel".
- Select "Display".
- Click on "Display Settings"
- Select "Extend these Displays" from the "Multiple Displays" drop down menu.

To initiate the presentation mode:

- Open the presentation.
- At the bottom of the screen there is a colored bar. Click on the icon shown below.

PRESENTATION MODE FEATURES

In presentation mode, the students will only see the current slide, but the facilitator will see the layout below. Some commonly used features are numbered in red and explained below:



1. Current slide – The current slide, and the slide that students can see on the projection screen.
2. Next slide – A preview of the next slide.
3. Notes – The notes for the current slide, which match the notes in the Facilitator Guide.
4. Pens – Allows you to use a laser pointer, pen, highlighter, or arrow, to emphasize points on the slide.
5. Zoom – Allows you to zoom in on specific items on the slide.
6. Black screen – If the facilitator would like to explain content further, the screen can be blacked out to help focus the students.
7. All slides – This will show small images of all of the slides on the facilitator's screen.

FACILITATION TIP

Use the pens and highlighters sparingly, so that they do not become a distraction.

FACILITATION TIPS

Facilitator tips, used to enhance instructional techniques, are placed throughout this guide. This section of the guide lists general instructional techniques.

INSTRUCTOR ROLES

Teacher/Instructor:

- Know the material thoroughly, be a subject matter expert.
- Present material logically, enthusiastically and clearly.
- Question students, ensure understanding
- Respond to student, assist with difficulties, coach, tutor, mentor

Leader:

- Role Model- professionalism and appearance
- Guide instruction
- Provide positive atmosphere

Evaluator:

- Review assessment items
- Administer/evaluate assessments
- Provide feedback and critique

Manager:

- Manage environment- temperature, lighting, equipment, supplies, etc.
- Maintain records- grades, attendance, counseling, interviews

INSTRUCTOR QUALITIES

Professionalism

- Exceed occupational norms and expectations: SME
- Timeliness
- Preparation
- Appearance
- Integrity

Ability

- Skills needed for presentation
- Creativity

Attitude: must be positive

- Desire to see others succeed, instruct
- Enthusiasm for the job shows in quality, facial expressions, and delivery
- Sincerity brings comfort to the classroom
- Sensitivity to student difficulties and changes in attitudes and behaviors

Courtesy/Friendliness

- Treat others politely and with consideration
- Respect for the essential dignity of others
- Courteous instructor has a courteous class
- Friendliness is contagious

QUESTIONS:

Effective use of questions may result in more student learning than any other single technique used by instructors. A considerable amount of classroom communication is in the form of questions; they play a key role in most teaching methods.

PURPOSE:

- Develop the Subject: Use a logical sequence to lead the students from the known to the unknown or from the simple to the complex when planning questions. Keep the questions on the intellectual and vocabulary level of the students.
- Obtain Student Participation: Plan a leadoff question that will generate discussion (Gain Attention). Leadoff questions should stimulate thinking and be phrased so that participants are aware of the main point. Keep the discussion lively (follow-up questions) and when developing questions to open/stimulate discussion, remember the purpose is to bring about discussion, not just to get answers. Avoid questions that require short, categorical answers.
- Guide the Discussion: A spontaneous question will command the student's attention immediately and back to the main point. The question should be one that controls the content of the lesson and ensures responses are pertinent. Seek clarification of the responses. It is also very important to establish a permissive atmosphere so students will feel free to offer answers at any time during the lesson without being “cut down.” After the permissive atmosphere is created, use questioning techniques to get students to start thinking in the direction selected.
- Promote Understanding: Proper use of questions gauges the effectiveness of the teaching approach. Questions help the students determine their progress, as well.

TYPES OF QUESTIONS:

- Knowledge Level: Allow students to remember factual information and to repeat what they have learned, characterized by such words as who, what, when, where, and which.
- Reasons for knowledge-level questions: In a demonstration- performance lesson, to determine if the students are keeping up with the explanation. Also, to determine if the students can recall basic principles and generalizations before an in depth instruction is started.
- Pitfalls: Because students can parrot back what was said in class or what they read does not necessarily mean they understand the material. If only knowledge-level questions are asked, there is a risk of slighting other intellectual processes of the students. If we want students to engage in more than just memory work, then more work in formulating questions is required.
- Comprehension Level: the emphasis is on understanding rather than mere recall also, to grasp concepts, to explain similarities and differences, and to infer cause-and-effect relationships.
- To achieve these results, ask open-ended questions that provoke thought and require more mental activity than simply remembering facts. For instance, questions containing the word "how" allow the students to compare and contrast; "why" questions encourage the students to question the causes of events or actions; "what if…" questions prompt the students to predict.
- Rhetorical: No answer is necessary. Gains attention, used throughout the lesson.
- Overhead: Directed to the entire group. An answer is expected. Can be overused. Be cautious.

- Direct: Asked of a specific person. Elicits involvement seeks an opinion, or draws out support for the topic areas can be used to get control of the class and to wake a student up discreetly.
- Reverse: Asked by a student and directed back to the same student. Used to stimulate thinking. Be sure the student has a reasonable chance of figuring it out. Give assistance if needed.
- Relay: Asked by a student then directed to another student.

DO'S AND DON'TS OF QUESTIONING:

1. Do not ask dead-end questions. You are likely to get a yes or no. They did nothing to promote thinking or discussion. If you do ask these, be sure to follow-up with how or why for them to explain their answers.
2. Do not ask foggy questions. These are unclear or vague, think about the desired response when formulating questions.
3. Do not ask multiple questions. Can be confusing. Let students focus on one question at a time.
4. Do not ask catch questions: The answer is implied in the question. Students do not reach the conclusions on their own. Not exactly a stimulating learning environment.
5. Do not ask loaded questions. A question is loaded because there is no good answer.
6. Do avoid stifling. Allow time to answer. Do not answer the question.
7. Be clear and concise. Energy is wasted in trying to answer vague and meaningless questions. Be very careful how you word your questions, the smart-aleck student is always waiting for their opportunity to get in a good one.
8. Encourage participation. Get the class involved in the process.
9. Be tactful. Especially of incorrect answers.
10. Be accepting of responses.

DEMONSTRATION/PERFORMANCE PHASES

EXPLANATION PHASE:

The instructor tells the students how to perform the skill. It should be a short lecture. The nature of the task will determine the appropriate organizational pattern.

- Most skills lend themselves to a sequential pattern where the skill is explained in the same step-by-step order normally used to perform it. When the skill is related to a previously taught or already known material, use the known to unknown strategy. When teaching more than one skill in the same lesson, the simple to complex strategy works well. By starting with the simplest skill, students build confidence and are less likely to become frustrated when building to more complex skills.
- Consider the language in the explanation phase.
- Instructors should attempt to speak at the learner level and avoid unnecessary jargon and technical terms the students may not understand. Clear communication is the key. Clearly describe the actions students are expected to perform. It is neither appropriate nor effective for instructors to try to impress the students with their expertise by using unnecessarily complicated language.
- Instructional aids are important in a Demonstration/Performance lesson. The best instructional aid is the actual equipment to be used.
- Other useful aids are charts, mockups, and models. When using aids, be sure they are readable, accurate, and that all students can see them.

DEMONSTRATION PHASE:

The instructor shows the students how to do the skill. At times, an explanation alone is too abstract and may need a simultaneous demonstration to aid in understanding. However, with a complicated or dangerous skill, the two phases are often better separated.

- The instructor must demonstrate the skill correctly and safely the first time it is demonstrated. When the skill is demonstrated incorrectly, the instructor may lose credibility, and students will have to unlearn the incorrectly presented material before they can learn it correctly.
- The skill should be demonstrated in the same sequence in which it was explained, thus avoiding confusion and reinforcing the steps. Since the students imitate the instructor's performance, the instructor must demonstrate the skill exactly the way the students are expected to practice it, including all safety procedures they must follow.

PERFORMANCE-SUPERVISION PHASE:

Before the students begin to practice the skill, the instructor must decide how much control to use. In the independent approach, the students practice the entire skill after seeing the demonstration, going from step to step at their pace. In the controlled approach ("by the numbers"), students practice each task step (or small group of task steps) after seeing them demonstrated. With dangerous or difficult skills, the controlled approach is recommended for the first practice as a minimum. In each case, the students should practice the entire skill independently as many times as practical to achieve mastery before they are evaluated. In many cases, over-learning to ensure proficiency may be desirable. Allow students to practice at least once under evaluation conditions.

- Each student's work must be supervised to ensure safe, correct performance. If any common error or safety hazards develop, the instructor should stop the group and reteach the area of difficulty. Students should be permitted to work on their own as much as possible without unnecessary interruption or too much assistance. The instructor should avoid distracting or non-purposeful talking or wandering. However, the instructor should not hesitate to interrupt if a student has made a mistake or is about to make a mistake.
- The time to identify errors is during the learning activity rather than the evaluation phase. The stronger, more proficient students may assist the less proficient ones. The stronger students may also be able to make some comments or suggest techniques all the students can use. Weaker students often make comments concerning their areas of difficulty. These comments provide excellent sources of information for improving subsequent instruction. In a self-paced environment, proficient students should not be held back when they can perform better and more quickly than their peers.

EVALUATION PHASE:

The most important consideration in the evaluation phase is to develop an appropriate rating instrument. The rating device must accurately measure achievement of the criterion objective. For example, if the conditions of the objective state that the skill will be accomplished without assistance, then the instructor must cover or remove all instructional aids, erase the board, put away worksheets, and ensure that the students perform the skill without references.

- When beginning the evaluation phase, instructors should give clear, complete instructions to the students. They should review the task steps, if necessary, and emphasize acceptable standards. They must allow for enough time, equipment, and supplies to evaluate all students on all standards.

SIX LAWS OF LEARNING

- Readiness: Students learn when they are ready, and learn little when they are not. Instructors need to motivate them in the beginning.
- Exercise: Things most often repeated are best remembered.
- Effect: People learn better from a positive situation versus a negative. Constant negative motivation stifles the learning process.
- Intensity: Students learn best from the real thing versus substitutes. Be creative if trying to mimic reality, audio/video adds vividness, the intensity is increased through performance/demonstration.
- Primacy: Teach it right the first time. Re-teaching requires more time and may not work immediately.
- Recency: The most recent learning idea is the easiest to recall. You can practice this law with summaries, re-stating, and conclusions.

SUMMARIES

Summaries are useful tools for maintaining continuity within a lecture and for highlighting areas of particular importance. Summaries prepared for use between main points are not always necessary in the lecture. If the point is very clear, a summary may be redundant and boring. You should use them, however, when main points are unusually long or contain complex or unfamiliar information.

- With summaries, we repeat information concisely to reinforce student understanding before new information is presented. Summaries should not take the place of transitions. They should provide a means for us to progress logically from one main point through the transition and into the next point.
- The summary given at the conclusion of the lecture should be designed so that it reviews for the students those facts or aspects of a concept or principle you consider particularly important. It may be helpful to think of this summary as a "capsulated" version of the lecture itself, in which key ideas are related both to each other and to the lesson objective. It is your final opportunity to reinforce critical aspects of the lesson.
- Use interim summaries throughout the lesson to recap and reinforce learning.

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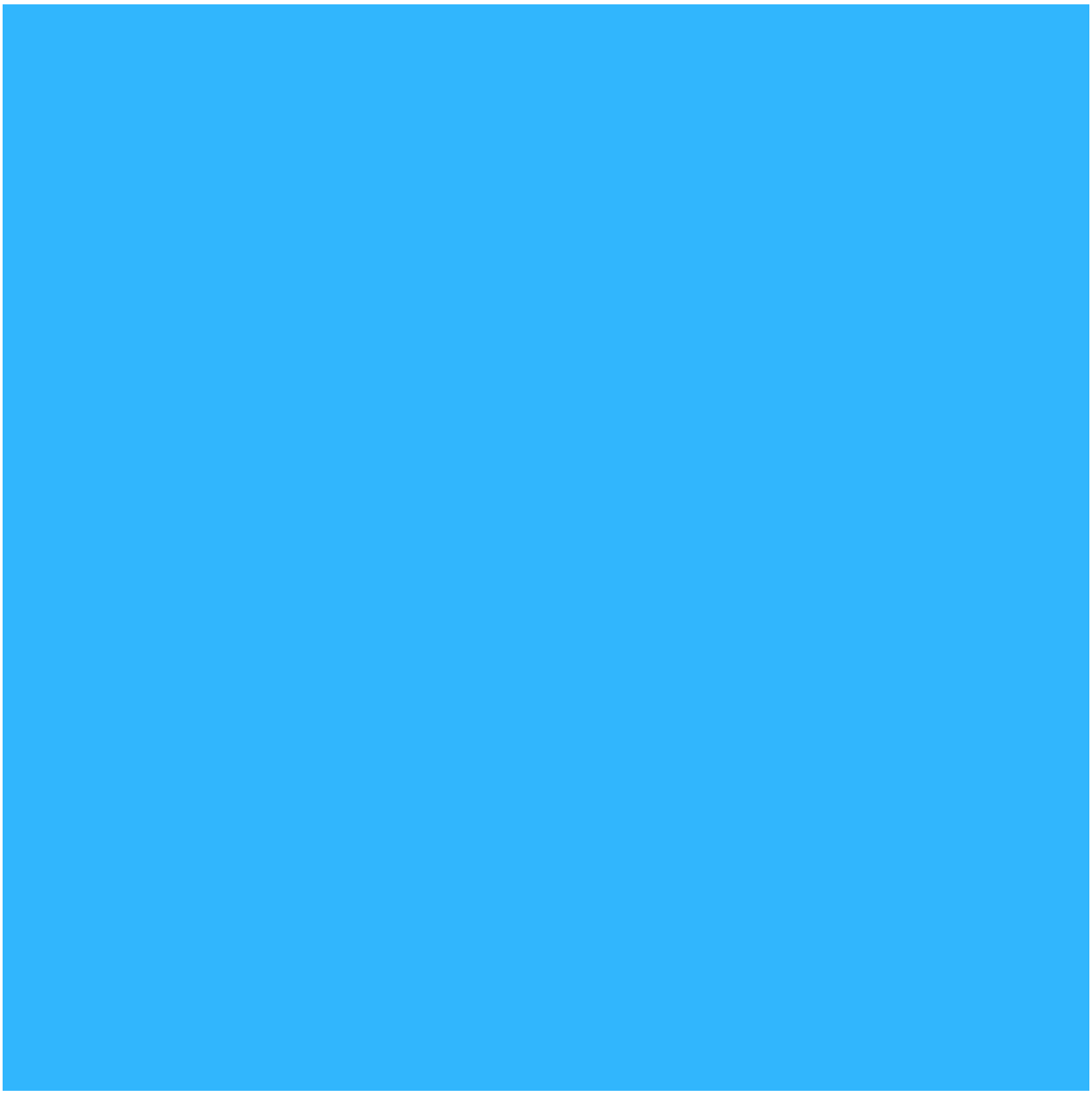
Modules



INTRODUCTION

The introduction contains introductory information about the course, the objectives of the course and the expectations of the facilitator.

ACTIVITIES

- Activity 1: Rigging Icebreaker
- Activity 2: Course Icebreaker
- Assessment 1: Pre Course Test

MATERIALS

Activity 2:

- Easel, flipchart and markers

Assessment 1:

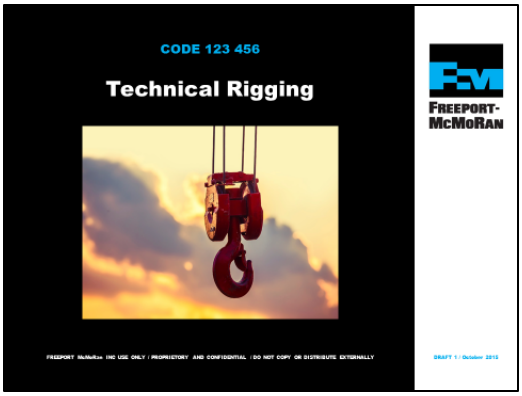
- Pre Course Test Paper– 1 per student
- Rigging Reference Guides – 1 per student
- Calculators - 1 per student

FACILITATION

This module is an introduction to the course: Groundrules, ice breakers, and an overview of the content.

Plan whether you will run through the course Learning Objectives, or all Learning Ojectives (course and all modules.).

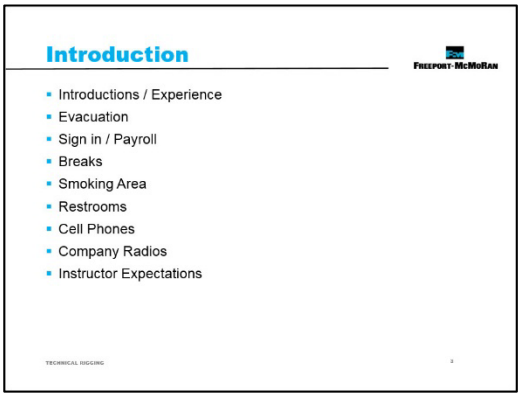
PPT slide 1



Instruction

- *Welcome students to class*
- *Pass out attendance sheet for students to sign*

PPT slide 2



Instruction

- Facilitator introduces self by stating;
  - your position at FMI,
  - how long you've been with FMI,
  - how long you've been in mining.
- Facilitator to discuss housekeeping:
  - Safety
    - Identify the appropriate evacuation procedures, gathering areas, fire extinguisher locations, and any other safety related items.
    - Participate in a Safety Share by giving volunteers the opportunity to talk about safety related incidents and concerns.
  - Breaks and Restrooms
    - Establish a break schedule and announce it to the class. Breaks should last 5-10 minutes to give students time to rest and relax before beginning the next learning session.
    - Point out where restrooms and smoking areas are located.

Continued on next page

- Facilitator to discuss their expectations of the students:
    - Technology policy
        - Review your expectations on cell phone and laptop use during the training.
    - Participation
        - This course requires significant participation. Students should be prepared for discussions and small group activities.
    - Set the class ground rules by verbalizing your expectations.

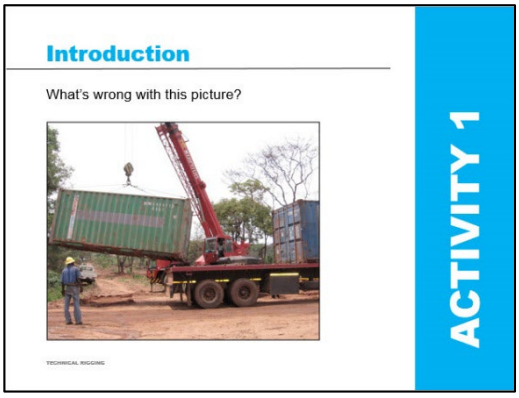
      Some suggestions are provided below:
        - Participate.
        - Be on time.
        - Stay on task.
        - Listen when others talk.
        - Respect the opinions and attitudes of others.

FACILITATION TIP

Instead of a prepared list of class ground rules, let the students set some of them. Adult learning theory suggests adults learn better when they feel empowered. (Malcolm Knowles)

ACTIVITY 1: RIGGING ICEBREAKER

PPT slide 3



Materials

No materials required.

Purpose

- This activity breaks the ice and encourages students to contribute their ideas and thoughts more freely throughout the course.
- The activity also encourages the students to offer prior learning and experience, and so helps the facilitator find out how much the students know about rigging.

Instructions

1. Ask the students "What's wrong in this picture?"
2. Discuss answers with the group.
3. Add any further answers not already discussed.

Answers

- Person in photo is in line of fire – too close to the load.
- Person in photo is in line of flight if anything were to go wrong.
- Is this person the signaler? If so, they cannot be seen by the crane operator.
- Low Sling Angles
- No tagline
- Offset Center of Gravity

Other points:

- Weather seems to be ok – no rain or lightening.
- Trees could interfere with crane / rigging if they were closer.
- Would perhaps need another spotter on the other side i.e. stopping traffic on the road.
- Load seems unstable, could items inside the container move.

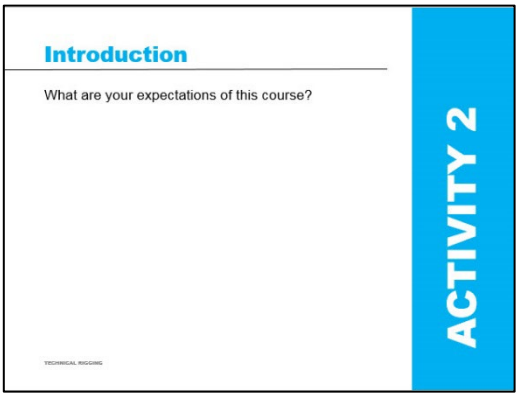
Background: Photograph taken at FCX mine in Tenke.

FACILITATION TIP

Using an Icebreaker promotes a safe learning environment. Reducing stress in the environment can increase a learners retention of the content. (Georgi Lozanoz)

ACTIVITY 2: COURSE ICEBREAKER

PPT slide 4



Materials

- Easel and Flipchart
- Markers

Purpose

This activity gains the attention of the students, encourages them to think about why they are on the course, relating the content to them and motivating them to learn.

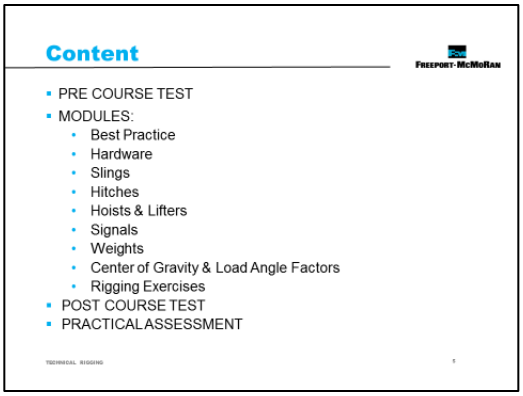
Instructions

1. Ask the students:
    - Why are you here today?
    - What do you hope to learn on the course?
2. Write the answers on the flipchart or white board.

FACILITATION TIP

Tips for using a flip chart: Never talk to the chart! Finish writing on it without speaking, then turn to your audience to continue the discussion.

PPT slide 5



Instruction

Run through the content of the course:

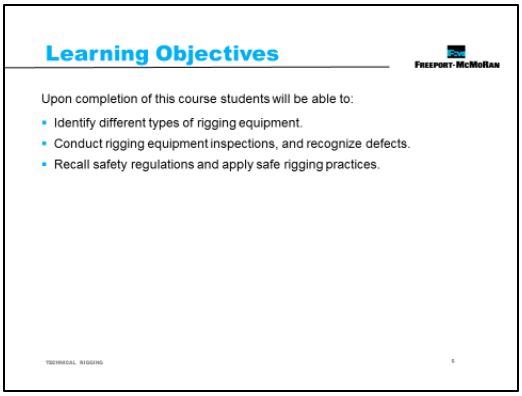
- Discuss the knowledge / module topics covered on the course, as listed on the slide.
- Explain that there will be a pre-test and post-test:
    - Both tests cover the same knowledge topics, however the post-test is at a more advanced level than the pre-test.
    - Students will be able to compare their pre and post course test scores, and therefore measure the skills and knowledge they have gained throughout the course.
    - The post-course test is a test of knowledge. Students must pass 80% of all questions before a 5000-23 can be issued.
    - The practical assessment is a test of skill. Students must pass all items to receive their 5000-23.
- Explain that there will also be a practical hands on assessment, where they will be required to identify rigging components, and demonstrate rigging skills.
- Tell students that if there is something they don't understand, to speak up - we cannot help if they don't ask! We need to know if they don't understand something – BEFORE they go out and use rigging!

FACILITATION TIP

Encourage participants to write key learnings – their "ahas"- as these occur during the training and the "so what' – how they can use each of them. (Making Learning Stick Barbara Carnes, 2010)

The instructor may wish to inform the students of the end of course questionnaire before the end of the class. Knowing about the evaluation will allow the student to make comments as the class progresses.

PPT slide 6, SG page vi



Instruction

- *Explain the objectives for the course*

FACILITATION TIP

By going over all of the objectives the instructor is using the Law of Readiness. The student is being prepared to learn.

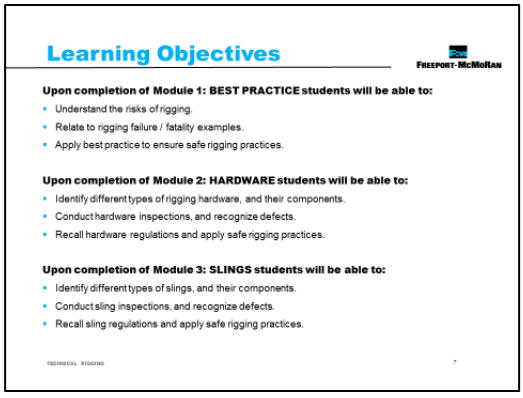
FACILITATION NOTE

All of the learning objectives are at the front of the SG, FG, and PowerPoint presentation. Module learning objectives are then repeated again at the start of each module. Choose whether you will go through them all in your course introduction, at the beginning of each module, or both.

FACILITATION TIP

According to the Law of Exercise, learning is increased by repetition. The more you hear, see, or do something the greater chance of retention.

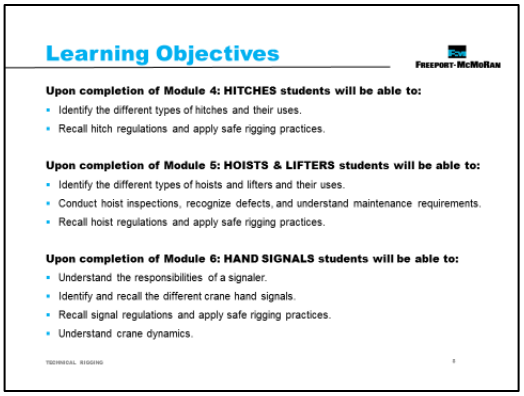
PPT slide 7, SG page vi



Instruction

- *Explain the objectives for modules 1, 2 and 3*

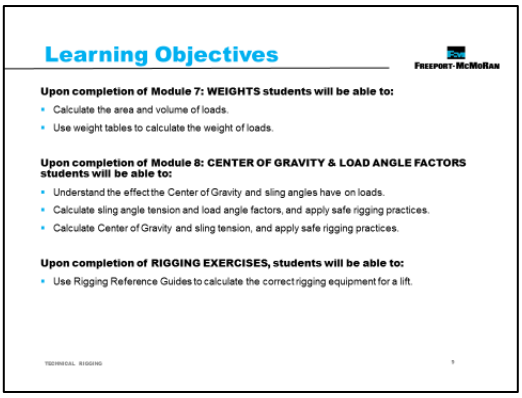
PPT slide 8, SG page vi, vii



Instruction

- *Explain the objectives for modules 4, 5 and 6*

PPT slide 9, SG page vii

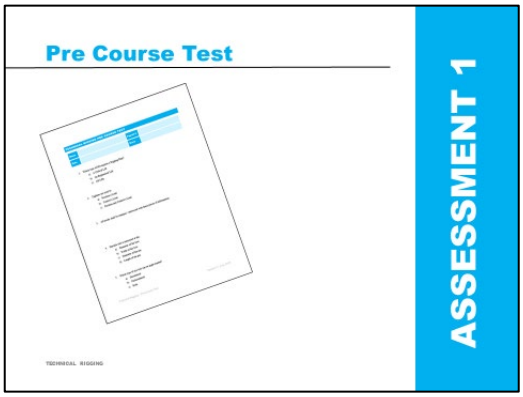


Instruction

- *Explain the objectives for modules 7, 8 and Rigging Exercises*

ASSESSMENT 1: PRE COURSE TEST

PPT slide 10



Materials

1 per student:

- Test Paper
- Rigging Reference Guides
- Calculator

Purpose

- This activity is to find out what employees know about rigging right now.
- At the end of the course students will be able to compare their pre and post test scores, and see firsthand what they have learned.

Instructions

1. Explain that the pre course test is not actually a test, it is to find out what they already know about rigging, to highlight any gaps in their knowledge, and areas they may need to pay particular attention to on the course.
2. Explain that at the end of the course students will see their own pre and post test scores.
3. Hand out the test paper:
    - Explain that the questions are mostly multiple choice (where there may be multiple answers), fill in the gaps, labelling diagrams, with a few calculations.
    - Explain that they are not to look answers up in the book, however, if they know how to use Rigging Cards, they may use them for the rigging problems.
4. When the students have finished you can either:
    - Collect the completed test papers, grade them and return them to the students with their graded post course test at the end of the course.
    - Or you can leave the pre-course test papers with the students: Most of the pre course test questions are also used as module quizzes. This gives the facilitator an opportunity to discuss the question, and explain the answer to the class.

MODULE 1: BEST PRACTICE

This module contains introductory information about rigging and the risks of rigging, and how we manage the risk through training and best practice.

LEARNING OBJECTIVES

Upon completion of Module 1, students will be able to:

- Understand the risks of rigging.
- Relate to rigging failure / fatality examples.
- Apply best practice to ensure safe rigging practices.

ACTIVITIES

Quizzes:

- 2 quiz questions at the end of the module.

MATERIALS

Slide 17, Hardware Selection:

- Refer to Rigging Reference Guide (Crosby Card)

PREPARATION

Slide 26, Site Specific Notes:

- Facilitator should research and record their site specific Tagline Procedure

FACILITATION

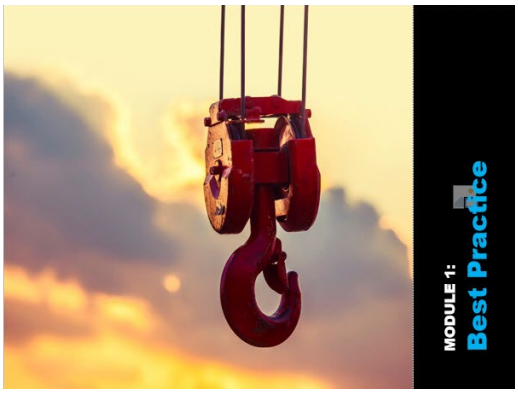
This module contains a brief introduction to rigging, and the importance of training. There are three Rigging Failure / Fatality incident descriptions, each followed by best practice points.

Further general best practice points are discussed on the following slides: Rigging Plans, Inspection, Inspection Logs, and Taglines.

FACILITATION TIP

The Law of Intensity is used to increase learning through lasting impression. Having a student read the "Learn from Others" stories, and then discussing them, helps show the importance of the training they are receiving.

PPT slide 11, SG page 1



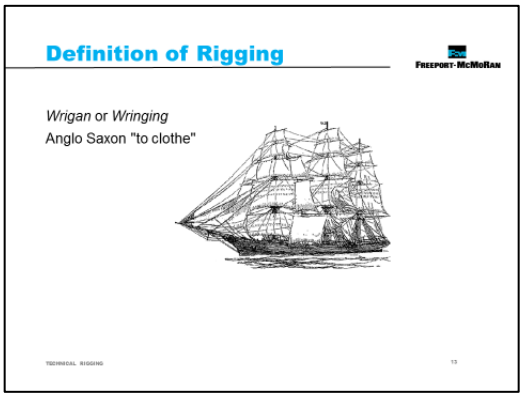
Instruction

Go over the learning objectives for the module.

Upon completion of this module, students will be able to:

- Understand the risks of rigging.
- Relate to rigging failure / fatality examples.
- Apply best practice to ensure safe rigging practices.

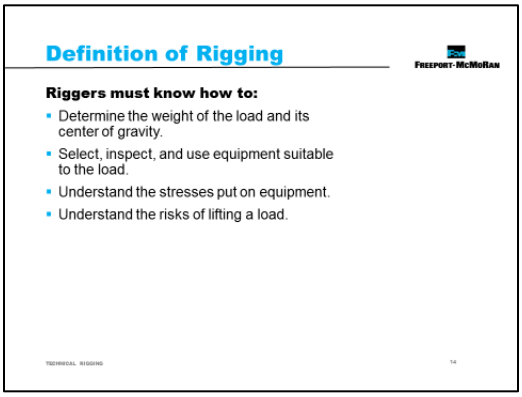
PPT slide 12, SG page 4



Instruction

- The word rigging comes from the Anglo-Saxon word *wrigan* or *wringing*, meaning "to clothe".
- It was originally used to describe the mechanical sailing apparatus of a ship; sails, masts, ropes, blocks and pulleys.

PPT slide 13, SG page 4

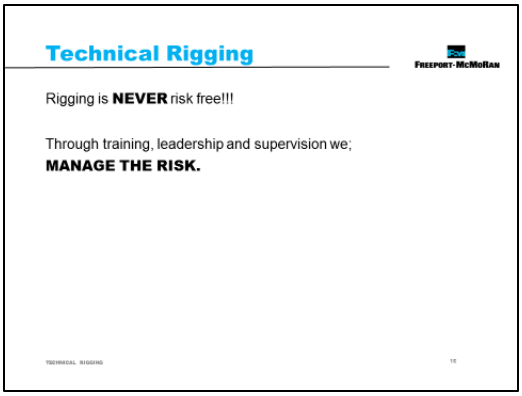


Instruction

- Today the word is used to describe any equipment used for lifting.
- The quality of rigging equipment has changed dramatically over the years, however the principals of rigging remain the same.

- *Run through the bullet points.*

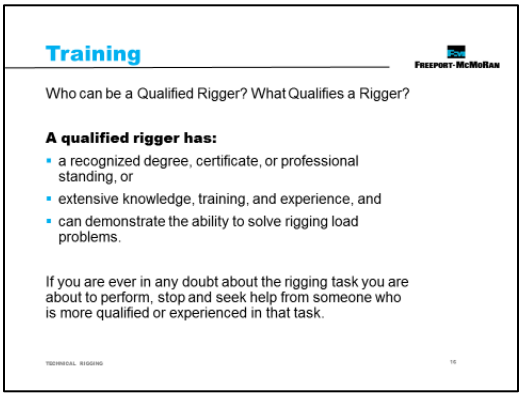
PPT slide 14, SG page 5



Instruction

- Improper rigging practices have led to many deaths and injuries, due to the fact that workers do not understand the different components of rigging equipment, their specific uses or capacities.
- Further incidents and fatalities occur when workers do not know how to secure loads properly, or they get caught between unpredictable moving loads.
- **Rigging is NEVER risk free!** Anytime there is a suspended load there is risk.
- Through training, leadership, and supervision we **manage the risk** associated with rigging and keep incidents to a minimum.

PPT slide 15, SG page 5



Instruction

- OSHA states employers must use Qualified Riggers during rigging activities.
- Who can be a Qualified Rigger? What qualifies a rigger?
- A qualified rigger has:
    - a recognized degree, certificate, or professional standing, or
    - extensive knowledge, training, and experience, and
    - can demonstrate the ability to solve rigging load problems.
- A Qualified Rigger is determined by their employer to be qualified to perform specific rigging tasks.
- Each Qualified Rigger may have different qualifications and / or experience, therefore not every rigger is qualified to do every rigging job.
- Upon completion of this course you will be considered a Qualified Rigger, however, each rigging task is unique, and has specific risks.
- If you are ever in any doubt about the rigging task you are about to perform, stop and seek help from someone who is more qualified or experienced in that task.

[1] United States Department of Labor, Occupational Safety & Health Administration, *FactSheet, Subpart CC – Cranes and Derricks in Construction: Qualified Rigger,* accessed April 2016, *https://www.osha.gov/Publications/cranes-qualified-rigger-factsheet.pdf*

Continued on next page

FACILITATION NOTE

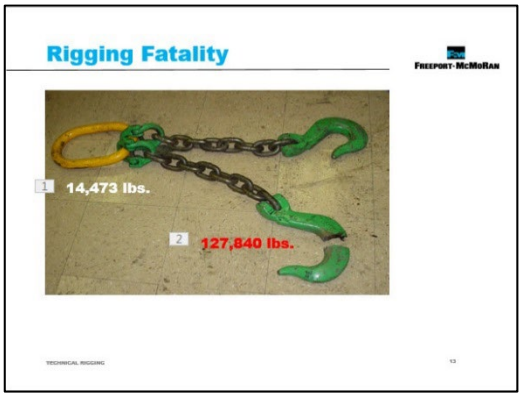
"Qualified Rigger" Ensure that students understand what this means as the following statement appears throughout the course:

"If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual."

FACILITATION TIP

According to the Law of Exercise, learning is increased by repetition. The more you hear, see, or do something the greater chance of retention.

PPT slide 16, SG page 6



Instruction

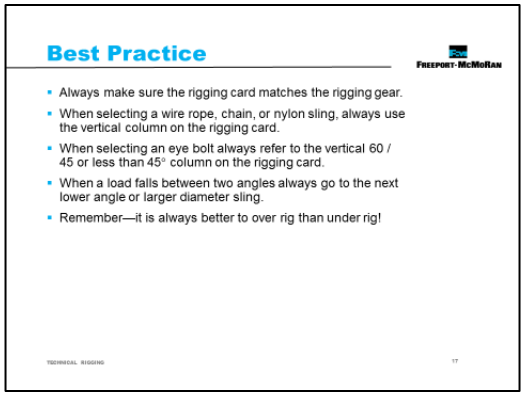
- The SWL of this hook was 14,473 lbs.
- But the force applied was 127,840 lbs.!
- The hook broke, recoiled and struck the worker on the head - killing him. He left behind a wife and three children.

- Who can stop an unsafe job? Anyone can!
- Anyone who sees anything unsafe can and should stop a job.
- Why did no one stop this job?

Background: This took place in an underground mine, in District 9, Salina, UT.

[2] United States Department of Labor, Mine Safety and Health Administration, Chain and Sling Safety Alert, *MSHA Coal Mine Safety and Health, District 9*, accessed September 2015, *http://www.msha.gov/DISTRICT/DIST_09/chainpresentation.htm*

PPT slide 17, SG page 6



Materials

- Rigging Reference Guides (Crosby Card).

Instruction

- Always use the correct equipment for the job!
- *Run through Best Practice points with the class: Refer to rigging cards throughout.*
- *Explain that all of these points will be discussed in detail during the course.*

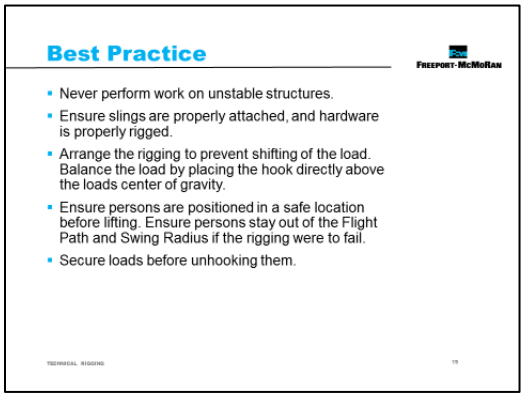
PPT slide 18, SG page 7

Instruction

- Miner crushed by suspended load: In this fatal rigging incident a 51-year-old master welder with 30 years mining experience was crushed by a suspended load.
- The victim was fabricating a screen tower section. Using an overhead bridge crane he was positioning the 3-beam, right side component for assembly.
- As he was communicating with the crane operator and positioning a chain sling, while standing on the bottom beam, the load shifted and fell, crushing him.

[3] United States Department of Labor, Mine Safety and Health Administration, *Metal / Nonmetal Mine Fatality,* accessed April 2016, http://arlweb.msha.gov/FATALS/2003/FAB03m09.HTM

PPT slide 19, SG page 7



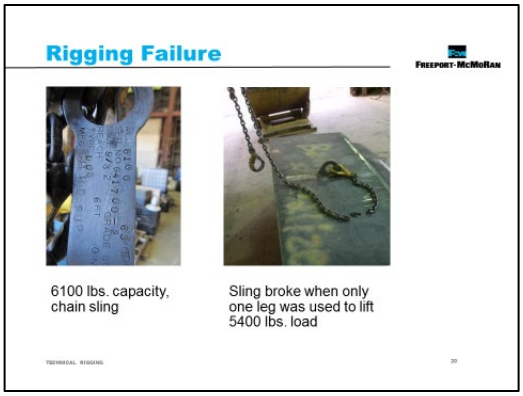
Instruction

- Always ensure the equipment is rigged correctly!
- *Run through Best Practice points with the class.*
- Explain that all of these points will be discussed in detail during the course.

PPT slide 20, SG page 8

Instruction

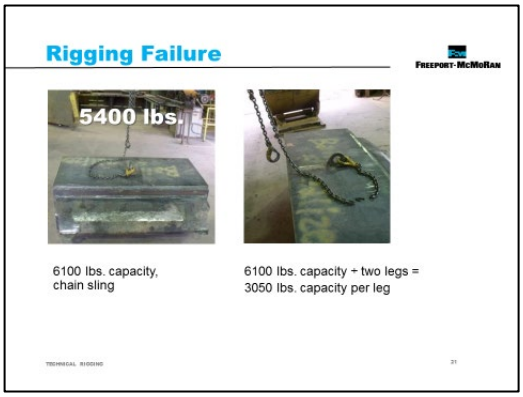
- The capacity tag states that this is a 6100 lbs. capacity chain sling.
- The sling broke when only one leg was used to lift a 5400lbs. load.



PPT slide 21, SG page 8

Instruction

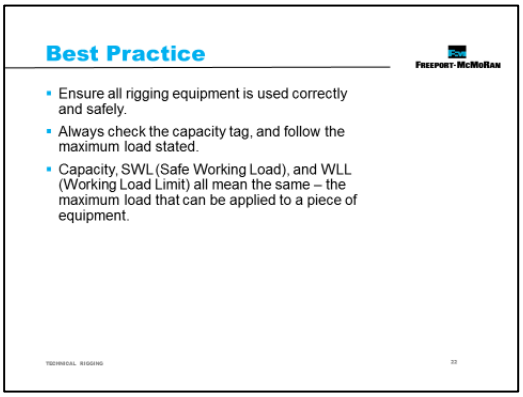
- Tag stated 6100 lbs. capacity chain sling, but it was being used as a single leg chain.
- 6100 lbs. divided by two (legs) = 3050 lb. per leg!
- One leg capacity is 3050 lb., yet it was being used to lift a 5400lbs. load.
- Always use the correct equipment for the job!



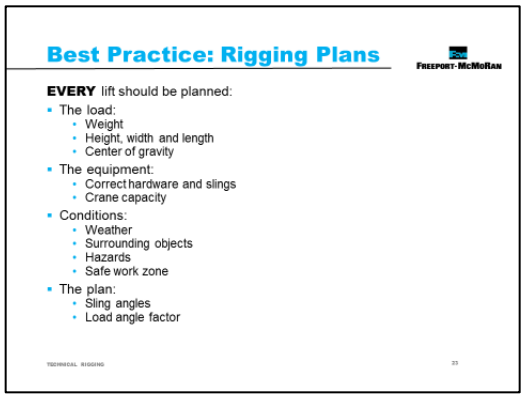
PPT slide 22, SG page 8

Instruction

- Always use the equipment correctly, and use it safely!
- *Run through Best Practice points with the class.*
- Explain that all of these points will be discussed in detail during the course.



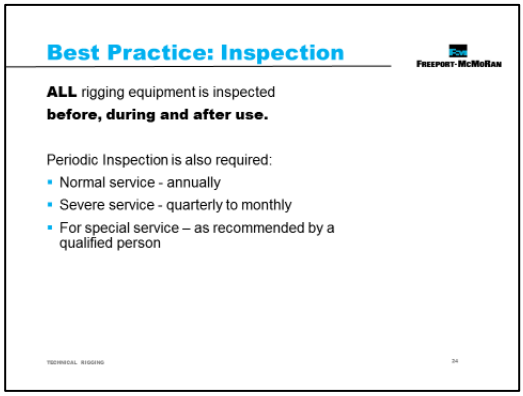
PPT slide 23, SG page 9



Instruction

- EVERY lift should be planned! Whether it is a typed document, a calculation on a scrap of paper, or that you have thought it through in your head.
- The purpose of a rigging plan is to identify the hazards, establish safety precautions, calculate the load, and select the correct equipment.
- Run through bullet points with the class.

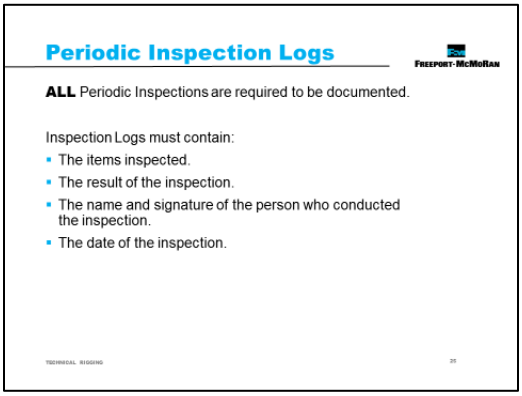
PPT slide 24, SG page 10



Instruction

- We all conduct Pre-Shift Inspections and Workplace Examinations, and recording our findings.
- All rigging equipment shall be inspected before, during, and after use, however, periodic inspection of equipment is also required:
    - For normal service this would be annually.
    - For severe service quarterly to monthly.
    - For special service – as recommended by a qualified person.

PPT slide 25, SG page 10

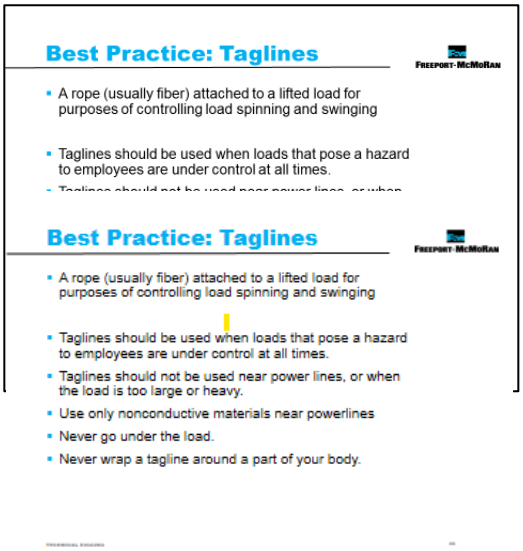


Instruction

- All periodic inspections are required to be documented, and documents retained as per FCX Records Retention Procedure. [4]
- Rigging equipment has specific documentation requirements. Inspection Logs must be maintained, and contain the following information:
    - The items inspected.
    - The result of the inspection.
    - The name and signature of the person who conducted the inspection.
    - The date of the inspection.

[4] Freeport-McMoRan, *Records Retention Schedule, Schedule v2.1, November 2014*, accessed July 2016, *https://fmwebhome.fmi.com/fss/RM/Documents/Records%20Retention%20Schedule.pdf*

PPT slide 26-27, SG page 10 & 11



Instruction

- When a load is lifted, it can swing into the objects around it, people on the ground, and even into the crane itself.
- Long ropes, called taglines, are attached to the load for the purposes of controlling load spinning and swinging.[5]

Note: Taglines should only be attached to a load by a qualified person who is trained in tagline attachment points and methods.

- Taglines should be used when loads that pose a hazard to employees are under control at all times. [6]
- Tag lines should not be used near power lines, or when the load is too large or heavy.
    - High voltage electrocution is the largest single cause of crane related deaths in construction.[7]
    - Contact your Health & Safety representative, or supervisor, for clarification if a tagline is not to be used.
- Never guide a suspended load by hand. Use taglines or a guide pole to guide the load into the desired position.
- A tagline should be long enough to safely get a hold of – never go under the load. Use a hook if necessary.
- Never wrap a tagline around a part of your body.

[5] United States Department of Labor, Occupational Safety and Health Administration, *Safety and Health Regulations for Construction, Cranes & Derricks in Construction, 1926.1401, Definitions*, accessed August 2016, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=13

[6] Why Workers died: Crane Collapses 1992 – 2006, *U.S. Bureau of Labor Statistics Census of Fatal Occupational Injuries Research File*, accessed August 2016, *http://www.elcosh.org/document/2053/d001029/Understanding+Crane+Accident+Failures%253A+A+report+on+the+causes+of+death+in+crane-related+accidents.html?show_text=14*

[7] United States Department of Labor, Occupational Safety and Health Administration, *Standard Interpretations – (Archived) Table of Contents, Standard Number 1926.751,* accessed August 2016, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21493

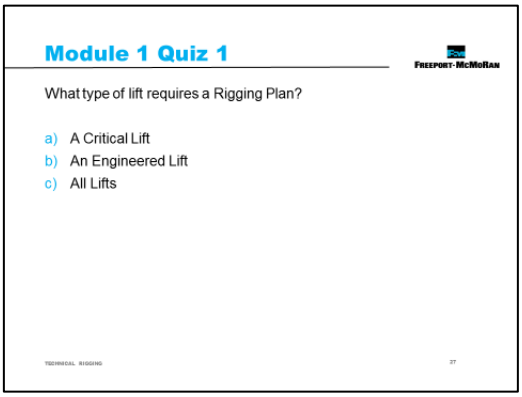
FACILITATION NOTE

Discuss site specific procedure. Students are to record details of site specific procedure in the notes section of their Student Guide – p11. Record your notes on the next page:

SITE SPECIFIC NOTES

MODULE 1 QUIZ 1

PPT slide 28, SG page 12



Instruction

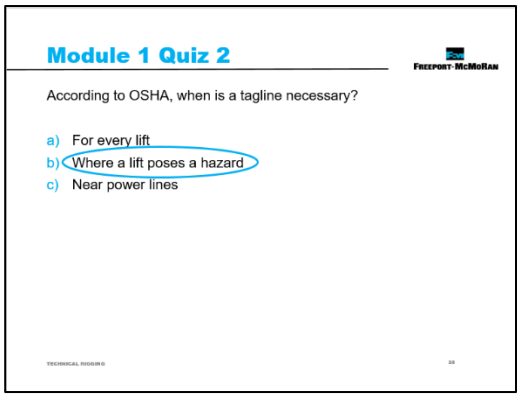
- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 1 on the pre-course test.*

Quiz Answer

- Answer: C. All lifts

MODULE 1 QUIZ 2

PPT slide 28, SG page 12



Instruction

- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 2 on the pre-course test.*

Quiz Answer

- Answer: B. Where a lift poses a hazard

  Discuss site specific procedure if it differs from OSHA regulations.

MODULE 2: HARDWARE

This module contains information about Rigging Hardware; how to identify, select and inspect hardware.

LEARNING OBJECTIVES

Upon completion of Module 2, students will be able to:

- Identify different types of rigging hardware, and their components.
- Conduct hardware inspections, and recognize defects.
- Recall hardware regulations and apply safe rigging practices.

ACTIVITIES

Quizzes:

- 1 quiz question at the end of each hardware item, not at the end of the whole module.

MATERIALS

Pass examples of hardware and B/O hardware around during this module:

- Hooks
- Shackles
- Eye Bolts
- Hoist Rings
- Turnbuckles
- Master Links

FACILITATION

This module contains a brief introduction on slides 29, 30 and 31. Do not go into detail on the introductory slides, all items will be covered thoroughly in the module.

Each hardware item is discussed in the following format:

- Components, Identification, Inspection, and Safe Rigging Practices.

FACILITATION TIP

Explain to the students that this module consists of "lecturettes". Each item of hardware is discussed individually, followed by a quiz question. This will prepare the students for the module material.

Continued on next page

FACILITATION TIP

Components: *Have the participants recite the names of the components as you point to them. Repeat the process until they are chanting in cadence.*

Identification: *Before advancing the slide, present the information in the form of questions, e.g.:*

- *"What information must be marked on a shackle?"*
- *"Can you use the hardware if these marks aren't present?*

Inspection: *Before advancing the slide, present the information in the form of questions, e.g.:*

- *"What are you looking for when performing a shackle inspection?"*

Ask questions directly of individual students. Make sure to refer to them by name. Make sure to wait for the answers.

NOTE: We would normally think of a 90° angle as being at a right angle to the surface. In the diagrams discussing side loading of hardware, the angle at a right angle to the surface is 0°. The 0° angle means it is "in-line", with no angle, no side loading, and no capacity reduction.

PPT slide 29, SG page 15

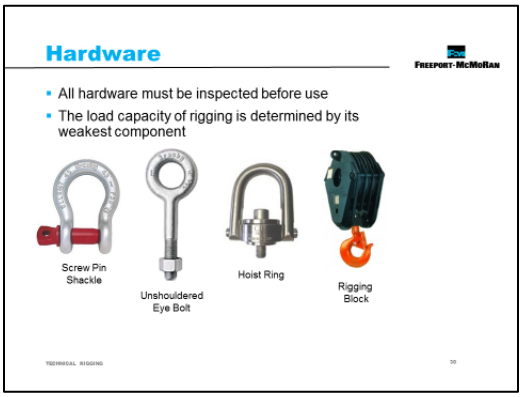
Instruction

Go over the learning objectives for the module.

Upon completion of Module 2, students will be able to:

- Identify the different types of rigging hardware, and their components.
- Conduct hardware inspections, and recognize defects.
- Recall hardware regulations and safe rigging practices.

PPT slide 30, SG page 16



Instruction

- All fittings / hardware must be inspected prior to each use.
    - If load bearing components are bent, twisted, distorted, stretched, elongated, cracked or broken, this is evidence that the hardware has been overloaded and it must not be used.
- The load capacity of rigging is determined by its weakest component.
    - At a minimum, hardware must have a capacity that is equal to that of the sling, therefore, match hardware size and rated load to slings.
- Hardware is an integral and important part of any rigging operation. For the lift to be made in a safe manner, all personnel must understand the rated capacity of hardware and be competent in the proper selection and inspection of hardware.

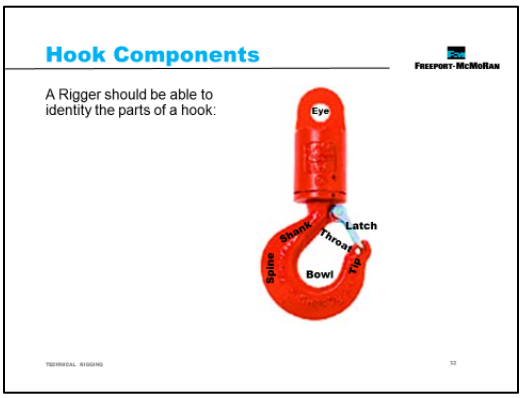
PPT slide 31, SG page 17

Instruction

- Makeshift hardware:
  - No makeshift hardware should ever be used!
  - No makeshift hardware shall be used to perform ANY lifting operation!
- Custom hardware:
  - Custom hardware must be properly engineered and "shall be marked to indicate the safe working loads and shall be proof-tested prior to use to 125 percent of their rated load." [8]
  - Completion of this course is not training or authorization to build custom hardware. Consult site SOPs regarding custom hardware requirements.

[8] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Materials Handling, Storage, Use, and Disposal, 1926.251 Rigging equipment for material handling, 1926.251(a)(4)

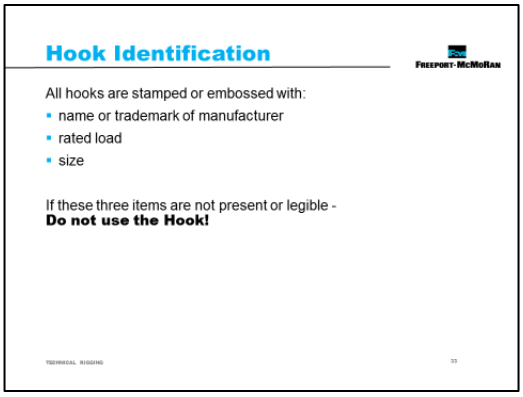
PPT slide 32, SG page 18



Instruction

- Hooks are the most commonly used piece of rigging hardware.
- A rigger should be able to identify the parts of a hook:
  - Eye
  - Shank
  - Spine
  - Bowl
  - Tip
  - Throat

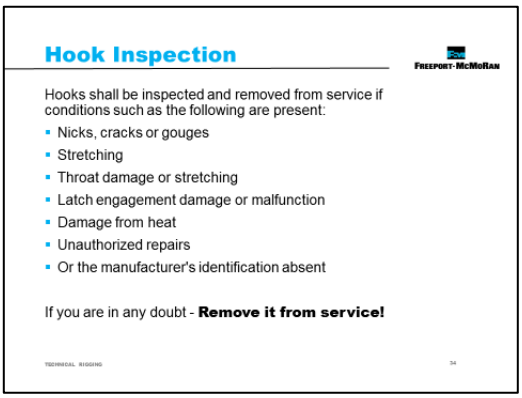
PPT slide 33, SG page 18



Instruction

- All hooks are stamped or embossed with:
  - name or trademark of manufacturer
  - rated load
  - size
- Hooks should be inspected prior to every use for these three pieces of information.
- If these are not present or legible - **do not use the Hook!**

PPT slide 34, SG page 19

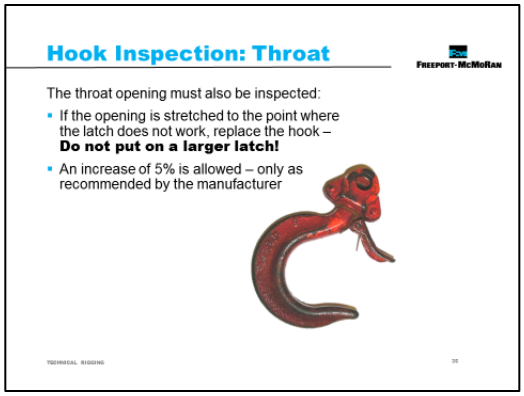


Instruction

- Hooks shall be inspected and removed from service if conditions such as the following are present:
  - Nicks, cracks or gouges
  - Stretching
  - Throat damage or stretching
  - Latch engagement damage or malfunction
  - Damage from heat i.e. evidence of heat exposure or welding
  - Unauthorized repairs e.g. evidence of drilling, machining, grinding, or modification
  - Or the manufacturer's identification absent
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

[9] American Society of Mechanical Engineers, B30.10-2014 Hooks, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 10-2 Hooks – Miscellaneous: Selection, Use, and Maintenance, Section 10-2.10: Inspection, Removal, and Repair, 10-2.10.6 Repairs and Modifications (b)

PPT slide 35, SG page 19



Instruction

In addition to the general inspection items, the throat opening of the hook must also be inspected:

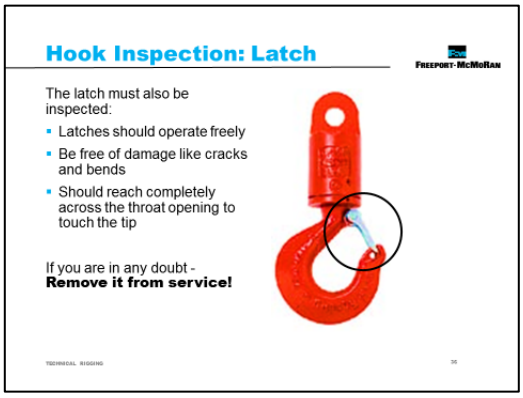
- If the opening is stretched to the point where the latch does not work, replace the hook – **do not put on a larger latch!**

Note: Latches should only be replaced by a qualified person and the hoist load tested, before it is put back into service.

- Some increase in the throat opening is allowable: Any distortion causing an increase in the throat opening of 5%, not to exceed ¼" (6mm) (or as recommended by the manufacturer).

[9] American Society of Mechanical Engineers, B30.10-2014 Hooks, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 10-2 Hooks – Miscellaneous: Selection, Use, and Maintenance, Section 10-2.10: Inspection, Removal, and Repair, 10-2.10.6 Repairs and Modifications (b)

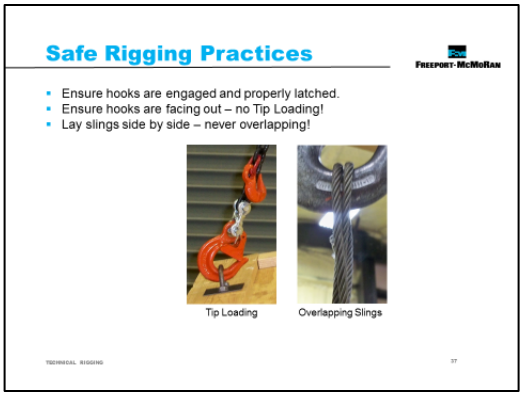
PPT slide 36, SG page 19



Instruction

- Latches keep hardware and slings retained in hooks.
- In addition to the general inspection items listed, it is important that the latch of the hook is also thoroughly inspected:
    - Latches should operate freely, be free of damage like cracks and bends, and should reach completely across the throat opening to touch the tip.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

PPT slide 37, SG page 20



Instruction

In addition to being able to inspect and identify damage, a rigger must be able to use hooks correctly and understand safe rigging practices.

- Ensure hooks are engaged and properly latched.
- Always face hooks out so that the load is on the thickest and strongest part of the hook.

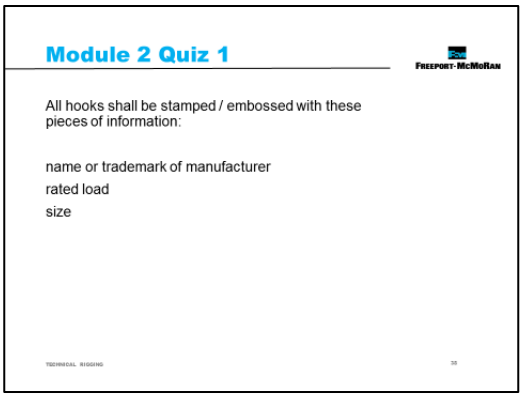
When hooks face in, we are tip loading. This reduces the capacity of the hook by as much as 60%.

- Slings should never overlap!

When placing multiple slings on a hook, they should be laid side by side, and never overlap.

MODULE 2 QUIZ 1

PPT slide 38, SG page 21



Instruction

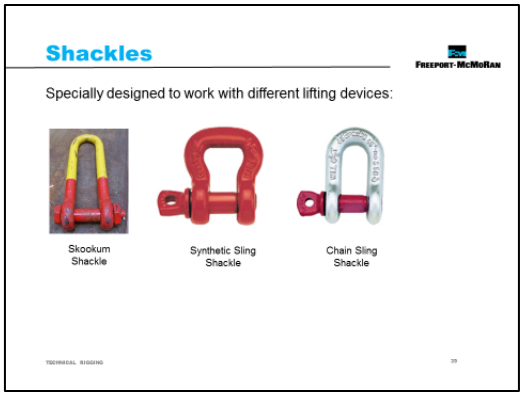
- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 3 on the pre-course test.*

Quiz Answer

- Answer: name or trademark of manufacturer, rated load and size

  If these three items are not present or legible - **do not use the Hook!**

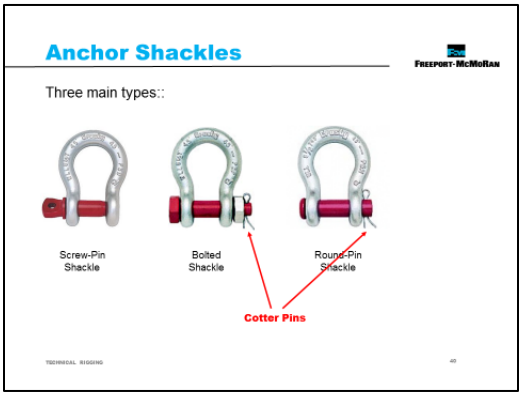
PPT slide 39, SG page 22



Instruction

- Shackles are used to connect two lifting devices; a sling to a hook, a sling to a sling, and even to connect a sling back to itself.
- Different types of shackles are used with different slings and applications.
    - Skookum Shackles are designed for pulling sheet piling, (interlocking steel sheet sections). They are used at Freeport-McMoRan because the longer depth allows us to pin the shackle to much deeper holes in items, specifically HDPE (High Density Polyethylene) Pipe.
    - Synthetic Sling Shackles are specifically designed for web slings that would normally bunch up in an anchor shackle. This shackle has a wider bearing surface, i.e. an increased area for load distribution on the sling.
    - Chain Sling Shackles are perfect for use with chains.

PPT slide 40, SG page 23



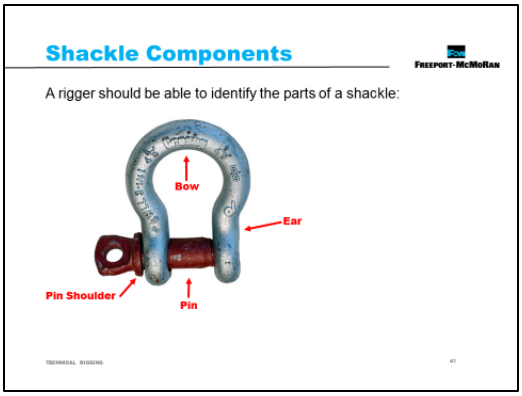
Instruction

- Anchor Shackles are excellent for attaching to hooks, master links, pad eyes and eye bolts.
- There are three main types of anchor shackles:
    - Screw pin shackles are the most commonly used due to the ease of inserting and removing the pin.
    - Bolted Shackles are used for more permanent applications.
    - Round Pin Shackles should never be used for lifting. There are some uses for this type of shackle, like load tie down applications, however, extreme caution must be taken to **NEVER SIDE LOAD A ROUND PIN SHACKLE.**
- Bolted and Round Pin Shackles have Cotter Pins. These are in place prevent the bolt from backing out of the shackle pin. In the photograph of the round-pin shackle, the only thing preventing the shackle pin from coming out is the cotter pin.

FACILITATION NOTE

Discuss the shackles first, then discuss the Cotter Pin using the animations.

PPT slide 41, SG page 23

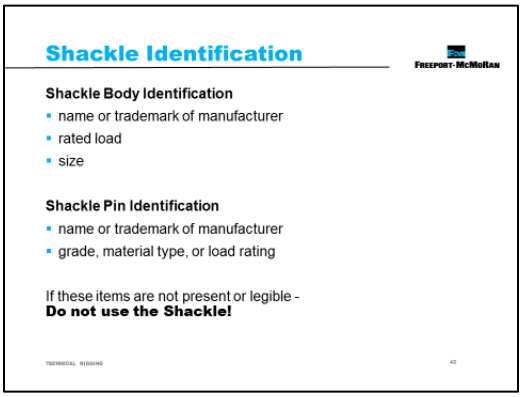


Instruction

A rigger should be able to identify the parts of a shackle:

- Bow
- Ear
- Pin and Pin Shoulder

PPT slide 42, SG page 24



Instruction

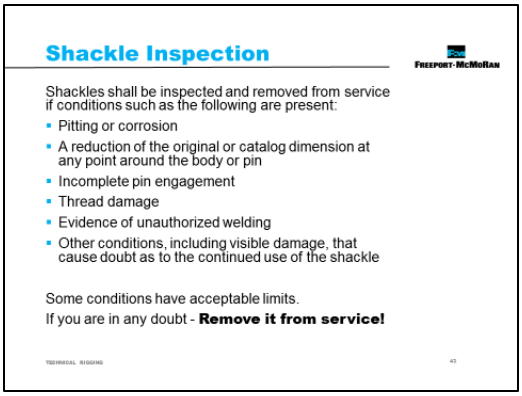
- All shackles used for lifting must have the manufacturer, the size, and the rated capacity stamped or embossed on them.

The manufacturers I.D. can be shown as either the name or the trade mark / logo.

- All shackles should be inspected prior to every use for these pieces of information. If these are not present or legible - **do not use the shackle!**
- The Shackle Pin is also marked with:
  - name or trademark of manufacturer
  - grade, material type, or load rating
- Shackles should not be dragged across abrasive surfaces, or come into contact with sharp edges, that could damage the shackle or its markings.

[10] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-1 Shackles – Selection, Use and Maintenance, Section 26-1.5: Identification.

PPT slide 43, SG page 25



Instruction

- Shackles shall be inspected and removed from service if conditions such as the following are present:
    - pitting or corrosion
    - a reduction in the dimension at any point around the body or pin
    - incomplete pin engagement
    - thread damage
    - evidence of unauthorized welding
    - other conditions, including visible damage, that cause doubt as to the continued use of the shackle
- Some conditions have acceptable limits, which differ between items and manufacturers.
    - Manufactures recommendations should be consulted for specific removal criteria.
    - Be sure that the recommendation you are referencing match the item you are inspecting.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

[11] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-1 Shackles – Selection, Use and Maintenance, Section 26-1.8: Inspection, Repair and Removal, 26-1.8.5 Removal Criteria

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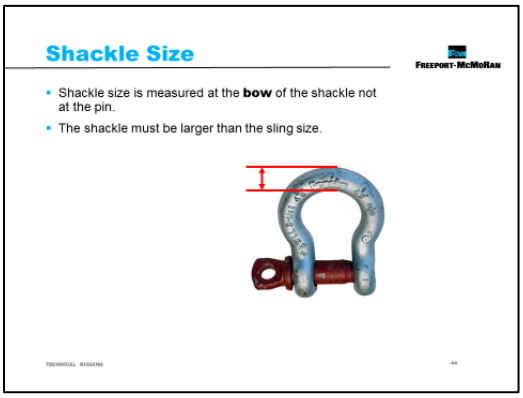
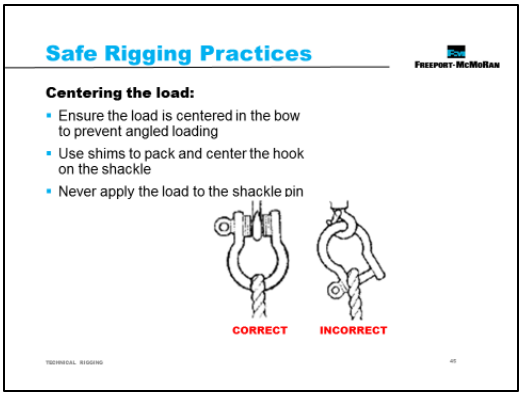
PPT slide 44, SG page 25



Instruction

- To be able to select the correct sized shackle, the rigger must understand that shackle size is measured in the **bow** of the shackle and not by the pin.
- The rigger must also understand that the shackle size must be larger than the size of the sling, for example when using a ¼" sling you would want to use at least a 5/16" shackle.

PPT slide 45, SG page 26



Instruction

- The load should be centered in the bow of the shackle to prevent angled loading.
- The diagram on the left shows washers (packing) being used as 'shims' to center the hook on the shackle.
    - This prevents the shackle from sliding on the hook, and will eliminate potential for angled loading.
    - It also reduces the possibility of the load being applied to the pin and eye of the shackle.
- Never apply the load to the shackle pin

[12] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-1 Shackles – Selection, Use and Maintenance, Section 26-1.9: Operating Practices, 26.1.9.4 Rigging Practices

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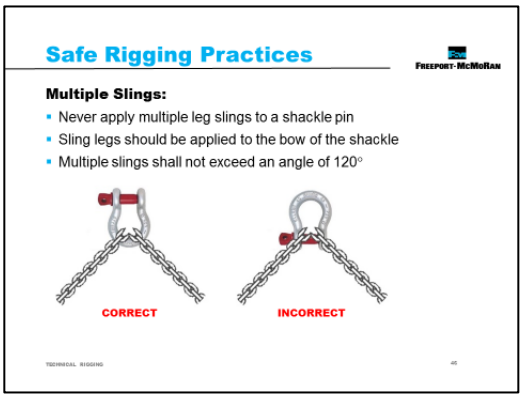
PPT slide 46, SG page 26



Instruction

- Multiple sling legs should not be applied to the shackle pin.
- Placing multiple slings in the bow prevents the possibility of the ears of the shackle being stretched by the weight of the load.
- Multiple slings in the body of a shackle shall not exceed 120° included angle.

[12] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-1 Shackles – Selection, Use and Maintenance, Section 26-1.9: Operating Practices, 26.1.9.4 Rigging Practices

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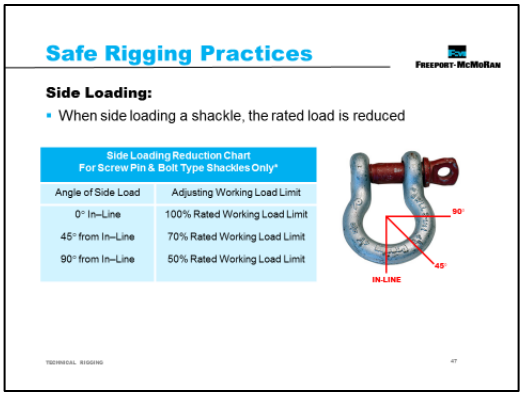
PPT slide 47, SG page 27



Instruction

- If the shackle is to be side loaded, the rated load shall be reduced according to the recommendations of the manufacturer, or the calculations of a rigger as shown in the chart.

[12] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-1 Shackles – Selection, Use and Maintenance, Section 26-1.9: Operating Practices, 26.1.9.4 Rigging Practices

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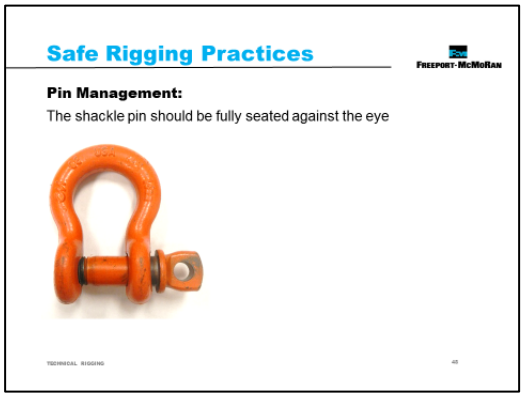
PPT slide 48, SG page 27



Instruction

The screw pin shackle shall not be rigged in a manner that would cause the pin to unscrew.

- The shackle pin should fully engage in the eye.
- The pin should easily thread into both eyes.
- The shoulder of the pin should be seated against the eye.
- The threads on the pin should be within the threaded portion of the eye.
- Shackle pins should never be forced tighter through the use of a wrench.
- Pins, once seated, should never be "backed off."

The slide image shows incorrect rigging of a screw pin shackle: The pin is not fully engaged / threaded, nor is the shoulder of the pin seated against the eye.

Screw pin shackles are not to be used in permanent applications unless the pin is moused.

- A moused pin is one in which the pin is secured from rotation by wrapping a small piece of wire several times through the hole in the pin, and to a point around the ear. This prevents the pin from backing out.
- Use a bolted shackle for permanent or long term applications.

[12] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-1 Shackles – Selection, Use and Maintenance, Section 26-1.9: Operating Practices, 26.1.9.4 Rigging Practices

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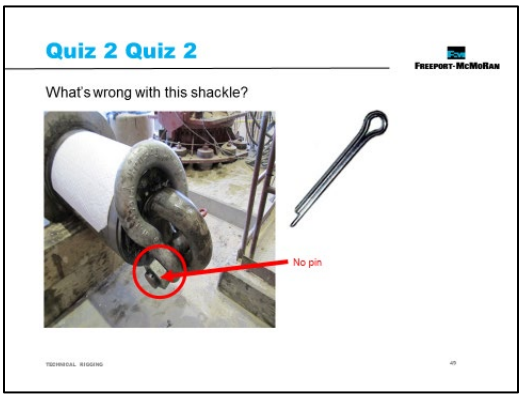
MODULE 2 QUIZ 2

PPT slide 49, SG page 28



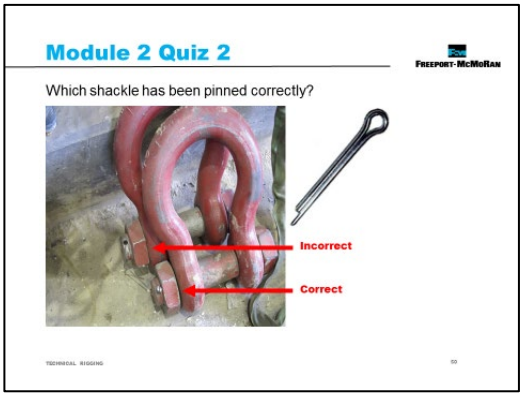
Instruction

- What is wrong with this shackle?
- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*

Quiz Answer

- Answer: No pin in the shackle

PPT slide 50, SG page 28



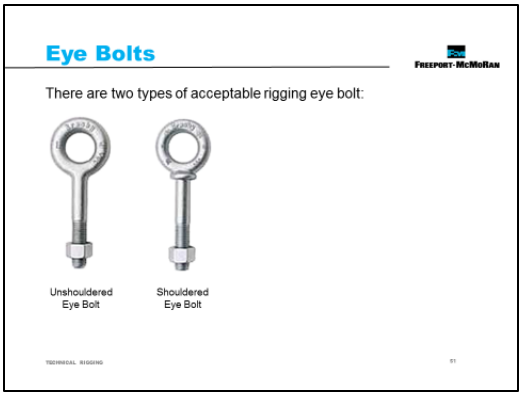
Instruction

- Which shackle has been pinned correctly?
- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*

Quiz Answer

- Answer: There is no pin in the back shackle – a thin piece of wire has been used, but this is not enough! The front shackle is correct.

PPT slide 51, SG page 29



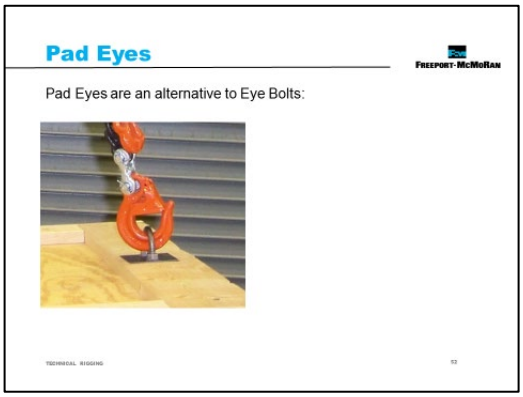
Instruction

There are two categories of eye bolts that are acceptable for rigging:

- Unshouldered Eye Bolts
    - Should only be used for vertical lifts, as angled loading will bend or break them.
- Shouldered Eye Bolts
    - Can be used for vertical and angled loading.

Although side loading is permissible, it should be done in the direction of the plane of the eye, and capacity reductions must be made.

PPT slide 52, SG page 29

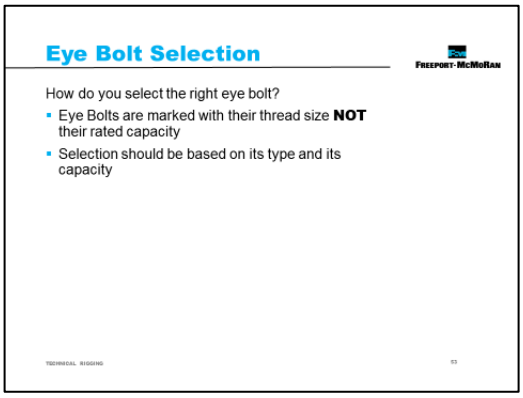


Instruction

Pad Eyes are another option available to the rigger:

- Pad Eyes are basically an eye on a flat pad.
- The pad is welded (or bolted) to the object you want to lift, and the rigging is then attached to eye as a lifting point.

PPT slide 53, SG page 29

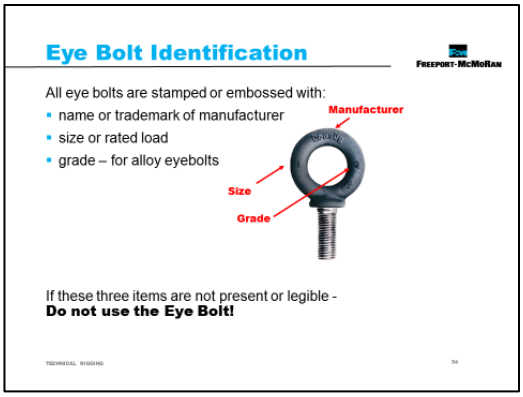


Instruction

How do you select the right bolt?

- Eye Bolts are marked with their thread size NOT with their rated capacity.
- The selection of an eye bolt should be based on its type and its capacity (i.e. its suitability for the lift you are conducting).

PPT slide 54, SG page 30



Instruction

All eyebolts are stamped or embossed with:

- name or trademark of manufacturer
- size or rated load
- grade for alloy eyebolts

Eye Bolts should be inspected prior to every use for these three pieces of information. If these are not present or legible - **do not use the Eye Bolt!**

[13] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-2 Adjustable Hardware – Selection, Use and Maintenance, Section 26-2.5: Identification, 26-2.5.1 Turnbuckle, Eyebolt, and Eye Nut Identification

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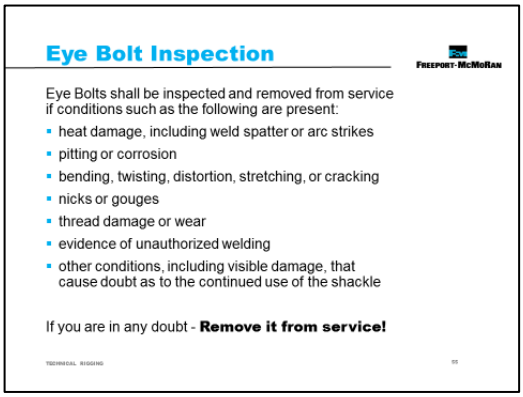
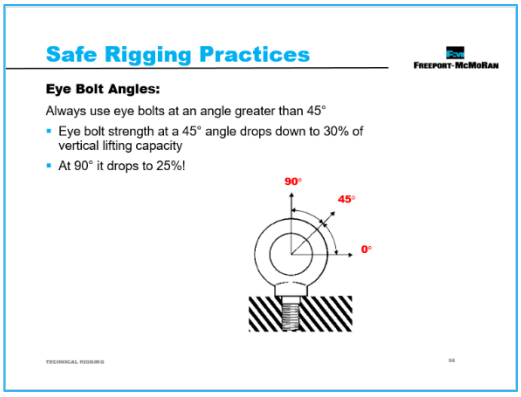
PPT slide 55, SG page 30



Instruction

- Eye Bolts shall be inspected and removed from service if conditions such as those listed are present.
- Run through bullet points.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

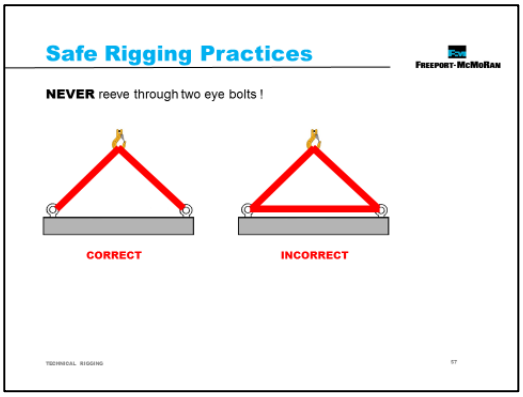
PPT slide 56, SG page 31



Instruction

- Always use eye bolts at an angle greater than 45°.
- *Run through bullet points.*

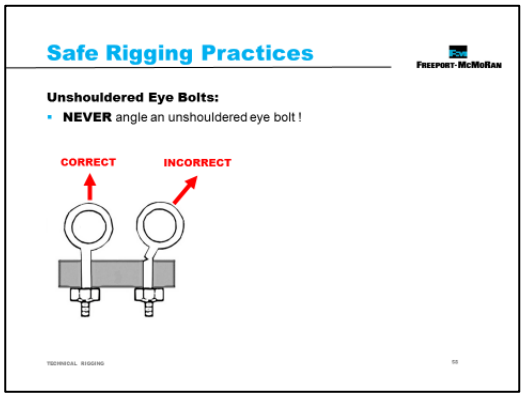
PPT slide 57, SG page 31



Instruction

- **NEVER** reeve through two eye bolts – it will increase the stress on the eye bolt even more!
- *Discuss correct and incorrect diagrams*.

PPT slide 58, SG page 31



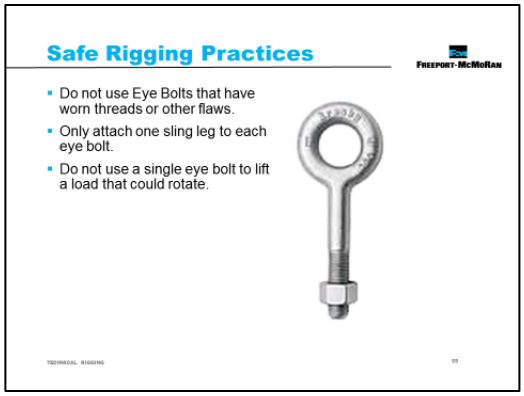
Instruction

- **NEVER** angle an un-shouldered eye bolt - it will deform.
- *Discuss correct and incorrect diagrams*.

PPT slide 59, SG page 31

Instruction

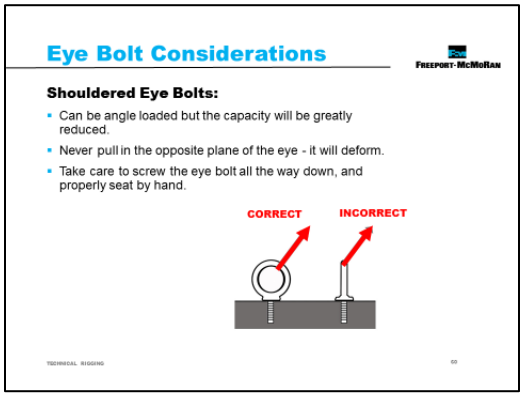
- *Run through bullet points.*



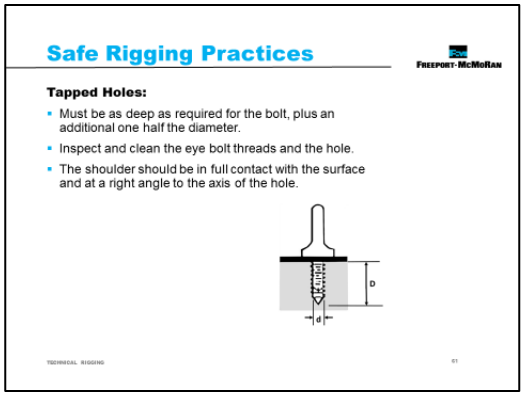
PPT slide 60, SG page 32

Instruction

- Run through bullet points.
- *Discuss correct and incorrect diagrams.*



PPT slide 61, SG page 32



Instruction

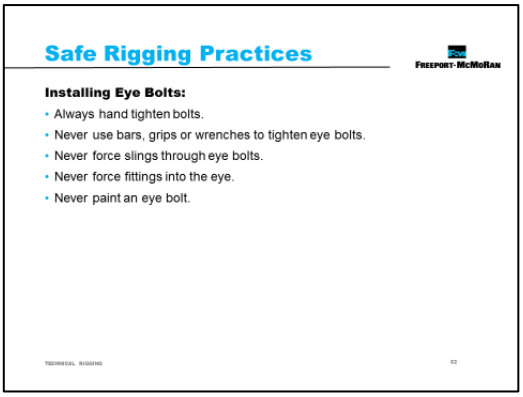
- The tapped hole for any screw eye bolt must be as deep as required for the bolt, plus an additional one half the diameter.*
- Inspect and clean the eye bolt threads and the hole.
    - Note: Do not use compressed air to clean any component.
- The shoulder should be in full contact with the surface of the object being lifted and at a right angle to the axis of the hole.

*References for tapped hole depth (not included in Student Guide):

Headley, James. Rigging. Crane Institute of America, Fourteenth Edition, 2013 / Fifteenth Edition 2015. Page 111: "When using machinery type eye bolts, the minimum tap depth is basic shank length plus one-half the nominal eye bolt diameter."

American Society of Mechanical Engineers, B30.20.2015 Rigging Hardware, Chapter 26-2 Adjustable Hardware – Selection, Use, and Maintenance, 26-2.9.4 Rigging Practices, 26-2.9.4.2 Eyebolts, (b): "When used in a tapped blind hole, the effective thread length shall be at least 1 ½ times the diameter of the bolt for engagement in steel."

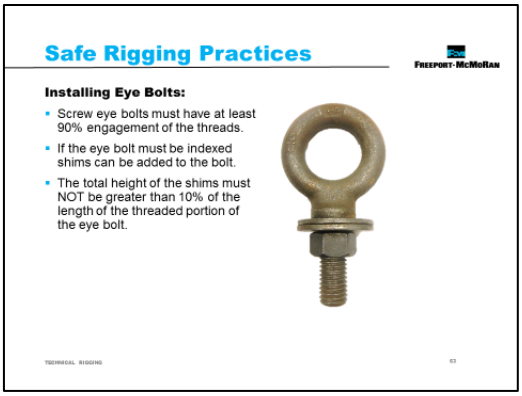
PPT slide 62, SG page 32



Instruction

- *Run through bullet points.*

PPT slide 63, SG page 32

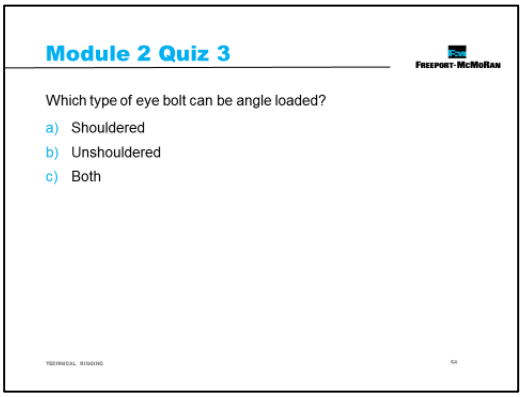


Instruction

- A properly installed screw eye bolt must have at least 90% engagement of the threads.
- If the eye bolt must be indexed (spun to the proper direction to accept the hook or shackle for lifting without side loading), it is permissible to add shims (like washers) to the bolt.
- The total height of the shims must NOT be greater than 10% of the length of the threaded portion of the eye bolt.

MODULE 2 QUIZ 3

PPT slide 64, SG page 33



Instruction

- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 5 on the pre-course test.*

Quiz Answer

- Answer: a) shouldered

  Side loading is permissible as long as done in the direction of the plane of the eye, however, huge deductions in its capacity must be made.

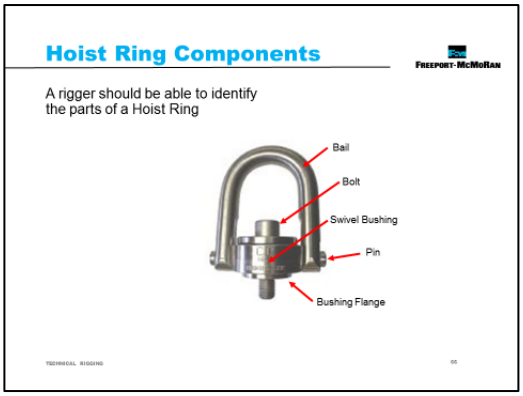
PPT slide 65, SG page 34

Instruction

- A hoist ring is excellent for angled lifts as the capacity is the same at every angle.
- It will adjust to any sling angle by rotating around the bolt and the hoisting eye pivots 180°.

Note: When loaded at an angle, hoist rings create additional tension. The load weight plus the tension must not exceed the rated capacity of the hoist ring.

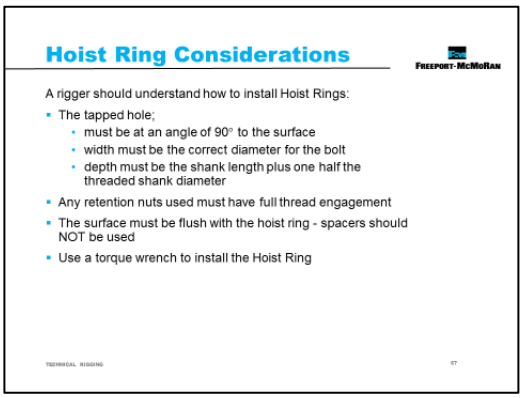
PPT slide 66, SG page 34



Instruction

- A rigger should be familiar with the parts of a hoist ring.
- *Run through the parts labeled on the photograph.*

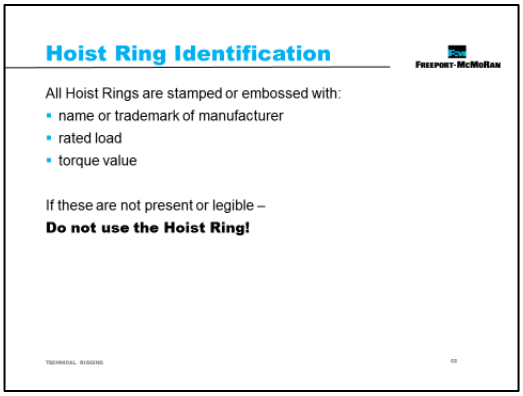
PPT slide 67, SG page 34



Instruction

- A rigger should be familiar with how to install and use hoist rings, including any manufacturer's instructions.
- *Run through bullet points.*
- *Explain that torque is the turning force of an object. The torque value is the amount of torque that can be applied to the bolt when installed.*

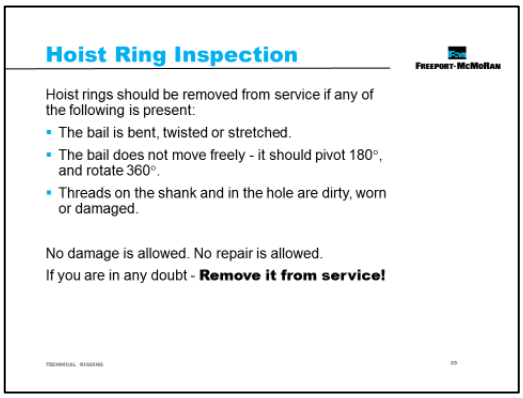
PPT slide 68, SG page 34



Instruction

- *Run through bullet points.*

PPT slide 69, SG page 34



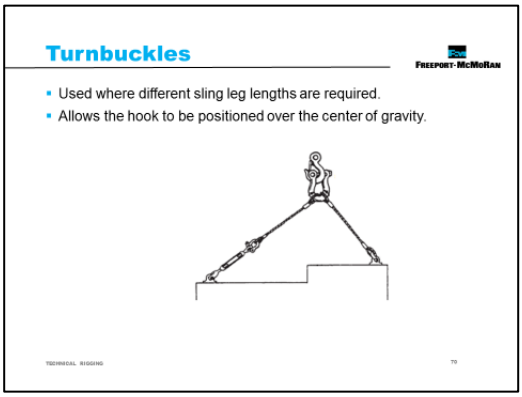
Instruction

- In addition to inspecting for corrosion, wear and damage, and that manufacturers identification marks are present, as per all hardware, hoist rings should be removed from service if any of the following is present:

Run through bullet points.

- No damage at all is allowed, and removal of damage is not permissible.
- Hoist rings that have signs of repair must also be removed from service.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

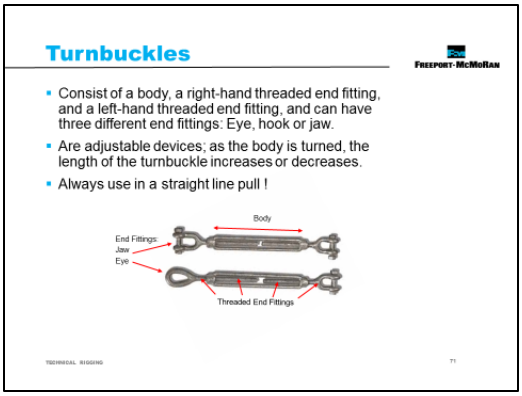
PPT slide 70, SG page 35



Instruction

- Turnbuckles are used where different sling leg lengths are required to allow the hook to be positioned over the center of gravity.

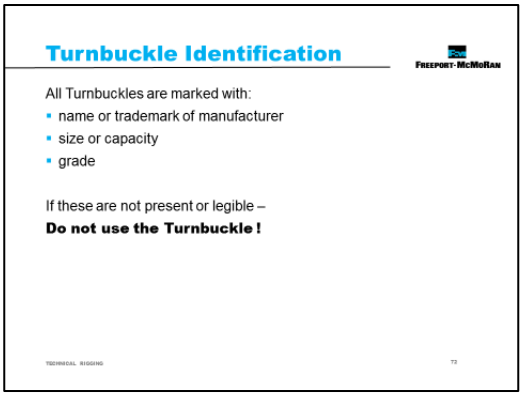
PPT slide 71, SG page 35



Instruction

- *Run through bullet points.*
- *Run through the parts labeled on the photograph.*

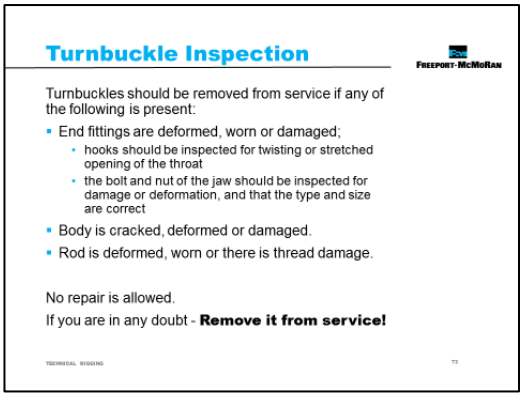
PPT slide 72, SG page 35



Instruction

- *Run through bullet points.*

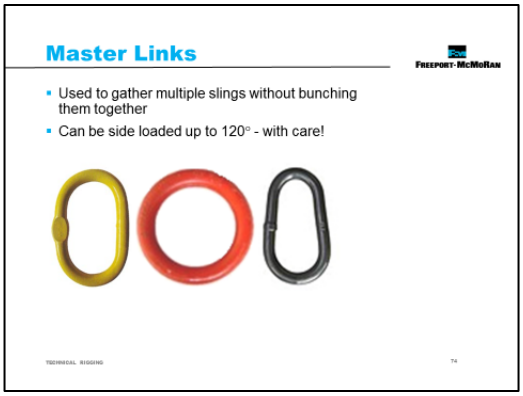
PPT slide 73, SG page 35



Instruction

- In addition to inspecting for corrosion, wear and damage, and that manufacturers identification marks are present, as per all hardware, Turnbuckles should be removed from service if any of the following are present:
- *Run through bullet points.*
- Turnbuckles must not be repaired without approval from the manufacturer.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

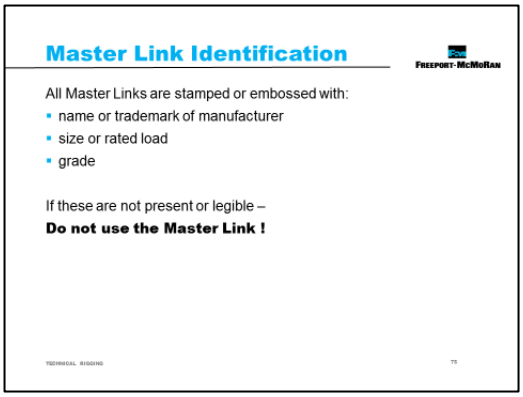
PPT slide 74, SG page 36



Instruction

- A master link is a steel link or ring used to gather multiple sling legs together, without bunching the slings up.
- Although Master Links can be side loaded up to 120°, care should be taken, as this will cause twice the stress of a vertical pick.

PPT slide 75, SG page 36



Instruction

- *Run through bullet points.*
- All Master Links should be inspected prior to every use for these three pieces of information. If these are not present or legible - **do not use the Master Link!**

[14] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-4 Links, Master Link Subassemblies, Rings, and Swivels, Section 26-4-5: Identification, 26-4.5.1 Links, Master Link Subassemblies, Rings, and Swivels Identification

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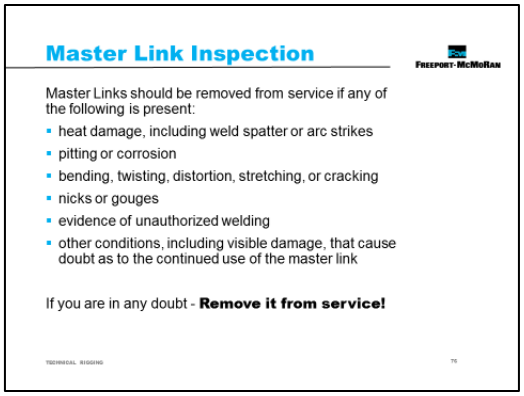
PPT slide 76, SG page 36



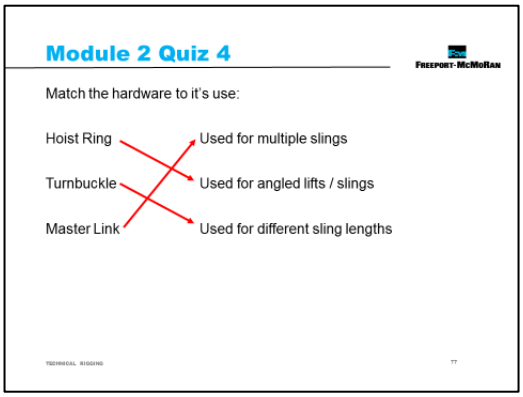
Instruction

- *Run through bullet points.*
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

[15] American Society of Mechanical Engineers B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-4 Links, Master Link Subassemblies, Rings, and Swivels, Section 26-4-8: Inspection, Removal, and Repair, 26-4.8.5 Removal Criteria

MODULE 2 QUIZ 4

PPT slide 77, SG page 37



Instruction

- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 6 on the pre-course test.*

Quiz Answer

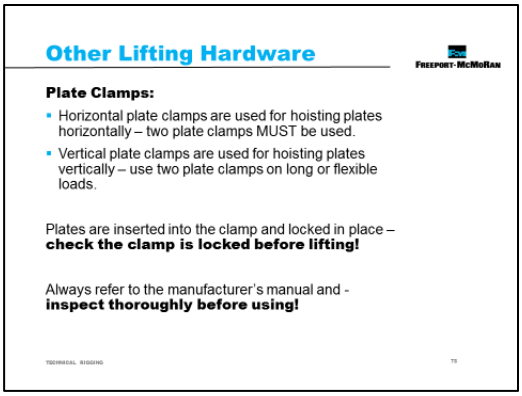
- Answers:

  Hoist Ring: Used for angled lifts / slings

  Turnbuckle: Used for different sling lengths

  Master Link: Used for multiple sling lifts

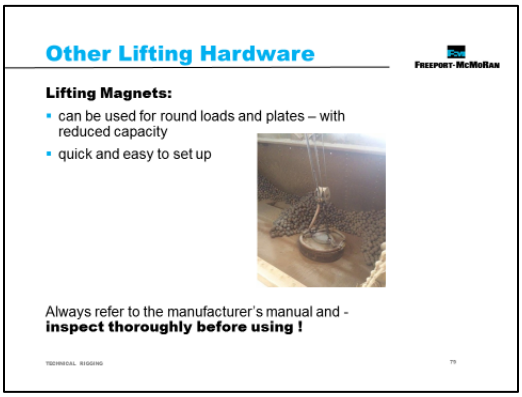
PPT slide 78, SG page 38



Instruction

- There are two styles of plate clamps, those designed for vertical or horizontal orientation of the plate:
    - Horizontal plate clamps are to be used when a plate must be hoisted in a horizontal orientation. Two horizontal plate clamps MUST always be used.
    - Vertical plate clamps are to be used when the plate must be hoisted in a vertical orientation. When hoisting a long or flexible plate in a vertical orientation, two vertical plate clamps should be used.
- The steel plates are inserted into the clamp, and locked in place – **be sure to check that the clamp is locked before lifting the load!**
- Always refer to the manufacturer's manual before using, and as with all lifting gear, **inspect thoroughly** before using.

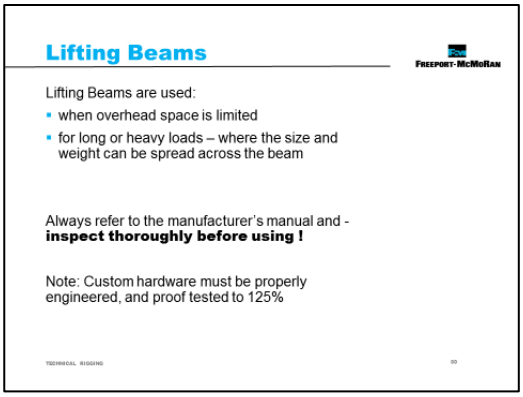
PPT slide 79, SG page 38



Instruction

- An alternative to Plate Clamps is Lifting Magnets.
- Can be used for round loads as well as flat plates, however, the loading rate is different - the capacity is significantly reduced!
- Quick and easy to set up – the magnet is centered on the load and the magnetic field turned on by a lever.
- Always refer to the manufacturer's manual before using, and as with all lifting gear, **inspect thoroughly before using**.

PPT slide 80, SG page 39

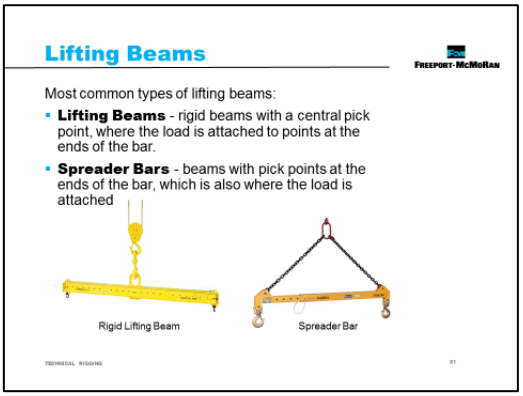


Instruction

- Lifting beams are useful when overhead space is limited.
- Generally used for long or heavy loads where the size, and more importantly the weight, can be spread across the beam.
- Always refer to the manufacturer's manual before using, and as with all lifting gear, **inspect thoroughly before using**.
- Custom hardware must be properly engineered and "shall be marked to indicate the safe working loads and shall be proof-tested prior to use to 125 percent of their rated load." [8]

[8] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Materials Handling, Storage, Use, and Disposal, 1926.251 Rigging equipment for material handling, 1926.251(a)(4)

PPT slide 81, SG page 39



Instruction

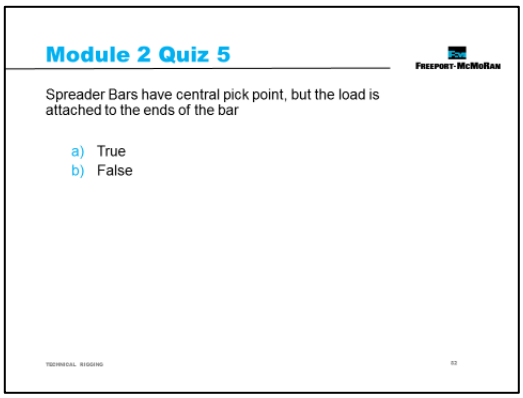
- The most common types of lifting beam are Lifting Beams and Spreader Bars.

The names are often switched but they are actually different devices:

  - Lifting Beams are rigid beams with a central pick point. The beam therefore has to be strong and rigid, as the pick point is central, but the load is attached to points at the ends of the bar.
  - Spreader Bars are beams with pick points at the ends of the bar, which is also where the load is attached. The weight is therefore spread across the beam.

MODULE 2 QUIZ 5

PPT slide 82, SG page 40



Instruction

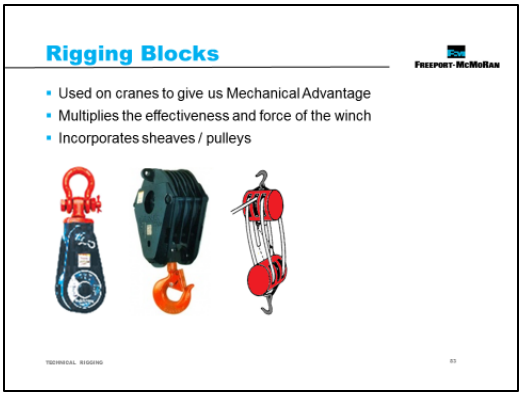
- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 7 on the pre-course test.*

Quiz Answer

- Answer: b) False

  Spreader Bars have pick points at the ends of the bar, which is also where the load is attached. Lifting Beams have a central pick point, but the load is attached to points at the ends of the bar.

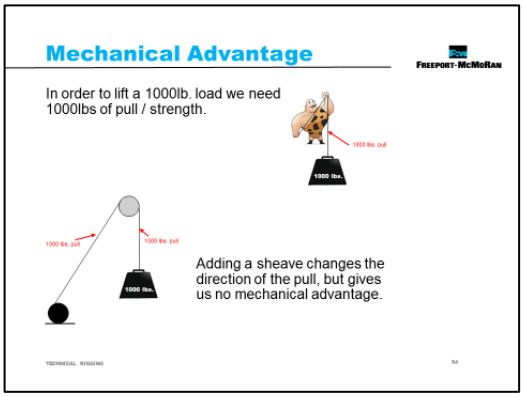
PPT slide 83, SG page 41



Instruction

- Rigging blocks are used mainly on cranes, to give Mechanical Advantage.
- Mechanical Advantage multiplies the effectiveness of the winch and amplifies force output.
- Examples of this would be gear boxes, chain and belt drives, levers, and the block and tackle systems.
- A block and tackle system incorporates a fixed Sheave (pulley) or set of Sheaves (pulleys) and a movable sheave (pulley) or set of sheaves (pulleys). Blocks range from one-sheave, up to 10 sheave blocks on larger cranes.
- Sheaves (pulleys) need to be used in the correct application in order to give us mechanical advantage.

PPT slide 84, SG page 41

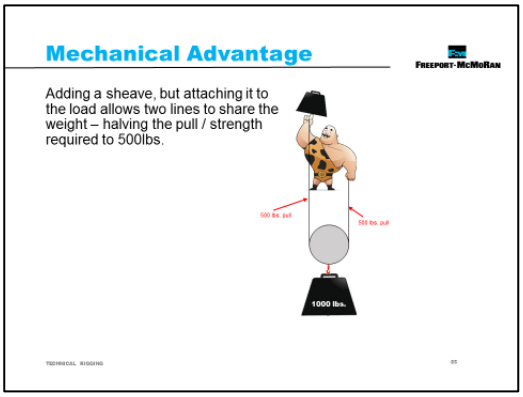


Instruction

- In order to lift the 1000 lb. load he needs to have an equal amount of pull (i.e. strength or force).
- If a sheave (pulley) is incorporated into the lift,
  - This changes the direction of pull.
  - But does not give mechanical advantage.

  This is because the full weight of the load is still supported by only one line.

PPT slide 85, SG page 41

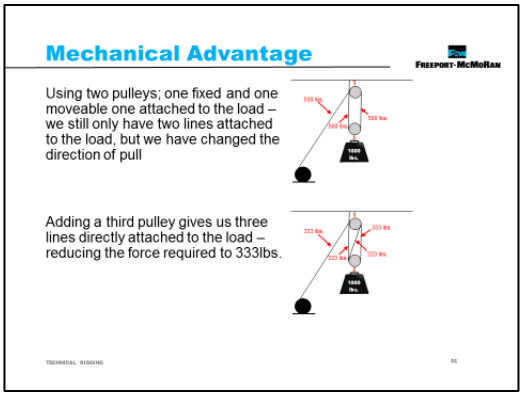


Instruction

- Adding a Sheave (Pulley) attached to the load, rather than in a fixed position:

  We now have two lines sharing the load, resulting in half the force (500 lbs.) being required to lift the load.

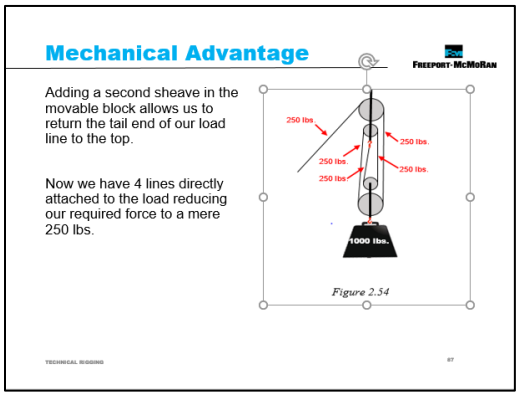
PPT slide 86, SG page 42



Instruction

- *Run through bullet points / discuss the diagrams.*

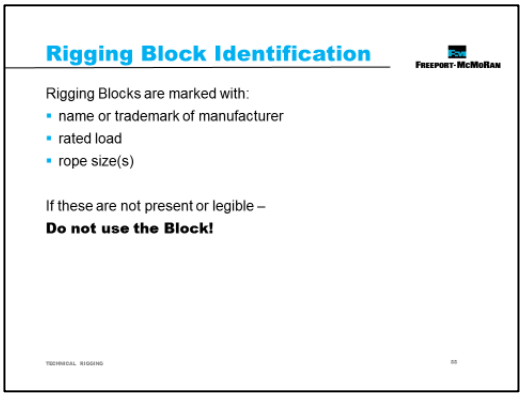
PPT slide 87, SG page 41



Instruction

- *Run through bullet points / discuss the diagrams.*
- We can continue to add Sheaves (pulleys) to our block and tackle system resulting in the ability to lift many times more weight than we could otherwise.
- Now we have 4 lines directly attached to the load reducing our required force to 250 lbs.

PPT slide 88, SG page 43



Instruction

- *Run through bullet points.*
- All Rigging Blocks should be inspected prior to every use for these three pieces of information.
- If these are not present or legible - **do not use the Block!**

[16] American Society of Mechanical Engineers, B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-5 Rigging Blocks – Selection, Use and Maintenance, Section 26-5.5: Identification, 26-5.5.1 Marking

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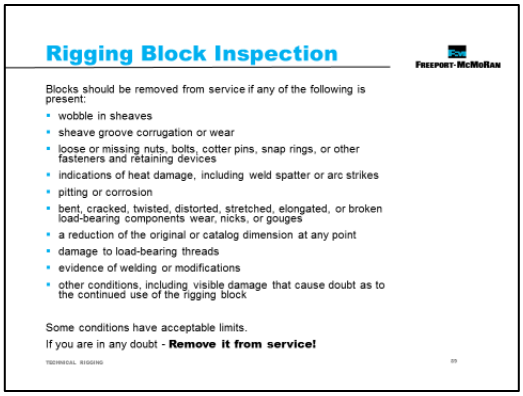
PPT slide 89, SG page 41



Instruction

- *Run through bullet points.*
- Some conditions have acceptable limits which differ between items and manufacturers.
    - Manufactures recommendations should be consulted for specific removal criteria.
    - Be sure that the recommendation you are referencing match the item you are inspecting.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

[17] American Society of Mechanical Engineers, B30.26-2015, Rigging Hardware: Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, Chapter 26-5 Rigging Blocks – Selection, Use and Maintenance, Section 26-5.8: Inspection, Repair and Removal, 26.5.8.5 Removal Criteria

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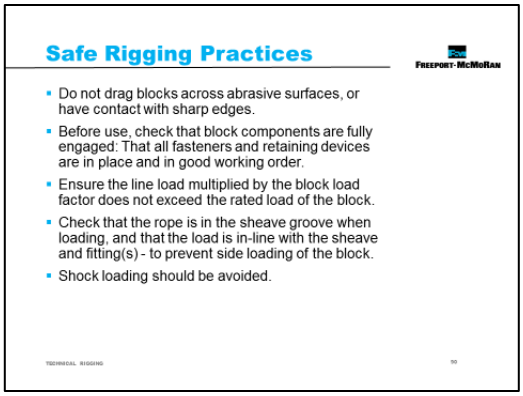
PPT slide 90, SG page 41

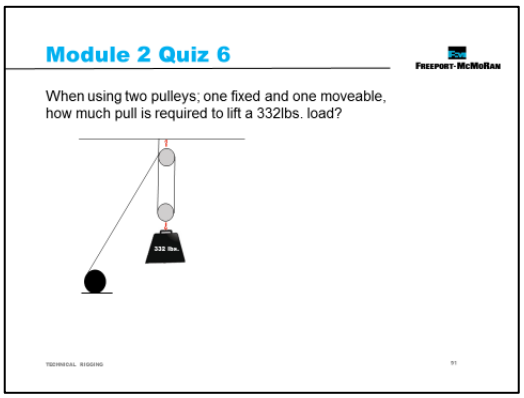


Instruction

- Damage to the rigging block should be avoided.
    - Rigging blocks should not be dragged on abrasive surfaces, or have contact with sharp edges.
- Before use, check that all rigging block components are fully engaged, with all fasteners and retaining devices in place and in good working order.
- Ensure the line load multiplied by the block load factor does not exceed the rated load of the rigging block.
- Check that the rope is in the sheave groove when the rigging block begins to take load, and that the load is in-line with the sheave and fitting(s) to prevent side loading of the block.
- Shock loading should be avoided.
    - Shock loading is when a sudden intense force is placed on a crane, and the crane cannot handle the pressure, which would not only damage the rigging, but cause structural damage to the crane itself.

MODULE 2 QUIZ 6

PPT slide 91, SG page 44



Instruction

- *Students will mark their answer to the quiz question in their SG.*
- *Review the answer as a class.*
- *Note: This quiz question is also Question 8 on the pre-course test.*

Quiz Answer

- Answer: 166 lbs.

MODULE 3: SLINGS

This module introduces the subject of rigging slings, and discusses the three main types of sling used at Freeport-McMoRan, their advantages, disadvantages, and safe rigging practices.

LEARNING OBJECTIVES

Upon completion of module, students will be able to:

- Identify different types of slings, and their components.
- Conduct sling inspections, and recognize defects.
- Recall sling regulations and apply safe rigging practices.

ACTIVITIES

Quizzes:

- 1 quiz question at the end of the introduction, and 2 quiz questions at the end of each sling type, not at the end of the whole module.

MATERIALS

Hold up, or pass examples of slings and B/O slings around during this module:

- Alloy Steel Chain
- Wire Rope
- Synthetic Web
- Synthetic Round
- Examples of capacity tags

Slide 125, Wire Rope Clip Installation:

- Refer to Rigging Reference Guide (Crosby Card)

PREPARATION

Slide 94, Site Specific Notes:

- Facilitator should research and record their site specific Sling Procedure

FACILITATION

This module contains a brief introduction on slides 93 through 99. Do not go into detail on the introductory slides, all items will be covered thoroughly in the module.

The module is then split into three sling types: Alloy Steel Chain Slings, Wire Rope Slings, and Synthetic Slings (containing Web Slings and Round Slings.) Each sling type has an introductory slide, followed by detailed information in the following format:

- Alloy Steel Chain Slings: Identification, Inspection, and Storage.
- Wire Rope Slings: Components, Measuring, and Lays. Identification and Inspection. Clips, Thimbles and Diameter. Storage.
- Synthetic Slings:
    - Web Slings: Identification, Inspection, and Storage.
    - Round Slings: Identification, Inspection, and Storage.

FACILITATION TIP

Explain to the students that this module consists of three "lecturettes". Each type of sling is discussed individually, followed by quiz questions. This will prepare the students for the module material.

FACILITATION TIP

Role Reversal:

- ***Diagrams:*** *Have a student discuss the diagrams and you ask the questions, for example:*
    - *Lay Length*
    - *Diameter / Diameter*
- ***Descriptions:*** *Have a student explain the description and you ask the questions, for example:*
    - *Different Lays*
    - *Never Saddle a Dead Horse*

Demonstration:

- ***Inspections****: Have a student perform an actual sling inspection. Coach them through the inspection if needed.*
- ***Demonstration****: Have a student perform installing a thimble and wire rope clips.*

PPT slide 92, SG page 47

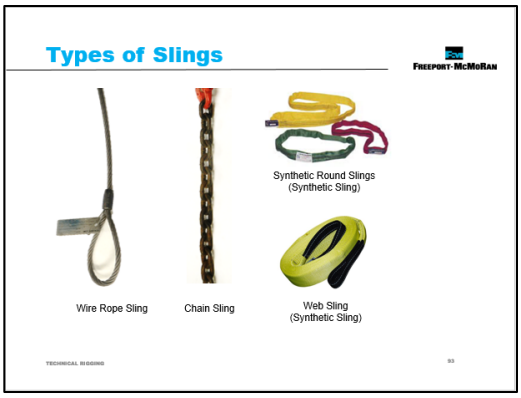
Instruction

Go over the learning objectives for the module.

Upon completion of this module, students will be able to:

- Identify the different types of slings and their materials
- Identify alloy steel chain sling configurations.
- Conduct bridle and chain inspections.

PPT slide 93, SG page 48



Instruction

- Slings are an essential part of rigging. There are many different sling types and variations available to the rigger. Each type has its advantages and disadvantages.
- These are types of slings commonly used at Freeport-McMoRan:
  - Alloy Steel Chain Slings
  - Wire Rope Slings
  - Synthetic Slings include Web Slings and Round Polyester Slings

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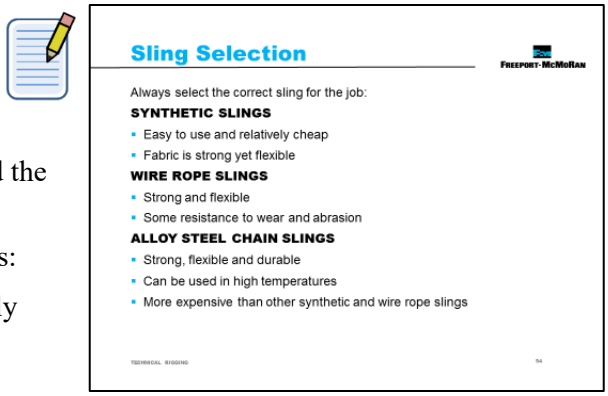
PPT slide 94, SG page 49



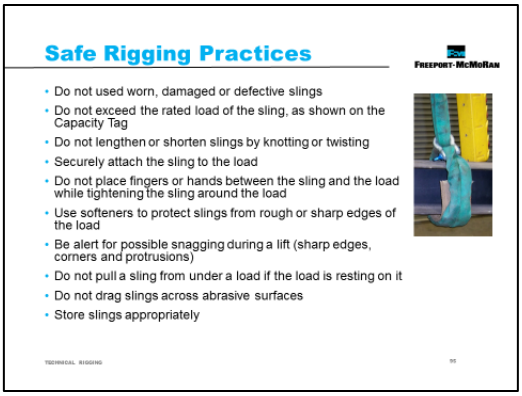
Instruction

- Always select the correct sling for the load and the environment.
- Each type has its advantages and disadvantages:
    - Synthetic slings are the most commonly used sling.
        - They are easy to use and inexpensive compared to other materials.
        - Made from nylon or polyester, the fabric is strong yet flexible.
    - Wire rope slings are also strong and flexible.
        - Smaller diameter wire rope offers more resistance to wear and abrasion.
        - Larger diameter rope with a higher number of strands is more flexible.
    - Chain slings are strong, flexible, and durable:
        - They can be used in environments that would destroy other types of slings, such as high temperatures.
        - However, chain slings are a lot more expensive than synthetic or wire rope slings.
- Always refer to the manufacturers specifications when using slings in adverse conditions, for example near chemicals or heat sources.

FACILITATION NOTE

Discuss site specific procedure. Students are to record details of site specific procedure in the notes section of their Student Guide – p49. Record your notes here:

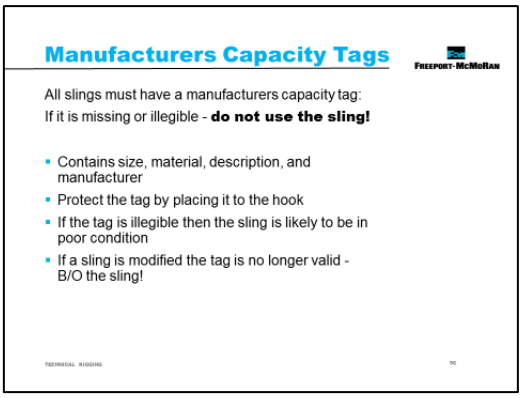
PPT slide 95, SG page 50



Instruction

- Whichever sling you chose for your lift, the following safe rigging practices shall be observed:
- Run through bullet points.

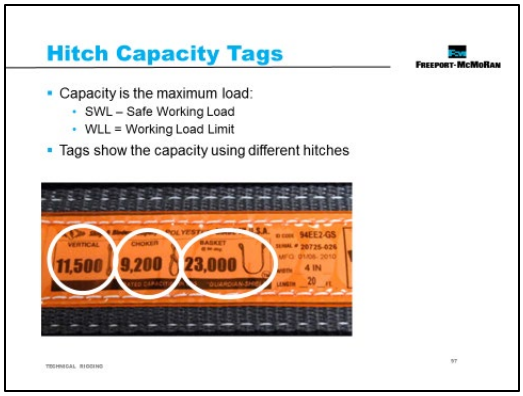
PPT slide 96, SG page 50



Instruction

- All slings must have a manufacturer's capacity tag.
- Slings shall be inspected prior to every use - including the capacity tag.
- If it is illegible or missing - **do not use the sling!**
- The tag contains information regarding the manufacturer, a description of the sling, the material it is made from, and its size.
- Most tags will eventually become hard to read with time, so when buying slings make sure they have a sturdy capacity tag that will stand up to normal wear and tear.
- Placing the tag to the hook (rather than the load) will protect the tag from damage.
- However, if the tag has become illegible, then it is likely the rest of the sling is in equally poor condition.
- Any modification to a sling, will mean that the Working Load Limit is no longer valid, therefore the sling should be B/O.
- If there is any doubt as to the condition or serviceability of any piece of equipment, **remove it from service** until a further inspection can be conducted by a qualified individual.

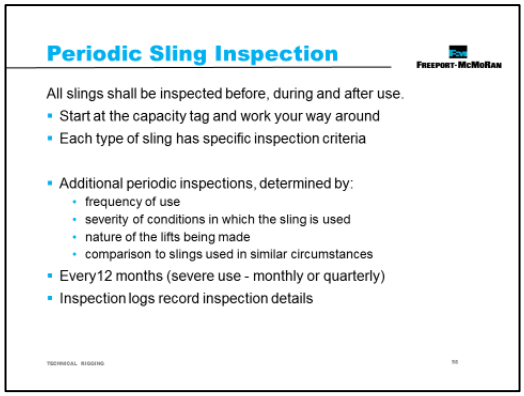
PPT slide 97, SG page 50



Instruction

- As the name suggests, the capacity tag shows the capacity of the sling, which can be displayed as:
    - Capacity,
    - or SWL (Safe Working Load),
    - or WLL (Working Load Limit).
- All of these terms mean exactly the same thing – it is the maximum load that can be placed on any piece of rigging equipment.
- The tag in the photograph shows the capacity using different types of hitches: Vertical, Choker, and Basket Hitch.

PPT slide 98, SG page 51

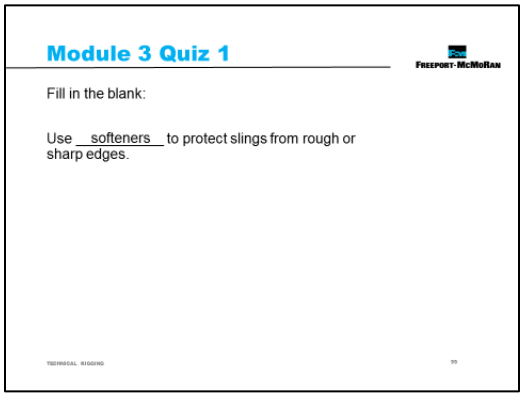


Instruction

- All slings shall be inspected before, during and after use.
- Start at one end and work your way around the sling to the other end.
    - Start your inspection at the end with the capacity tag, checking first that it is attached, and that all information is legible.
- Each type of sling has specific inspection criteria, as listed in the individual sections of this module.
- Additionally a qualified person performs a periodic inspection, which is determined by:
- Run through bullet points.
- Periodic inspections shall take place at intervals no greater than 12 months.
- However, slings in severe use shall be inspected monthly to quarterly.
- Inspection logs are used to record details and ensure regular inspections are conducted.

MODULE 3 QUIZ 1

PPT slide 99, SG page 51



Instruction

- Fill in the blank.
- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This quiz question is also Question 9 on the pre-course test.*

Quiz Answers

- Answer: softeners

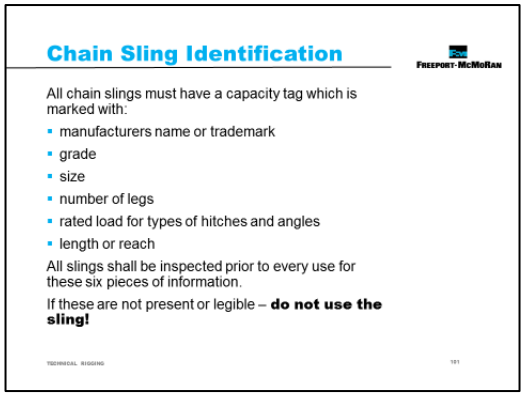
  Use softeners to protect slings from rough or sharp edges.

PPT slide 100, SG page 52

Instruction

- Chain slings are strong, flexible, and durable.
- They can be used in environments that would destroy other types of slings, such as high temperatures.
- However, chain slings are a lot more expensive than synthetic or wire rope slings.
- Note: Chain slings used for overhead lifting are always made from Alloy Steel only.

PPT slide 101, SG page 52



Instruction

- *Run through bullet points*.

[18] American Society of Mechanical Engineers, B30.9, Slings: Alloy Steel Chain, Section 9-1.7 Sling Identification, 9-1.7.1 Marking Requirements

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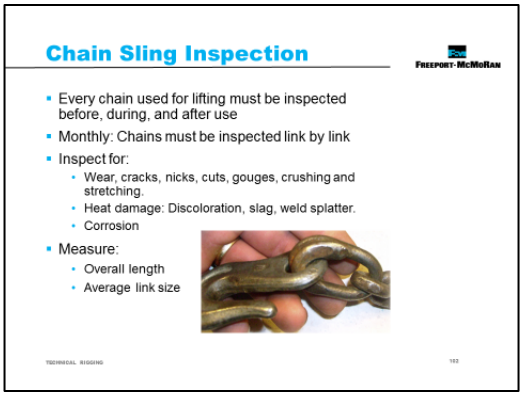
PPT slide 102, SG page 52

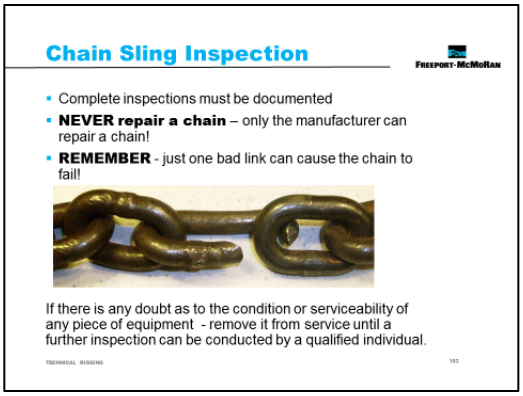


Instruction

- Every chain used for lifting must be inspected before, during, and after use.
- Monthly, chains must be inspected link by link.
    - This inspection must be documented so that any changes are monitored.
    - For this reason, it is advisable to identify each chain or bridle with a unique number or identifier.
- In order to do a thorough inspection inspect each link of the chain individually for:
    - Wear, cracks, nicks, cuts, gouges, crushing and stretching.
    - Chains shall also be inspected for heat damage (discoloration, slag, weld splatter)
    - and corrosion.
- There are several methods for measuring chains during an inspection.
    - Overall length can be measured by hanging the chain and measuring top to bottom.
    - A representative sampling of the chain can be taken by measuring several links in one section, then another section, and so on, and an average link size determined.
    - Some manufacturers provide “go/no-go” gauges for users to use in inspections.

[19] American Society of Mechanical Engineers, B30.9, Slings: Alloy Steel Chain, Section 9-1.9 Inspection, Removal, 9-1.9.4 Removal Criteria

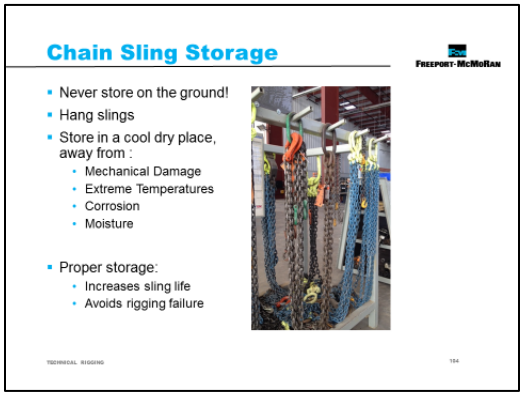
PPT slide 103, SG page 52



Instruction

- Regardless of the method used to inspect chains, complete inspections must be documented.
- **Never repair a chain** – only the chain manufacturer can repair a chain!
- And **remember** - just one bad link can cause the chain to fail!
- If there is any doubt as to the condition or serviceability of any piece of equipment, remove it from service until a further inspection can be conducted by a qualified individual.

PPT slide 104, SG page 53

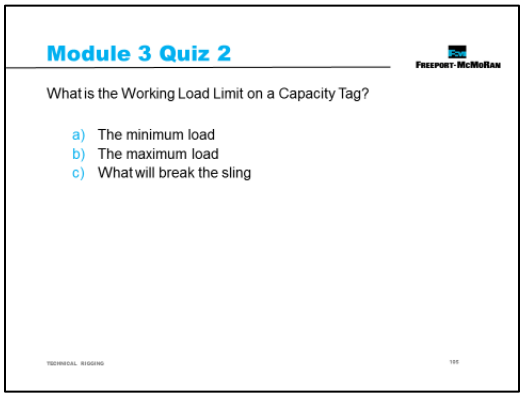


Instruction

- Never store slings on the ground!
  - In addition to being a tripping hazard, there is also risk of mechanical damage.
- Slings should be hung.
  - Ideally on a storage rack sorted by size, purpose etc.
  - This keeps slings out of the way of potential damage, but it also makes retrieval and selection much quicker and easier.
- Chain slings can be damaged by;
  - abrasion and sharp corners
  - heat and corrosion
- Store in a cool dry place, away from any environmental damage such as corrosion, moisture, or extreme temperatures.
- Proper storage can increase the life of slings as well as help to avoiding rigging failure.

MODULE 3 QUIZ 2

PPT slide 105, SG page 54



Instruction

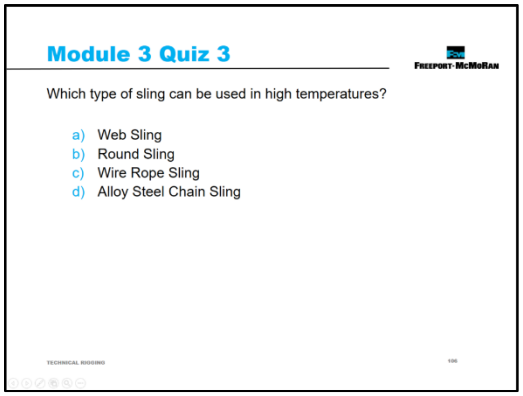
- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This quiz question is also Question 10 on the pre-course test.*

Quiz Answers

- Answer: B the maximum load

MODULE 3 QUIZ 2

PPT slide 106, SG page 54



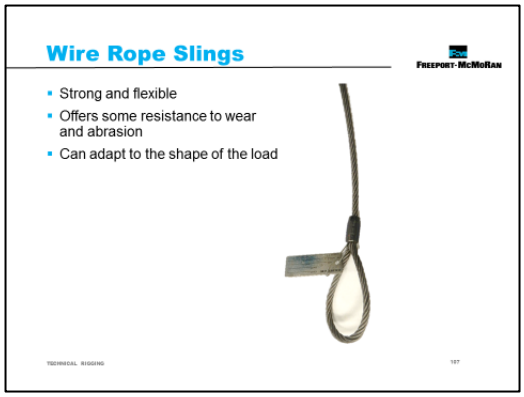
Instruction

- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This quiz question is also Question 11 on the pre-course test.*

Quiz Answers

- Answer: D. Alloy Steel Chain Sling

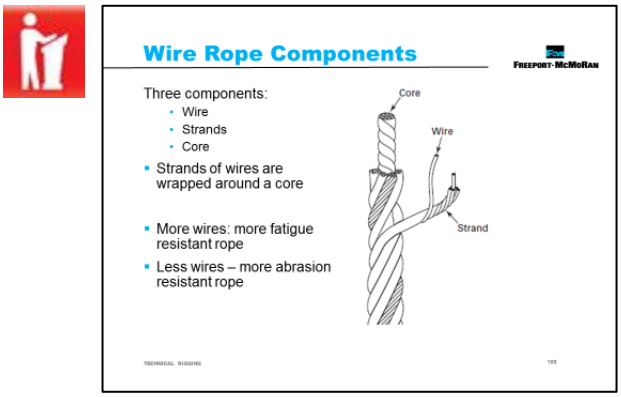
PPT slide 107, SG page 55



Instruction

- *Run through bullet points.*
- Wire rope slings are strong, durable and offer some resistance to abrasion.
- Wire rope slings have the ability to adapt to the shape of the load, and can also be used to lift hot loads.

PPT slide 108, SG page 55



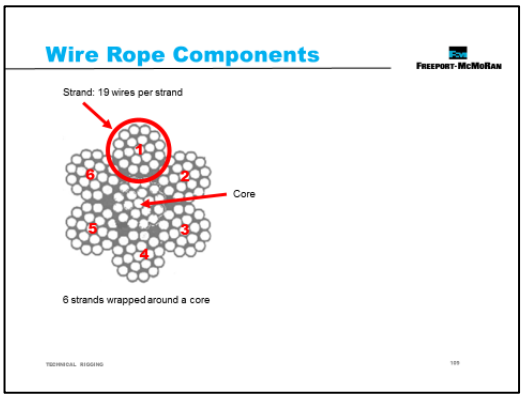
Instruction

- All wire rope has three basic components:
  - Wires
  - Strands
  - Core
- The lower the second number, the more abrasion resistant the rope will be.
- The higher the number, the more fatigue resistant the rope will be.
- Knowing and understanding the differences in the various ropes can help a rigger identify which rope is best in various applications.

FACILITATION TIP

Ask the students to explain why the statements on the slide are true. Allow several seconds for them to formulate their thoughts. Asking them to focus on the content increases the likelihood that they will acquire the knowledge and skills. (Creative Facilitation Techniques for Training, Julie Patrick:2011)

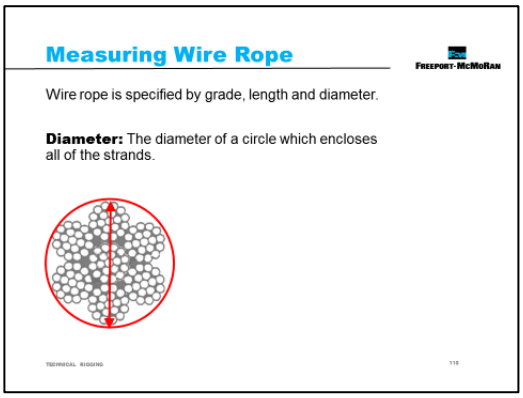
PPT slide 109, SG page 55



Instruction

- Types of wire ropes are identified by number, and the type of core. The numbers are nominal:
  - A 6 x 19 rope will have 6 strands of approximately 19 wires wrapped around the core (depends upon the manufacturer).
  - A 6 x 37 rope will have 6 strands of approximately 37 wires wrapped around the core (depends upon the manufacturer).
- That core may be independent, wire, or fiber.
- Generally the greater the number of wires and the smaller the diameter, the more flexible the rope will be.

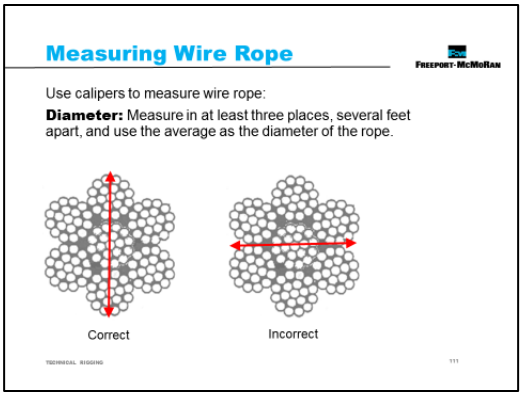
PPT slide 110, SG page 56



Instruction

- Wire Rope is specified by its length and diameter.
- The measurement systems used for length, width and grade are specific to Wire Rope, and must be understood by the rigger.
- Wire rope is measured across its diameter.
- The true diameter of a piece of wire rope is the diameter of a circle that will just enclose all of its strands.
- *Discuss the diagram.*

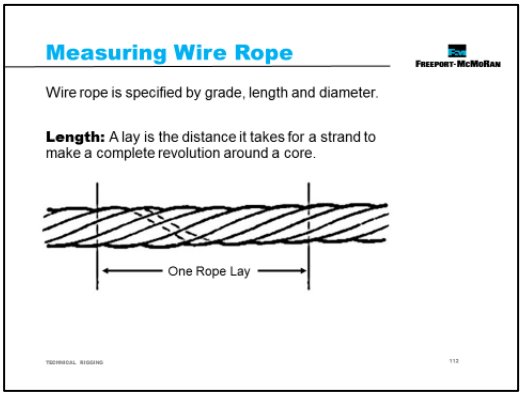
PPT slide 111, SG page 56



Instruction

- *Discuss the diagrams.*
- The diagrams compare the correct and incorrect ways to measure wire rope:
    - The correct way to measure is from the top edge of one strand to the bottom edge of the opposite strand.
    - Do not measure across where the two strands are side by side.
- Use calipers to measure wire rope.
    - For accuracy, measure the rope in at least three places, several feet apart, and use the average of all three measurements as the diameter of the rope.

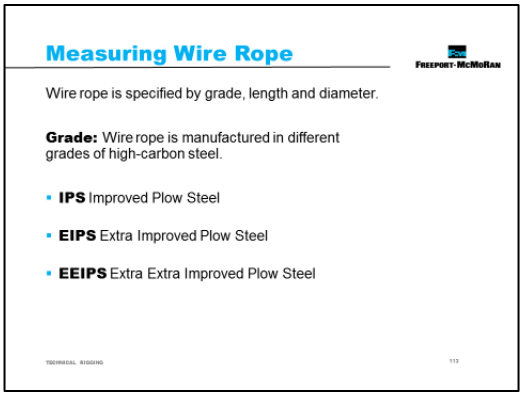
PPT slide 112, SG page 57



Instruction

- The length of a rope is measured in “lays”.
- A lay length refers to the distance it takes for a strand to make a complete revolution around a core, (i.e. the distance from where a strand spirals down and back up).

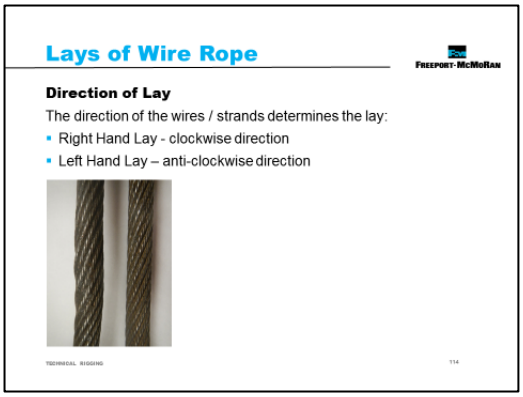
PPT slide 113, SG page 57



Instruction

- Wire rope is generally made from high-carbon steel, which is manufactured at different grades:
    - Improved Plow Steel (IPS)
    - Extra Improved Plow Steel (EIPS)
    - Extra Extra Improved Plow Steel (EEIPS)
- EIPS is the most commonly used grade.

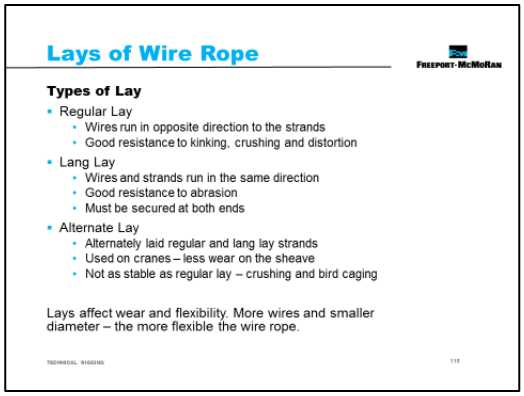
PPT slide 114, SG page 58



Instruction

- Wire rope is identified not only by its components, but also by how it has been manufactured.
    - The direction of the wires and strands determines the “lay”.
- Left hand lay or right hand lay describe how the strands are laid to form the rope.
- To determine the lay of strands, look at the rope as it points away from you:
    - If the strands appear to turn in a clockwise direction, (or like a right-hand thread), the rope has a right hand lay.
    - If the strands appear to turn in an anti-clockwise direction, the rope has a left hand lay.
- Rotation resistant wire rope has the inner and outer strands laid in opposite directions.

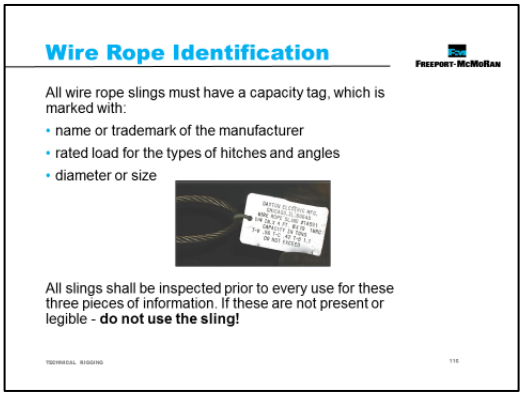
PPT slide 115, SG page 58



Instruction

- Regular lay ropes:
    - The direction of the wires in the strands is in the opposite direction to the strands.
    - The wires appear to run parallel to the axis of the rope.
    - As a commonly used multipurpose rope, regular lay has good resistance to kinking, crushing and distortion.
- Lang laid rope:
    - Wires are laid in the same direction as the strands.
    - The outside wires providing good resistance to abrasion.
    - To prevent unwinding, lang rope must have both ends attached and should never be used in a single part or used with a swivel.
- Alternate lay and left lay rope:
    - Where regular lay and lang laid strands are alternately laid around the core.
    - These special ropes are used on cranes as they have a greater surface which results in less wear on the sheave.
    - However, they are not as stable as regular lay ropes and will often crush or bird cage *(refer students to page 60 of the Student Guide).*
- The lay of wire rope affect its resistance to wear and flexibility. Generally the greater the number of wires and the smaller the diameter, the more flexible the rope will be.

PPT slide 116, SG page 59



Instruction

- *Run through bullet points.*
- If these are not present or legible - **do not use the sling!**

[20] American Society of Mechanical Engineers, B30.9, Slings: Wire Rope, Section 9-2.7, Sling Identification, 9-2.7.1 Identification Requirements

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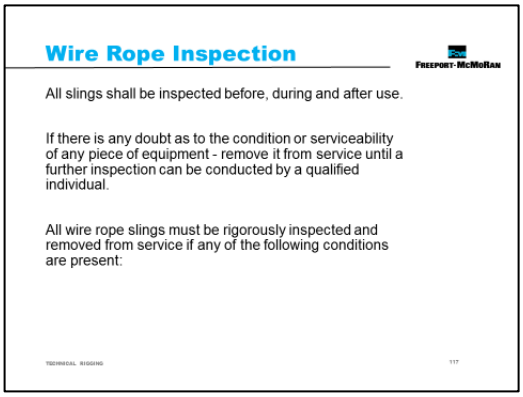
PPT slide 117, SG page 59



Instruction

- *Run through bullet points.*

[21] American Society of Mechanical Engineers, B30.9, Slings: Wire Rope, Section 9-2.9.1, Inspection, Removal, 9-2.9.4 Removal Criteria

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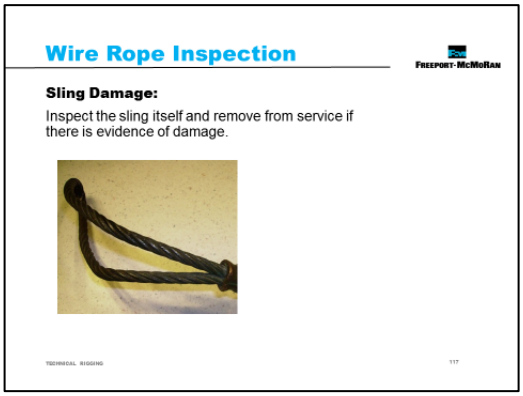
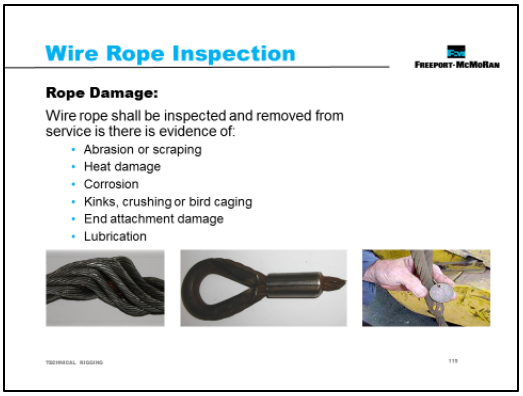
PPT slide 118, SG page 59



Instruction

- Inspect the sling itself and remove from service if there is evidence of damage.
- If there is any damage which causes doubt as to the capacity of the sling, it is cause for removal from service – **do not use!**

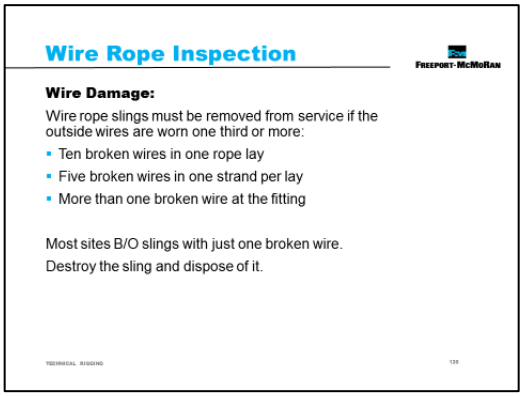
PPT slide 119, SG page 60



Instruction

- Wire rope shall be inspected and removed from service is there is evidence of:
    - Abrasion or scraping
    - Heat damage
    - Corrosion
    - Inspect for kinks, crushing, or bird caging.
        - Bird caging (where outer strands stand up) can be caused by shock loading, or when rope is opened up by twisting. In addition to damaging the slings, shock loading can cause structural damage to the crane, therefore all shock loading is prohibited.
    - Inspect end attachments or fittings shall be inspected for crushing, damage and corrosion.
    - Wire Rope is lubricated during manufacture.
        - To lengthen service it is regularly lubricated in the field.
        - If a rope looks dry and brown, it should be removed from service for lubrication by a qualified person.
        - Dirt and dust also affect the lubrication of slings – store slings correctly and do not leave slings on the ground.

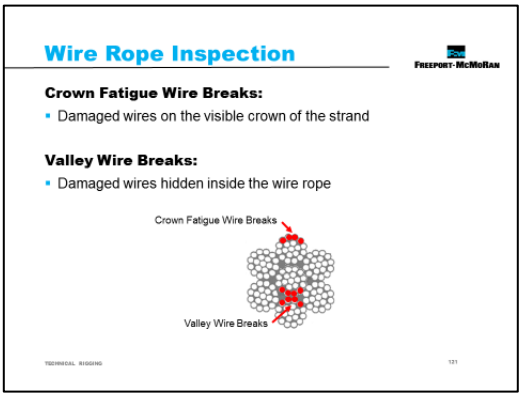
PPT slide 120, SG page 61



Instruction

- *Run through bullet points.*

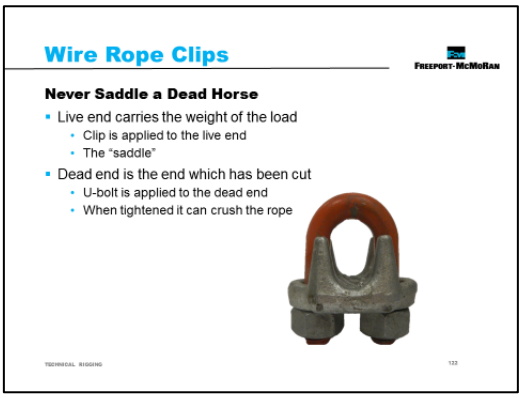
PPT slide 121, SG page 61



Instruction

- Crown Fatigue and Valley wire breaks are two common defects found in wire rope slings.
- Crown Fatigue wire breaks are where wires are damaged on the visible crown of the strand.
    - This is usually caused by running the rope over a sheave that is too small, or placing the rope over a shackle that has a smaller diameter than the rope.
- Valley wire breaks are on the lower part of the strand and hidden inside the wire.
    - If there is one valley wire break, there may be others that cannot be seen, and the rope shall be removed from service.

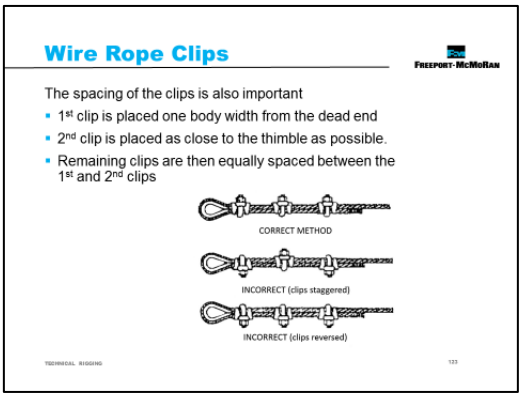
PPT slide 122, SG page 62



Instruction

- You have probably heard the saying: "Never Saddle a Dead Horse"?
- This refers to properly applying hardware when forming an eye at the end of a wire rope.
    - The live end of a rope is the end which will carry the weight of the load.
    - The dead end is the end which has been cut.
- A U-bolt is applied to the dead-end of the rope, and a clip to the "live" end.
    - The "saddle" is therefore on the live end.
    - The saddle should never be placed on the dead end or "horse" because as the U-bolt is tightened down, it often crushes the wire rope – we want the crushing to be on the dead end.
    - The saddle never goes over the dead end.

PPT slide 123, SG page 62

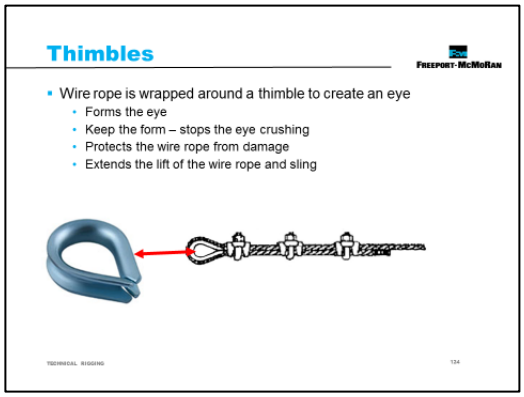


Instruction

- The spacing of the clips is also important:
  - The first clip should be one body width away from the dead end.
  - The second clip should go as close to the thimble as possible.
  - The remaining clips should be equally spaced between the first and second clips.

Note: For overhead lifting, suspension and fall protection life lines, do not use a U-bolt style clip, always use a Fist Grip Clip.

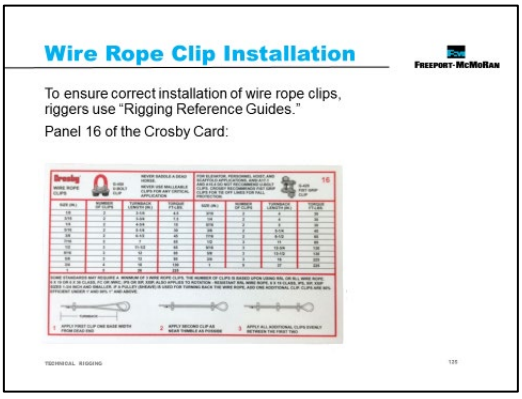
PPT slide 124, SG page 62



Instruction

- Wire Rope is wrapped around a thimble to create an eye.
  - Thimbles help form and keep the form of the eye of wire rope slings.
  - In addition to keeping the eye from crushing, they help to protect wire rope from damage by offering a strong surface for attaching hardware.
  - Use of thimbles can extend the life of wire rope and wire rope slings.

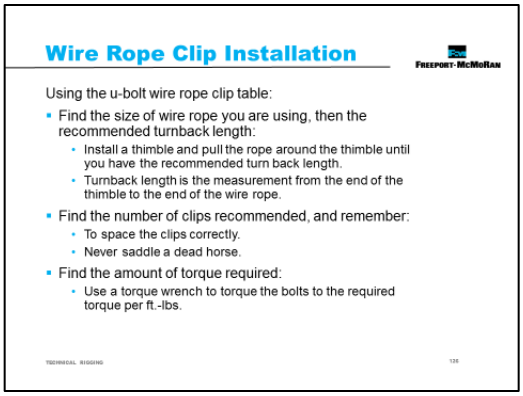
PPT slide 125, SG page 63



Instruction

- To ensure the correct installation of wire rope clips, riggers refer to manufacturer's guides.
- *Explain that we will go into more detail about these rigging cards in the last module of this course – exercises.*
- Panel 16 of the Crosby Users Lifting Guide, commonly known as The Crosby Card, lists the wire rope sizes, number of clips, the turnback length, and torque required.

PPT slide 126, SG page 63



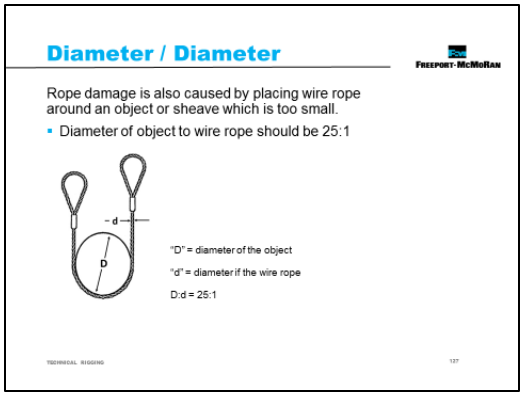
Instruction

- Using the left hand table* (the u-bolt wire rope clips table), as a reference, riggers shall complete the following steps when installing wire rope clips:

- Find the size of wire rope you are using in the first column, and the recommended turnback length required for that size in the third column.
    - Install a thimble on the underneath of the wire rope, and then pull the rope around the thimble until you have the recommended turn back length. This length is the measurement from the end of the thimble to the end of the wire rope.
- In the second column, check the number of clips recommended for that wire rope size. When installing wire rope clips, remember:
    - That the spacing of clips is also important, (see slide 123, SG page 62).
    - Never saddle a dead horse.
- The fourth column lists the torque required for the bolts of the clip. Check the amount of torque required for that wire rope size.
    - Use a torque wrench to torque the bolts to the required torque per ft.-lbs.

*Note: The right hand chart of panel 16 lists recommendations for Fist Grip Clips. It is not recommended that u-bolt wire rope clips are used on wire rope for fall protection. Also note that Freeport-McMoRan requires that any fall protection system is only installed by a qualified person in accordance with FCX02.

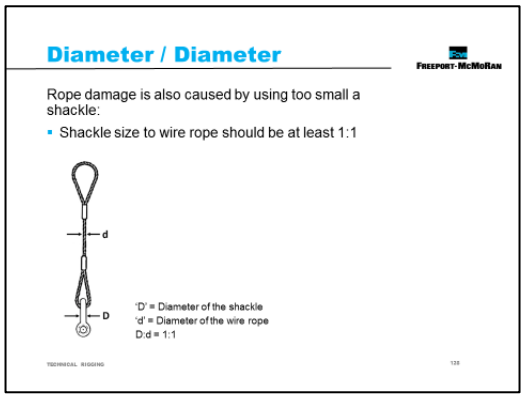
PPT slide 127, SG page 64



Instruction

- Rope damage is also caused by placing wire rope around an object or a sheave that is too small.
- In the illustration, the large "D" represents the diameter of the object, and the small "d" represents the diameter of the wire rope.
    - The diameter to diameter ratio should be 25 to 1, meaning that the object that you are choking should be 25 times larger than the diameter of the rope being used.
- *Discuss the diagram.*

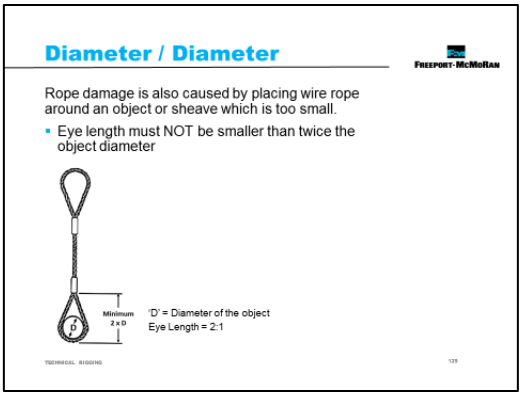
PPT slide 128, SG page 64



Instruction

- Never use a shackle smaller than the diameter of the rope.
    - It places abnormal tension on the outside wires, shortening the life of the sling.
- Wire rope should always have a shackle with a diameter larger than the wire rope.
    - It should never be placed over anything that is more than half of the length of the eye.
    - If the shackle or object has only 2 times the diameter of a 6-strand wire rope sling (D/d 2:1) the basket sling capacity must be reduced by 40%. It is better to use a larger shackle or a Wide Body shackle type.
- If the shackle or object has at least 5 times the sling diameter (D/d 5:1) the basket sling capacity must still be reduced by about 25%.
- *Discuss the diagram.*

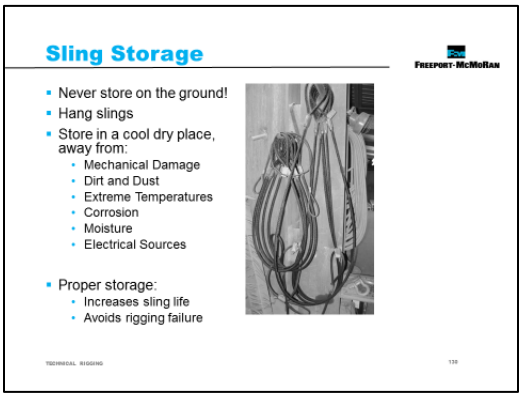
PPT slide 129, SG page 64



Instruction

- Eye length must NOT be smaller than twice the object diameter whether it is a shackle, pad eye or hook.
- The real danger for wire rope sling eyes is that putting an object in that is too large, will put tension on the fitting and try to pull it apart.
- *Discuss the diagram.*

PPT slide 130, SG page 65

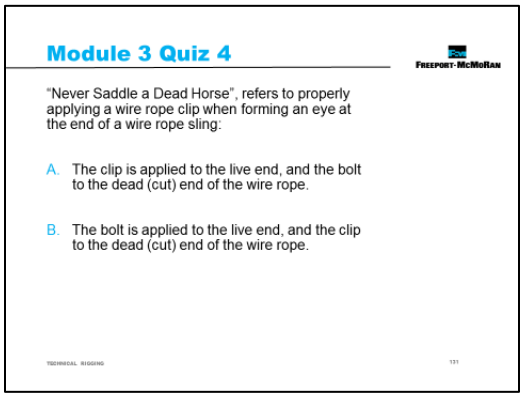


Instruction

- Never store slings on the ground!
  - In addition to being a tripping hazard, there is a high risk of mechanical damage such as kinking, crushing and strand displacement.
- Slings should be stored in a cool dry place away from environmental damage such as and corrosion, moisture, extreme temperatures and electrical sources.
- Dirt and dust on the ground will also affect the lubrication of wire rope slings.
- Slings should be hung, ideally on a storage rack sorted by size, purpose etc.
  - This keeps slings away from potential damage, but also makes selection quicker and easier.
- Proper storage can also increase the life of slings and help avoid rigging failure.

MODULE 3 QUIZ 4

PPT slide 131, SG page 66



Instruction

- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This is question 12 on the pre-course test.*

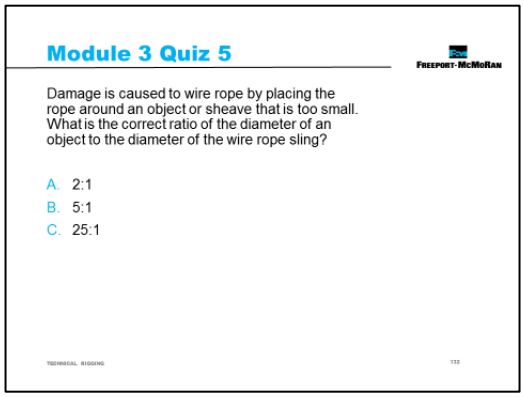
Quiz Answers

- Answer: A. The clip is applied to the live end, and the bolt to the dead (cut) end of the wire rope.

  The saddle should never be placed on the dead end or "horse" because as the U-bolt is tightened down, it often crushes the wire rope – we want the crushing to be on the dead end. The saddle never goes over the dead end.

MODULE 3 QUIZ 5

PPT slide 132, SG page 66



Instruction

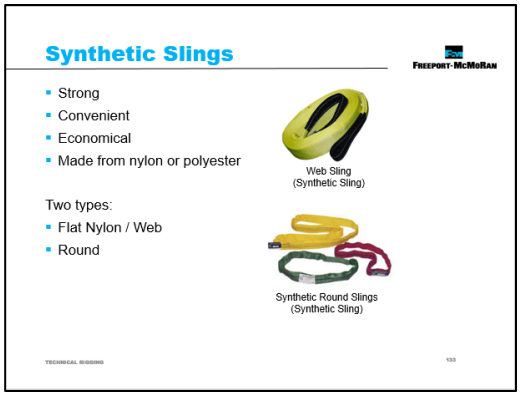
- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This is question 12 on the pre-course test.*

Quiz Answers

- Answer: C. 25:1

  The object that you are choking should be 25 times larger than the diameter of the rope being used.

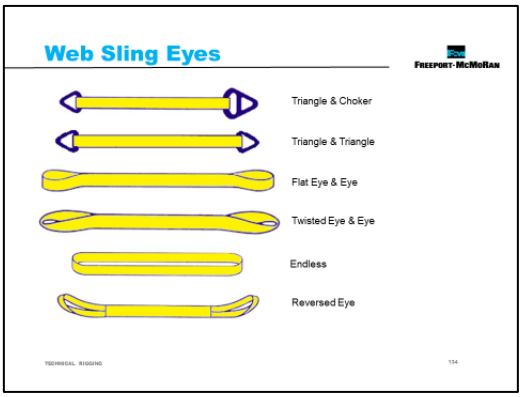
PPT slide 133, SG page 67



Instruction

- Synthetic slings are strong, convenient and economical, and are generally made from nylon or polyester type yarns.
- There are two types of synthetic slings used at Freeport-McMoRan:
    - Web Slings
    - Round Slings.

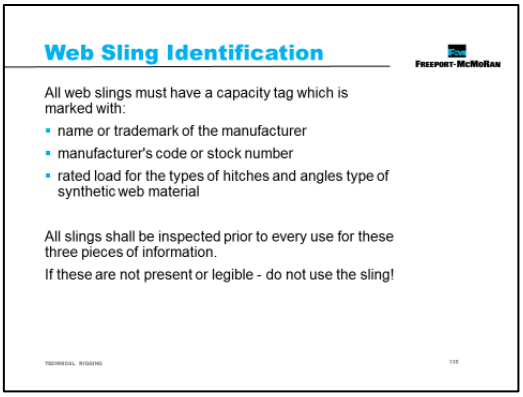
PPT slide 134, SG page 67



Instruction

- Web Slings are flat, and made from nylon or polyester yarns, i.e. synthetic fibers.
- Web slings tend to have an eye at either end:
    - Triangle and Choker: Hardware on each end produces the most effective choker hitch.
    - Triangle and Triangle: Hardware on each end for use in basket or vertical hitch.
    - Flat Eye and Eye: Popular, versatile sling used in vertical, choker and basket hitches.
    - Twisted Eye and Eye: Eyes turned at a right angle to sling body. Forms superior choker hitch and allows better fit on crane hook in basket hitch.
    - Endless: Economical and adaptable sling with no fixed wear points. Used in all hitches.
    - Reversed Eye: Extremely strong and durable for continuous and/or abusive applications. Wear pads on both sides of body.
- *Run through the diagrams / descriptions.*

PPT slide 135, SG page 68



Instruction

- *Run through bullet points.*
- All slings shall be inspected prior to every use for these three pieces of information.
- If these are not present or legible - do not use the sling!

[22] American Society of Mechanical Engineers, B30.9, Slings: Synthetic Webbing, Section 9-5.7, Sling Identification, 9-5.7.1 Identification Requirements

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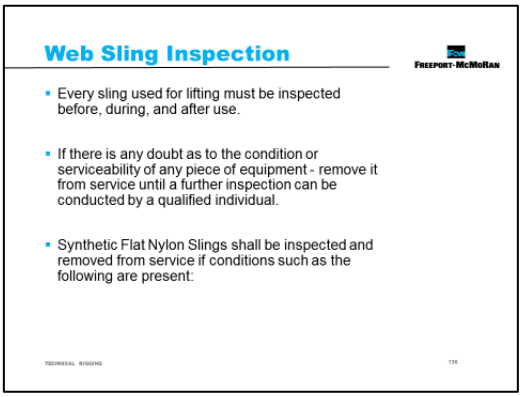
PPT slide 136, SG page 68



Instruction

- *Run through the bullet points.*

[23] American Society of Mechanical Engineers, B30.9, Slings: Synthetic Webbing, Section 9-5.9, Inspection, Removal, 9-5.9.4 Removal Criteria

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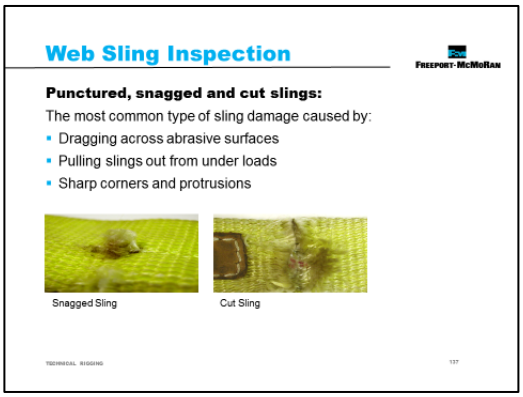
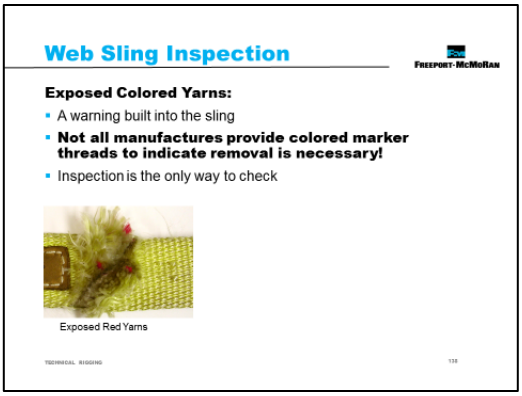
PPT slide 137, SG page 68



Instruction

- Punctured, snagged or cut slings are the most common type of damage.
    - Usually this is caused by dragging slings across abrasive surfaces.
    - Never set loads down on top of slings, or pull slings out from under loads.
    - Protect slings when they are wrapped around sharp corners or protrusions.

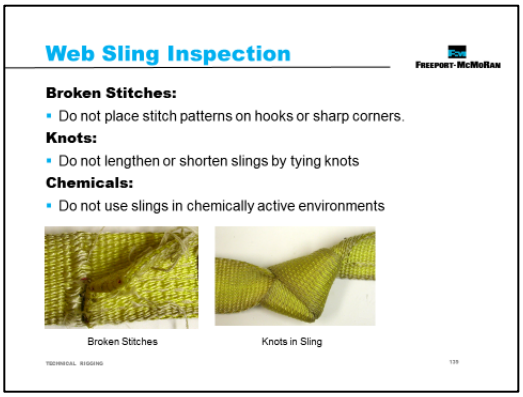
PPT slide 138, SG page 69



Instruction

- Sometimes when slings are damaged, we can see exposed colored yarns.
- This is a warning built into the sling however:
  - Note: Not all manufactures provide colored marker threads to indicate removal is necessary!
- Regular and detailed inspection is the only way to check that slings are good for use.

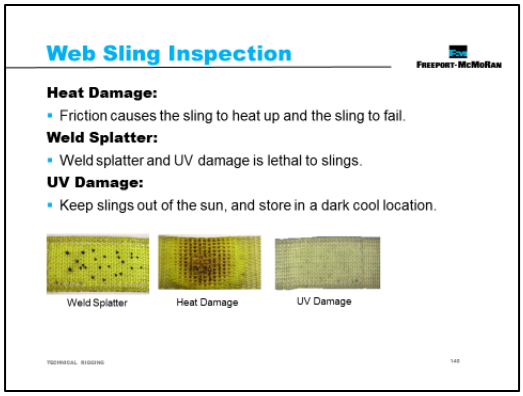
PPT slide 139, SG page 69



Instruction

- Broken stitches usually occur when stitching is put against sharp corners, or bent while in a tight choker.
- Always protect this part of the sling,
  - Do not place stitch patterns (laps) on hooks, around sharp corners, or at choker bearing points.
- Do not be tempted to lengthen or shorten synthetic flat slings by tying knots!
- The strength of synthetic slings can also be affected by chemically active environments.
  - Slings may be susceptible to damage from caustic or acid substances, vapors, or fumes.
  - When slings are required to be used in these conditions the manufacturer should be consulted.

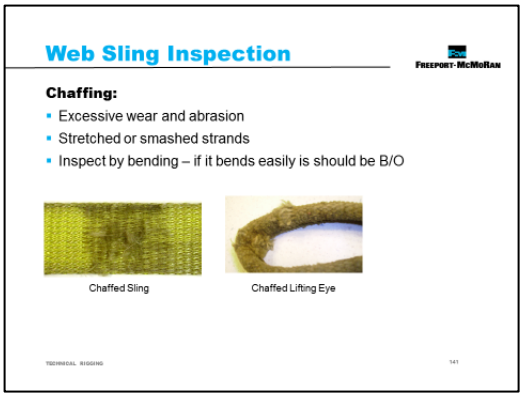
PPT slide 140, SG page 70



Instruction

- Web Slings should never be in contact with an object or temperatures above 194°F or below -45°F.
- Heat damage can also be caused by friction:
  - If the load is not properly centered in a choker or basket hitch, the sling can slide while being lifted trying to adjust. This friction will cause the sling to heat up and possibly fail.
- Weld splatter is also lethal to synthetic slings.
  - Never weld anything hung from a sling, and keep synthetic slings away from areas where hot work is taking place.
  - Regardless of potential splatter slings can sustain UV damage from welding too.
- Nylon and polyester slings are susceptible to damage from ultra-violet light.
  - Discoloration is an indicator of UV damage or caustic chemical exposure.
  - When slings start to look bleached it is time to replace them.
- Store slings in a dark, cool, dry location - always keep them out of the sun when not in use.
- Never throw slings in the back of a truck!

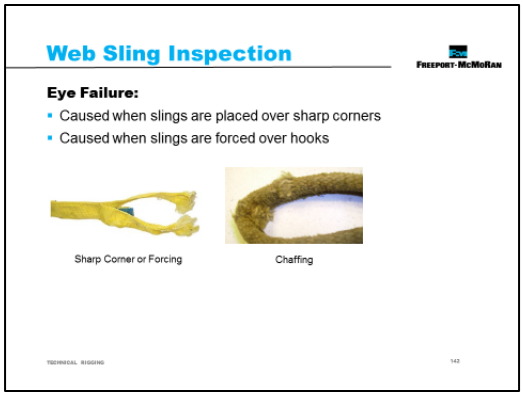
PPT slide 141, SG page 71



Instruction

- Chaffing, excessive abrasive wear, and strands that have been stretched or smashed, are an indication of overloading or improper storage.
- All synthetic slings, over time, will eventually start to chaff. Often this will be in the bite of the sling, if it is used in a tight basket.
- Inspect chaffed slings often, by bending them in worn areas to see if there is internal damage. If the sling bends easier in one location than the rest, then it is damaged and should be discarded.

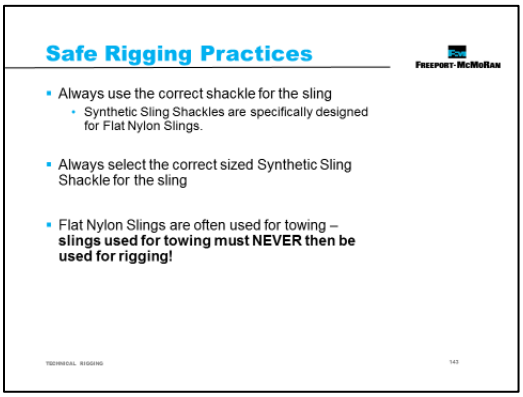
PPT slide 142, SG page 71



Instruction

- The eye failure in the image to the right is probably due to the sling being placed over a sharp corner, or being forced over a hook or pick point that was too wide.
    - Slings that have twisted eyes will fit into hooks and shackles without bunching up and failing.
- Sling eyes should also be inspected for chaffing and wear as shown in the image on the right.

PPT slide 143, SG page 71



Instruction

- Always use the correct shackle for the sling.
- Synthetic Sling Shackles are specifically designed for Web Slings.
    - The flat sling lays flat in the flat shackle without bunching.

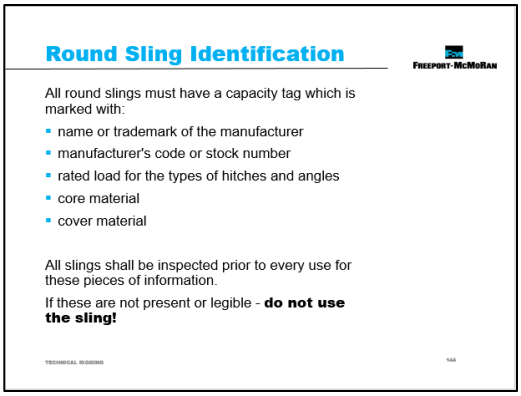
Note: Synthetic Sling Shackles are not always available. When using an anchor shackle make sure that the sling is not bunched or folded in the bow of the shackle.

- Always select the correct sized Synthetic Sling Shackles.
    - Too small a shackle will result in bunching too.
- Web Slings are often used for towing

  – slings used for towing must NEVER then be used for rigging!

If a sling has been used for towing or pulling it should be marked with some sort of identifier so that it can never be used for lifting.

PPT slide 144, SG page 72



Instruction

- Also made from synthetic materials.
- A Round Sling is a continuous loop of yarn, encased in a tough synthetic tubular woven sleeve.
- All round slings must have a capacity tag which is marked with:
    - name or trademark of the manufacturer
    - manufacturer's code or stock number
    - rated load for the types of hitches and angles
    - core material
    - cover material
- All slings shall be inspected prior to every use for these pieces of information.
- If these are not present or legible - do not use the sling!

[24] American Society of Mechanical Engineers, B30.9, Slings: Synthetic Round slings, Section 9-6.7, Sling Identification, 9-6.7.1 Identification Requirements

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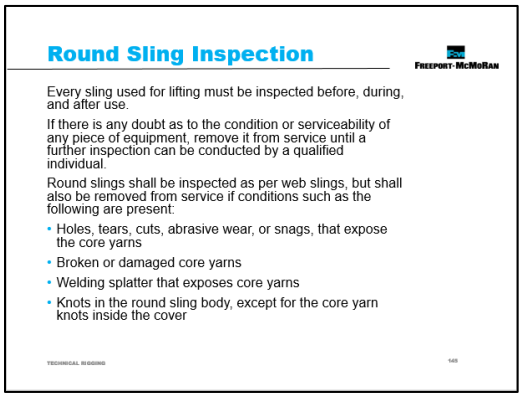
PPT slide 145, SG page 72



Instruction

- Every sling used for lifting must be inspected before, during, and after use.
- If there is any doubt as to the condition or serviceability of any piece of equipment, remove it from service until a further inspection can be conducted by a qualified individual.
- Synthetic round slings shall be inspected as per web slings (pages 68 to 71).
- However, round slings shall also be removed from service if conditions such as the following are present:
    - Holes, tears, cuts, abrasive wear, or snags, that expose the core yarns
    - Broken or damaged core yarns
    - Welding splatter that exposes core yarns
    - Knots in the round sling body, except for the core yarn knots inside the cover

[25] American Society of Mechanical Engineers, B30.9, Slings: Synthetic Roundslings, Section 9-6.9, Inspection, Removal, 9-6.9.4 Removal Criteria

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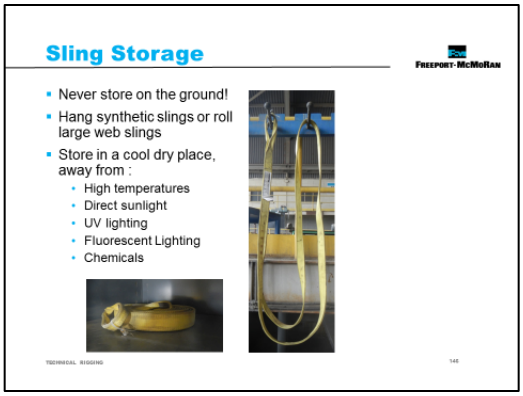
PPT slide 146, SG page 73

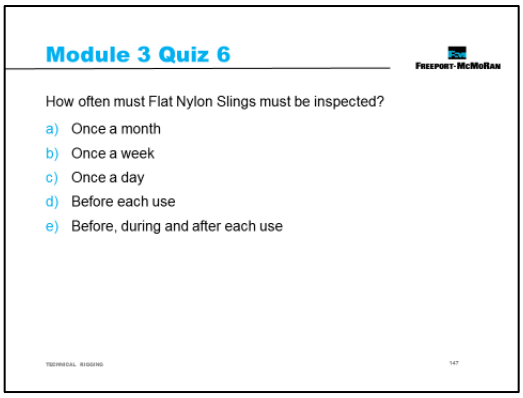


Instruction

- Never store slings on the ground!
- In addition to being a tripping hazard, there is also risk of damage.
- Slings should be stored away from high temperatures, and out of direct sunlight, UV light, and even fluorescent lighting.
- Keep away from atmospheric or direct contact with chemicals.
- Synthetic slings can be hung, ideally on a storage rack sorted by size, purpose etc., like other types of slings.
- Web slings can also be rolled for storage.
- Large web slings are typically rolled and stored on pallets.

MODULE 3 QUIZ 6

PPT slide 147, SG page 74



Instruction

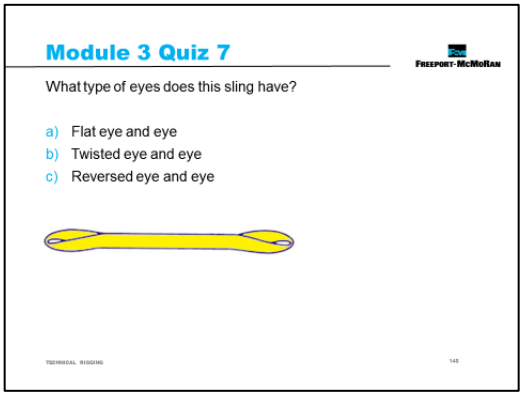
- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This is question 14 on the pre-course test.*

Quiz Answers

- Answer: E. Before, during and after each use

MODULE 3 QUIZ 7

PPT slide 148, SG page 74



Instruction

- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This is question 15 on the pre-course test.*

Quiz Answers

- Answer: B. Twisted Eye and Eye

MODULE 4: HITCHES

This module discusses the methods of attaching slings to a load.

LEARNING OBJECTIVES

Upon completion of module, students will be able to:

- Identify the different types of hitches and their uses.
- Recall hitch capacity reductions and apply safe rigging practices.

ACTIVITIES

Quizzes:

- 3 quiz questions at the end of the module.

MATERIALS

Demonstrate / pass examples of hitches around during this module:

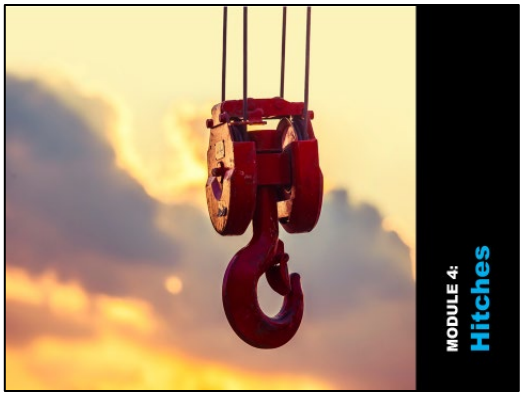
- Single Leg / Vertical Hitch
- Choker Hitches
- Basket Hitch
- Bridle Hitch

FACILITATION

This module contains a brief introductory slide on the four main types of hitches on slide 150. Do not go into detail on the introductory slides, all items will be covered thoroughly in the module.

There is a single slide description of single leg / vertical hitches, then the module is split into two sections: Choker Hitches and Basket Hitches. Both sections have an introductory slide, followed by detailed information on the four types of Choker / Basket Hitches.

PPT slide 149, SG page 77



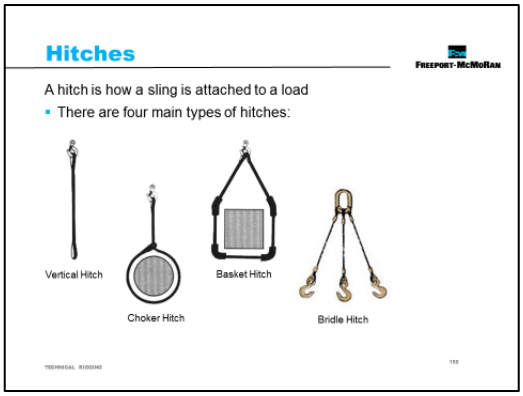
Instruction

Go over the learning objectives for the module.

Upon completion of this module, students will be able to:

- Identify the different types of hitches and their uses.
- Recall hitch capacity reductions and apply safe rigging practices.

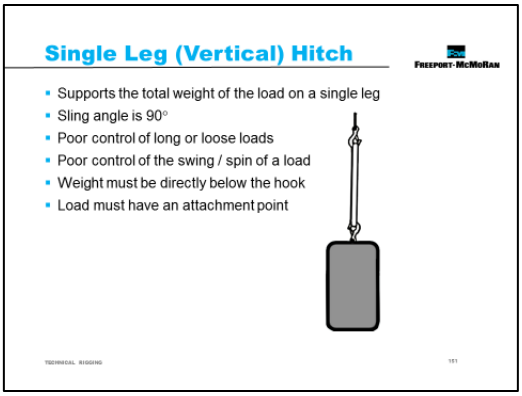
PPT slide 150, SG page 78



Instruction

- A hitch is the method by which a sling is attached to a load.
- You have selected the correct hardware and sling for your lift. Now you must select the correct hitch for the job.
- There are four main types of hitches:
    - Vertical hitches are also known as single leg hitches.
        - One eye is attached to the load and the other to the hook, on a vertical (90°) sling angle.
    - Choker hitches are where the sling passes around the load and through one eye.
        - The sling passes around the load and through one eye, and therefore has less than 360° contact with the load.
        - This also creates an ‘angle of choke’ resulting in a choker hitch having only 70 – 80% of the capacity of the vertical hitch.
    - Basket hitches are where the sling passes around the load, but both legs are attached to a hook (or hooks).
        - This allows twice the capacity of a vertical hitch, however, the load must be balanced.
        - When using a choke or basket hitch, a double wrap method can be used to help prevent slippage.
    - Bridle hitches are where two or more legs are attached to one master link.
        - Provides good stability and weight distribution as the lifting hook is directly over the load's center of gravity.
        - Note: when three or four sling legs are used, two legs will be carrying the weight of the load while the other legs act to balance it.

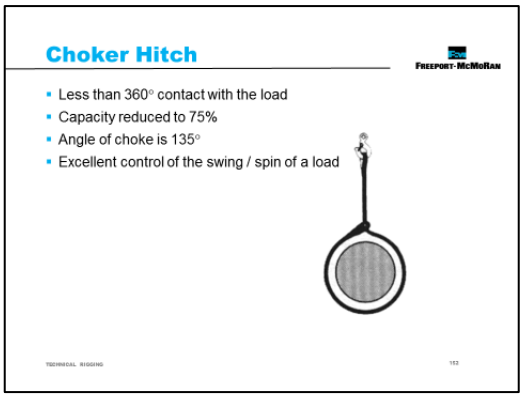
PPT slide 151, SG page 79



Instruction

- The Single Leg Vertical Hitch supports the total weight of the load on a single leg.
- The sling angle is 90°.
- It should not be used for lifting loose or lengthy loads, such as pipes or rods, or loose bundles of materials,
    - it provides very little control over the load
    - it also offers poor control of the swing and spin of the load.
- Should only be used on loads where the bulk of the weight is concentrated directly below the hook, and the load is equipped with a rated eye bolt, shackle or attachment point.
- Multiple single leg vertical hitches can be used in tandem, on a spreader bar or lifting beam, (as discussed in Lifting Beams, page 39 of the SG.)

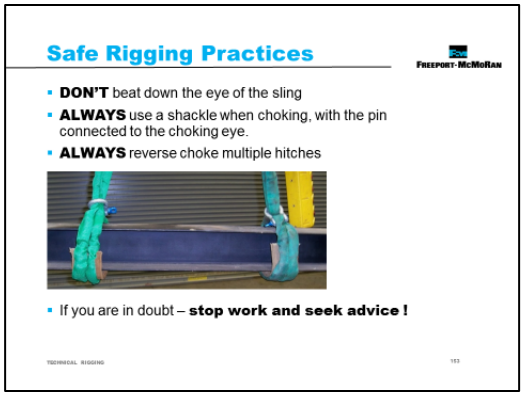
PPT slide 152, SG page 79



Instruction

- A choker hitch has minimal grip because it has less than 360° contact with the load.
    - (A double choker however, has excellent grip because it has full contact with the load. See slide 157, SG page 82.)
- When a sling is being used in a choker hitch there is a reduction in its rated capacity, usually to around 75% of a vertical hitch, due to the ‘angle of choke’.
- If a load is hanging free, the normal choke angle is approximately 135°.
    - This is a “true” choker hitch - approximately 75% of the capacity of the vertical hitch, e.g., if the capacity of a sling in a vertical hitch is 12,000 lbs., then the capacity in a true choker hitch would be around 9,000 lbs.
    - The key word here is “true.”
- Choker hitches offer excellent control of the load, with little swing or spin.

PPT slide 153, SG page 80



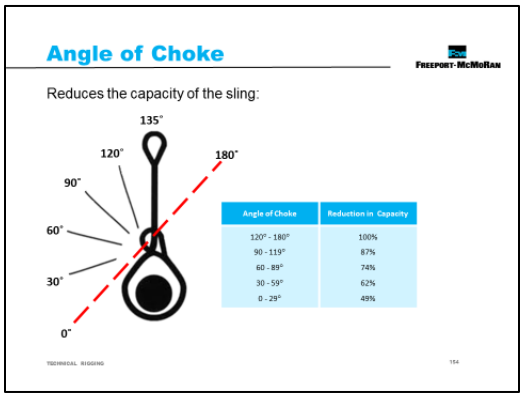
Instruction

Best Practice and practices to avoid when using choker hitches:

- If the eye of the sling is beat down on the load, the capacity is further reduced.
    - This is where the sling eye has been forced down the other side of the sling and onto the load.
    - This reduces the capacity as it further reduces the sling angle.
- Always use a shackle when choking.
- Always connect the pin to the choking eye of the sling.
    - This avoids spinning the pin as the load tightens, which would tighten or loosen it.
- Always reverse choke multiple hitches: One sling shall be choked in one direction around the load, and the other sling is choked in the opposite direction, as shown in Figure 4.9. This keeps the load even and symmetrical stopping it from twisting or rolling over.

If you are in any doubt as to the effectiveness or safety of the hitch, stop work, and seek advice from a qualified individual.

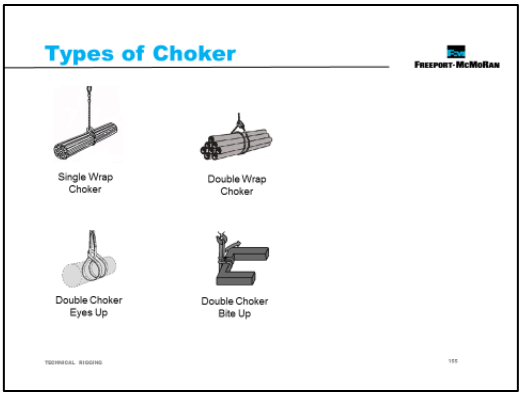
PPT slide 154, SG page 81



Instruction

- When a choker hitch is used at an angle of less than 120°, you must reduce the hitch's rated capacity, as shown in the table below.
- Manufacturers recommend a choker hitch is never used in an angle less than 30°, however, an angle of 120° or more is ideal.
    - Although we can calculate low angles of choke, we should always avoid using them!
- Some hitches used with specific hardware can avoid a reduction in capacity, for example when using cradle grab hooks with chain slings, the reduction in capacity is 0.

PPT slide 155, page 82

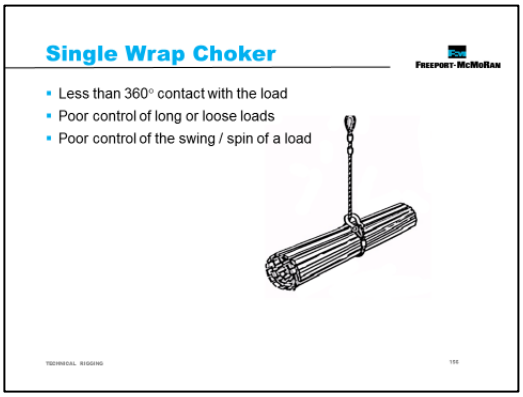


Instruction

There are four main variations of chokers that are commonly used:

- Single Wrap Choker
- Double Wrap Choker
- Double Choker Eyes Up
- Double Choker Bite Up

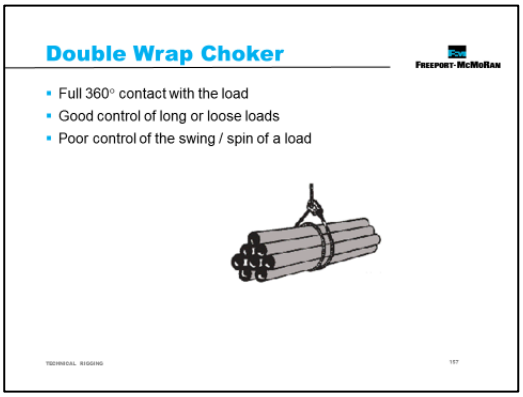
PPT slide 156, SG page 82



Instruction

- The Single Wrap Choker hitch forms a noose around the load.
- It does not provide full 360° contact with the load.
- Should be avoided when lifting difficult to balance or loosely bundled loads.
- It also offers poor control of the swing and spin of the load.
- Can be doubled up to provide twice the capacity.
    - Doubling a single choker hitch is not the same as using a double choker hitch.

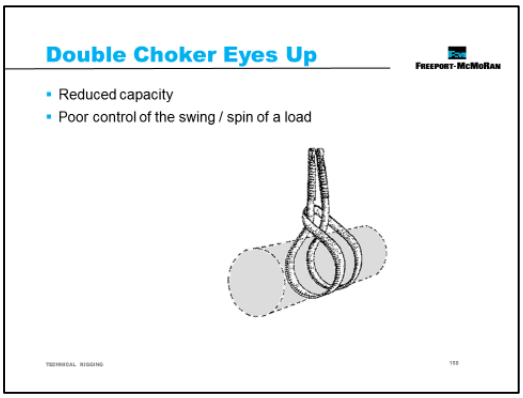
PPT slide 157, SG page 82



Instruction

- A double wrap choker is completely wrapped around the load.
- It is in full 360° contact with the load, drawing it tightly together, and is therefore good for loose bundles.
- It offers poor control of the swing and spin of the load.
- Can be used singly on short easily balanced loads, or in pairs on longer loads.
    - If two slings are used, the second sling should be reverse choked.

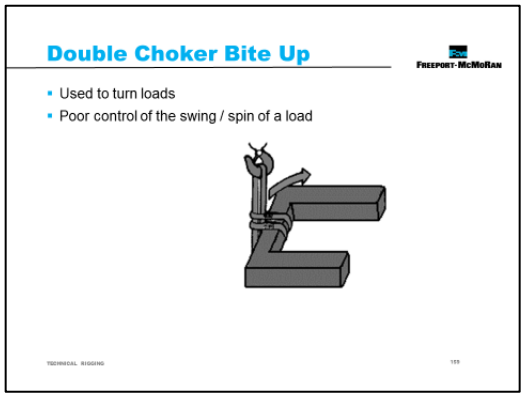
PPT slide 158, SG page 82



Instruction

- A double choker eyes up, is made by putting the eyes through the bite of the sling and hanging them on the hook.
- However, if you are going to double up the slings into a double choker it is better not to have the eyes up, since the sling won't be able to adjust itself, resulting in one of the legs having more tension than the other, thus reducing its capacity.
- It offers poor control of the swing and spin of the load.

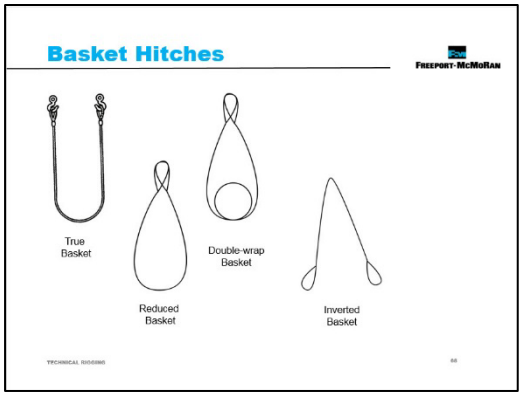
PPT slide 159, SG page 82



Instruction

- The double choker, bite up, is a better choice than eyes up, and can be used to turn loads.
- However, the Double Choker Bite Up offers poor control of the swing and spin of the load.

PPT slide 160, SG page 83

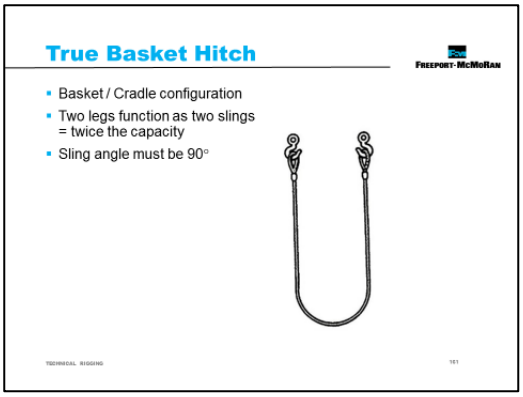


Instruction

These are the four commonly used variations of basket hitches:

- True Basket
- Reduced Basket
- Double Wrap Basket
- Inverted Basket

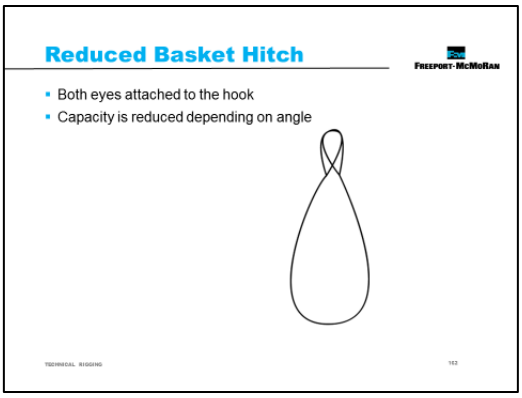
PPT slide 161, SG page 83



Instruction

- A basket hitch has a basket / cradle configuration.
- This allows the two extending ends (legs) of the sling to function as if they were two separate slings.
    - The capacity of the sling is therefore twice that of a vertical hitch,
    - but only if the sling angle of each leg is 90°.
- Lifting with both legs at 90° would normally require two lifting devices or a spreader bar, (see page 39).

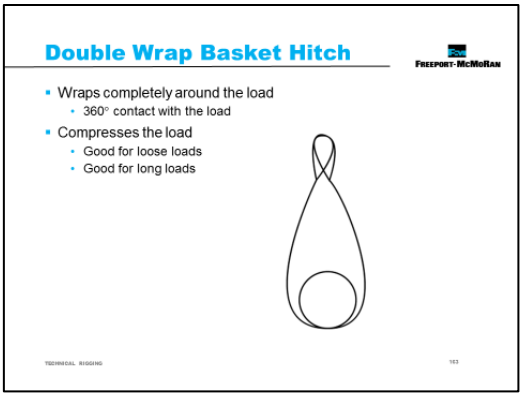
PPT slide 162, SG page 83



Instruction

- A reduced basket is where both eyes are attached to the hook.
- The capacity is reduced depending on the angle of the two legs.
- Like the vertical hitch the basket hitch is excellent for loads that have a pick point / hook directly above the center of gravity.

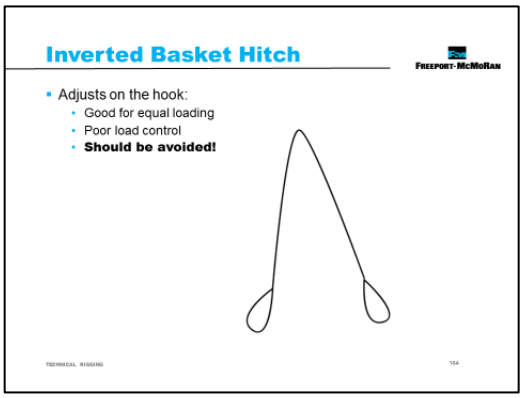
PPT slide 163, SG page 83



Instruction

- The double-wrap basket is wrapped completely around the load, compressing it rather than just supporting it.
- Because the sling is in full 360° contact with the load and tends to draw it together.
- Double wrap basket hitches can be used in pairs, which is particularly useful for loose loads, long loads, and/or smooth cylindrical loads such as pipe or rods.

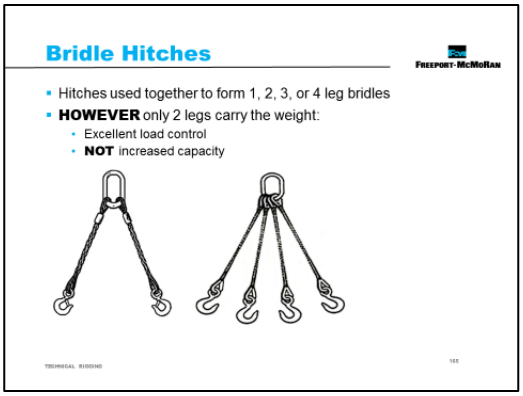
PPT slide 164, SG page 83



Instruction

- An inverted basket hitches main advantage is that it adjusts on the hook so you get equal leg loading.
- However, this hitch has several disadvantages:
    - It adjusts on the hook and so provides poor load control.
    - It complicates the D:d ratio (as discussed in Wire Rope).
    - It affects the shackle. It can crimp and bend the rope.
- The use of an Inverted Basket hitch should therefore be avoided.

PPT slide 165, SG page 84

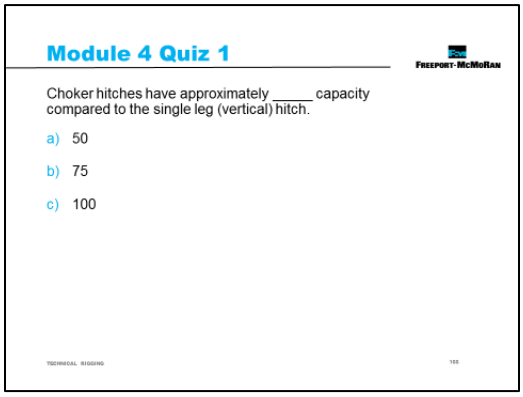


Instruction

- Hitches can be used together to form a two, three or four leg bridle.
- They are used for hoisting loads that are equipped with the rated attachment points.
- The legs are then attached in a fitting, to a lifting hook or gather.
- In multiple leg slings, where three or four legs are used, two legs will carry the weight of the load while the other legs balance it.
    - A bridle hitch proves better load control NOT increased capacity!
- Bridle hitches provide excellent load stability:
    - The hook is positioned directly over the load's center of gravity; the load is raised level, however, to distribute the load equally it may be necessary to adjust the leg lengths.
- Proper use of a bridle hitch requires that the increased tension caused by sling angles be carefully measured to ensure that the sling is not overloaded.
- Bridle hitches can have complex load angles and an offset center of gravity.
- Also, remember that three and four legged bridles require calculating the lift capacity on two legs.

MODULE 4 QUIZ 1

PPT slide 166, SG page 85



Instruction

- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This is question 16 on the pre-course test.*

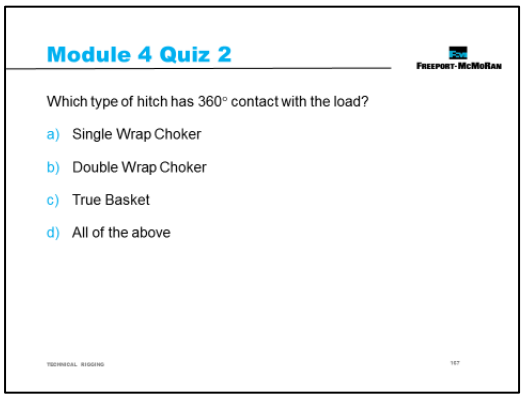
Quiz Answers

- Answer: B. 75%

  When a sling is being used in a choker hitch there is a reduction in its rated capacity, usually to around 75% of a vertical hitch, due to the 'angle of choke'.

MODULE 4 QUIZ 2

PPT slide 167, SG page 85



Instruction

- *Students will write answers to the quiz questions in their SG.*
- *Review the answers as a class.*
- *Note: This is question 17 on the pre-course test.*

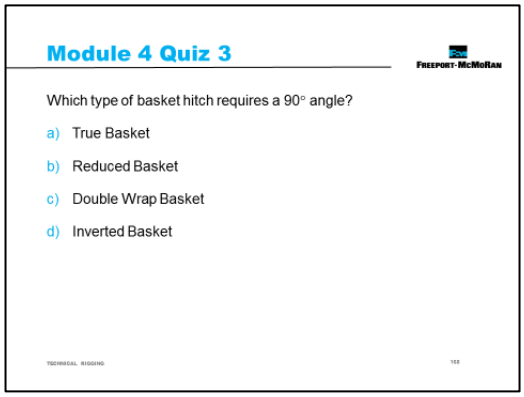
Quiz Answers

- Answer: B. Double Wrap choker

  A double wrap choker is completely wrapped around the load. This hitch is therefore in full 360° contact with the load, drawing it tightly together which is particularly good for loose bundles.

MODULE 4 QUIZ 3

PPT slide 168, SG page 85



Instruction

- *Students will write answers to the quiz questions in their SG .*
- *Review the answers as a class.*

Quiz Answers

- Answer: A. True Basket

  Two legs function as two slings, which gives us twice the capacity, however, the sling angle must be 90°

MODULE 5: HOISTS & LIFTERS

This module contains information about hoists and lifters, and their inspection and maintenance requirements.

LEARNING OBJECTIVES

Upon completion of module, students will be able to:

- Identify the different types of hoists and lifters and their uses.
- Conduct hoist inspections, recognize defects, and understand maintenance requirements.
- Recall hoist regulations and apply safe rigging practices.

ACTIVITIES

Quizzes:

- 4 quiz questions at the end of the module.

MATERIALS

Demonstrate / pass examples of portable hoists around during this module:

- Lever Hoists / Come Alongs
- Chain Hoists

PREPARATION

Slide 117, Site Specific Notes:

- Facilitator should research and record their site specific Hoist Maintenance procedure.

FACILITATION

This module contains a brief introductory slide on the four main types of hoists on slide 170. Do not go into detail on the introductory slide as the four types of hoist are then discussed on individual slides.

After discussing the four types of hoists, the module contains general hoist topics: Safe Rigging Practices, Maintenance, Identification, and Inspection.

PPT slide 169, SG page 89

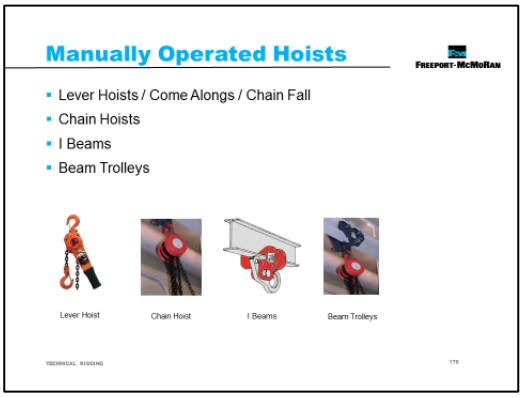
Instruction

Go over the learning objectives for the module.

Upon completion of this module, students will be able to:

- Identify the different types of hoists and lifters and their uses.
- Conduct hoist inspections, recognize defects, and understand maintenance requirements.
- Recall hoist regulations and apply safe rigging practices.

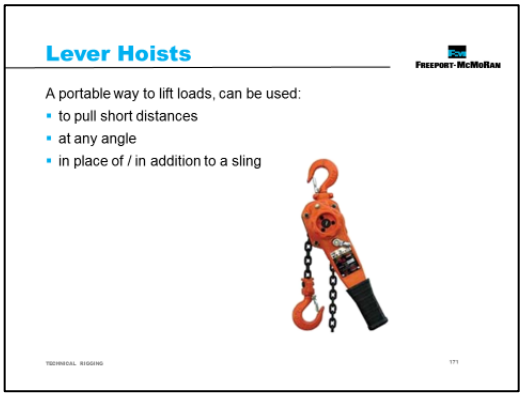
PPT slide 170, SG page 90



Instruction

- Lever Hoists
  - also known as Come Alongs / Chain Fall
- Chain Hoists
- I Beams
- Beam Trolleys

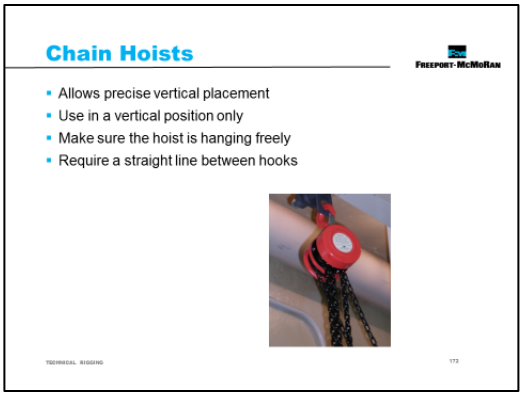
PPT slide 171, SG page 90



Instruction

- Lever Operated Hoists are a portable way to lift loads.
- They can also be used to pull loads short distances, (which is why they are also often referred to as come alongs.)
- They can be used at any angle in place of a sling, or in addition to a sling to increase its length.
- A hoist that requires the use of a cheater, or the help of another worker to move a load, is inadequate for the job - a hoist with the correct capacity should be used!

PPT slide 172, SG page 90

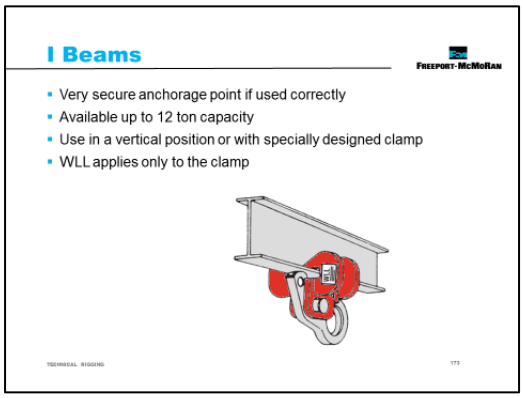


Instruction

Chain hoists are useful as they travel slowly, and can be stopped and kept stationary at any point, allowing precise vertical placement of loads.

- Chain hoists should always be rigged so that there is a straight line between the upper and lower hooks.
    - They are intended for use in a vertical or near vertical position only.
    - If rigged at an angle, the upper hook can be damaged at the shank and the throat may open up.
- If the gear housing is resting against an object while under load it can be damaged or broken. Always make sure that the hoist is hanging freely.

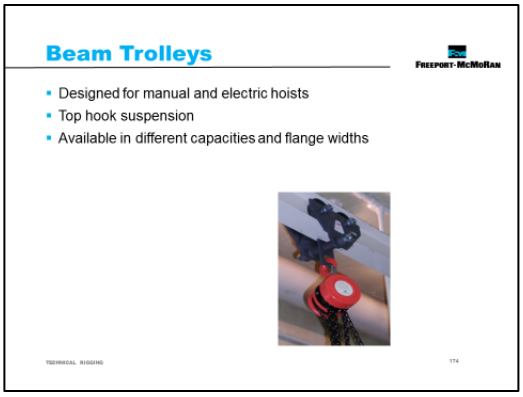
PPT slide 173, SG page 91



Instruction

- Beam clamps provide a very secure anchorage point if used correctly:
    - They should be centered on the beam flange and properly seated.
- Beam clamps are available with capacities up to 12 tons, with various jaw widths.
- They are designed for use at 90° to the flange.
    - For applications requiring angled loading, make sure that the clamp is designed for it and that the beam can withstand it.
    - Be careful that the load does not deform the flange, particularly in light sections where the flange is wide and thin.
- Manufacturers are required to mark beam clamps with working load limits but the ratings apply only to the clamps - the capacity of the beam must be evaluated separately.
- Chain hoists, come-alongs, and other rigging devices all require secure anchorage points.
    - Anchor points could be overhead, in the floor, or in walls or other structures.
    - The rigging could involve a variety of devices, such as beams, slings, or blocks.
    - Whatever the method, the working load limit needs to be applied to the anchorage as well as the rigging devices.
- Note: Never use an anchorage point which is intended for fall protection.

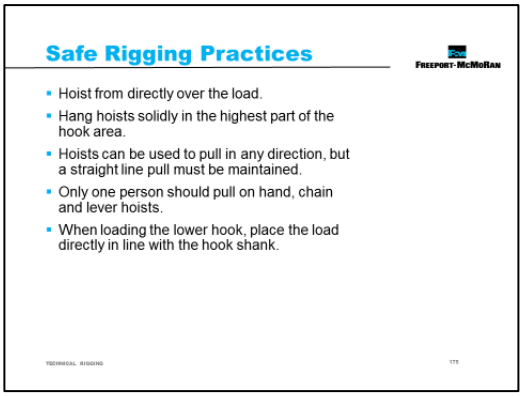
PPT slide 174, SG page 91



Instruction

- Trolleys are designed for both manual and electric operated hoists with a top hook suspension.
- Both the Push Trolley and Hand Geared Trolley are easily adjusted for a wide range of flange widths, and are available in many different capacities.
- Hand-pushed overhead I-beam trolleys are suitable for carrying a wide range of equipment such as: Tools, Power Tools, Hoists, and Welding Apparatus
- Determining the correct size of Overhead Beam Trolley will depend upon:
    - The capacity you require, or the total load that the trolley will be carrying.
    - The type and size of beam the overhead trolley be riding on.

PPT slide 175, SG page 92



Instruction

How should you use a hoist safely?

- Hoist from directly over the load.
    - If not centered, the load may swing when lifted.
- Hang hoists solidly in the highest part of the hook area.
    - The hook support is then directly in line with the hook shank.
- Only one person should pull on hand, chain and lever hoists.
- When loading the lower hook, place the load directly in line with the hook shank.
    - The load chain then makes a straight line from hook shank to hook shank.

FACILITATION NOTE

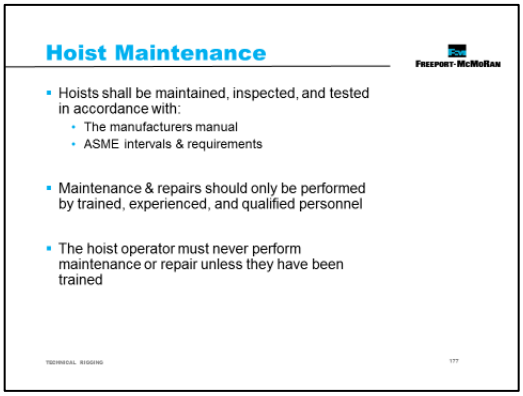
Refer to Appendix 2 at the back of the Student Guide, for a comprehensive list of ‘Hoist Operators Do’s & Don’ts.

PPT slide 176, SG page 92

Instruction

- Hoists can be used to pull in any direction, but a straight line pull must be maintained.
    - Side pulling increases wear and dangerous stress levels on the hoist.
- In the left hand photo we can see that the chain is wrapped around the handrail. (Plus the hook is hooked onto the beam, and is tip loaded.)
- The right hand photo is actually the other end of the hoist – the chain is going around the conduit.

PPT slide 177, SG page 93



Instruction

- Hoists should be inspected and maintained in accordance with the manufacturer's manual and at the intervals stated in ASME B30.20.
- The frequency of inspections depends upon whether the crane is used frequently or periodically, and it's exposure to wear, deterioration and malfunction.
- Hoist inspection, maintenance, and repair depends upon the conditions, policies, and practices of the owner, which are determined by
    - the size of the operation and number of employees,
    - the availability of trained and experienced in-house maintenance persons,
    - and the type of hoist.
- Hoists should be visually inspected prior to each use, and a complete inspection performed annually.
    - Covers are removed for the thorough annual inspection, which includes all internal components.
    - A detailed inspection report records the annual inspection.
- Inspection, maintenance, and repair should be performed only by trained, experienced, and qualified personnel.

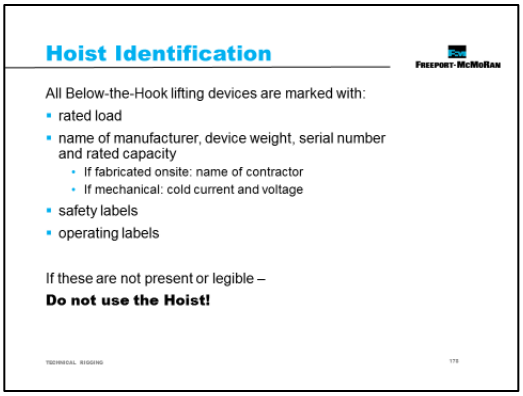
The hoist operator cannot provide maintenance or repair, unless they are trained, qualified and designated by the hoist owner.

FACILITATION NOTE

Discuss site specific procedure. Students are to record details of site specific procedure in the notes section of their Student Guide – p93. Record your notes on the next page:

SITE SPECIFIC NOTES

PPT slide 178, SG page 94



Instruction

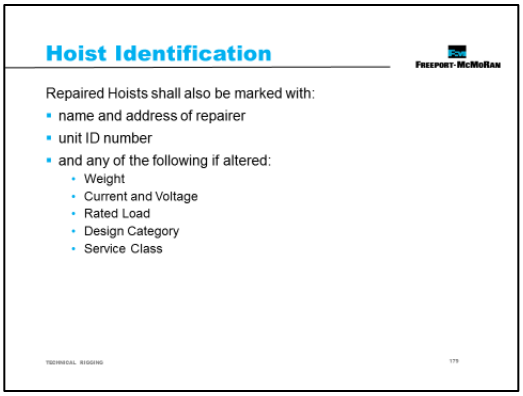
All below-the-hook lifting devices are marked with:

- The rated load
    - On the main structure and all detachable lifting parts
- The manufacturers name, the device weight, serial number, and rated capacity.
    - If the lifting device has been fabricated onsite, it should be marked with the contractor's name.
    - Mechanical lifting devices shall also be marked with the cold Current and Rated Voltage.
- Safety labels which provide warnings against;
    - exceeding the rated load,
    - operating a damaged hoist,
    - making alterations to a hoist,
    - lifting people,
    - lifting over people,
    - leaving suspended loads unattended,
    - lifting loads too high,
    - and removing said labels
- Operating labels describing
    - the function of each control
    - the result of each control

Hoists should be inspected prior to every use for these pieces of information. If these are not present or legible - **do not use the Hoist!**

[26] American Society of Mechanical Engineers, B30.20.2013 Below-the-Hook Lifting Devices, Chapter 20-1 Structural and Mechanical Lifting Devices, Section 20-1.2: Marking, Construction, and Installation, 20-1.2.1 Marking

PPT slide 179, SG page 94



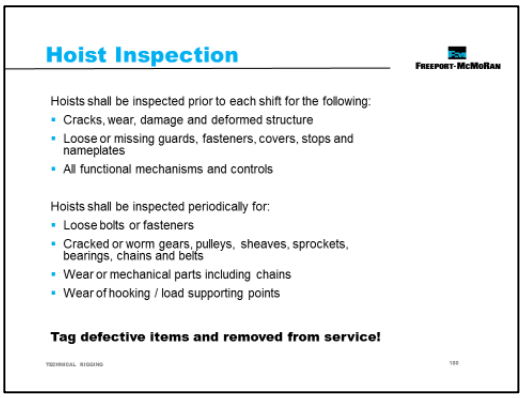
Instruction

Repaired or altered hoists shall also be marked with

- the repairers name and address
- and unit identification number,
- and any of the following if altered;
    - weight,
    - current and voltage,
    - rated load,
    - design category
    - and service class.

[27] American Society of Mechanical Engineers, B30.20.2013 Below-the-Hook Lifting Devices, Chapter 20-1 Structural and Mechanical Lifting Devices, Section 20-1.2: Marking, Construction, and Installation, 20-1.2.1 Marking

PPT slide 180, SG page 94



Instruction

The operator or designated person shall visually inspect each lifting device at the beginning of each shift, or prior to use if the hoist has not been in regular service.

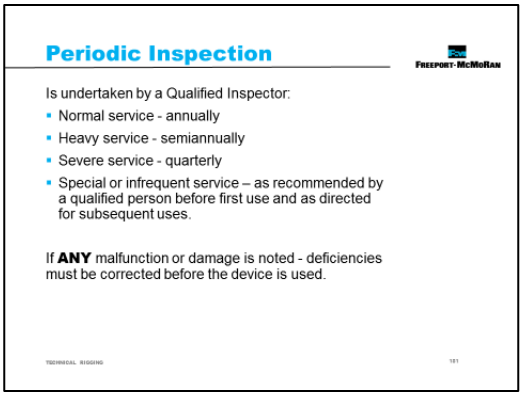
Inspection of the following items or conditions is required:

- Hoists should be inspected every working day for the following:
    - Cracks, wear, damage and deformed structure
    - Loose or missing guards, fasteners, covers, stops and nameplates
    - All functional mechanisms and controls
- Hoists should be inspected periodically for:
    - Loose bolts or fasteners
    - Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains and belts
    - Wear or mechanical parts including chains
    - Wear of hooking / load supporting points
- If ANY malfunction or damage is noted during inspection,
    - the hoist should not be operated,
    - the operator should contact their supervisor so that it can be corrected.
    - Defective items should be tagged and removed from service.
    - Operators should also be aware that damage / malfunction can occur during operation, even after a thorough inspection. If so,
        - the operator should immediately stop working,
        - and contact their supervisor so that malfunction / damage can be corrected.

If there is any doubt as to the condition or serviceability of any piece of equipment, remove it from service until a further inspection can be conducted by a qualified individual.

[27] American Society of Mechanical Engineers, B30.20.2013 Below-the-Hook Lifting Devices, Chapter 20-1 Structural and Mechanical Lifting Devices, Section 20-1.3: Inspection, Testing and Maintenance, 20-1.3.3 Frequent Inspection (See Also Table 20-1.3.3-1 Minimum Inspection for Below-the-Hook Lifting Devices)

PPT slide 181, SG page 95



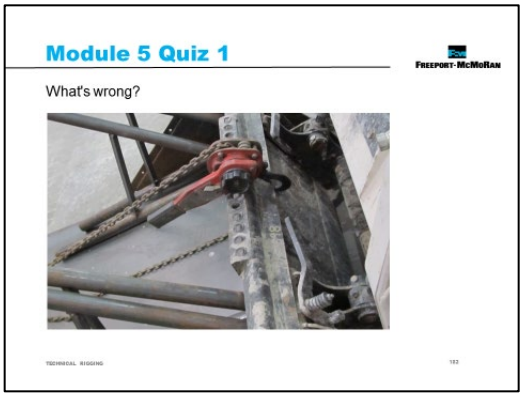
Instruction

- Periodic inspection of lifting devices, by a qualified inspector, is also required.
- If ANY malfunction or damage is noted during inspections, the deficiencies must be corrected before the device is used.
    - Normal service (annually):
        - Inspect equipment on site.
    - Heavy service (semiannually):
        - Inspect equipment on site, unless disassembly is required for detailed inspection.
    - Severe service (quarterly):
        - Inspect equipment on site, unless disassembly is required for detailed inspection.
    - Special or infrequent service:
        - As recommended by a qualified person before the first use.
        - As directed by the qualified person for any subsequent uses.

[28] American Society of Mechanical Engineers, B30.20.2013 Below-the-Hook Lifting Devices, Chapter 20-1 Structural and Mechanical Lifting Devices, Section 20-1.3: Inspection, Testing and Maintenance, 20-1.3.4 Periodic Inspection (See Also Table 20-1.3.3-1 Minimum Inspection for Below-the-Hook Lifting Devices)

MODULE 5 QUIZ 1

PPT slide 182, SG page 96



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

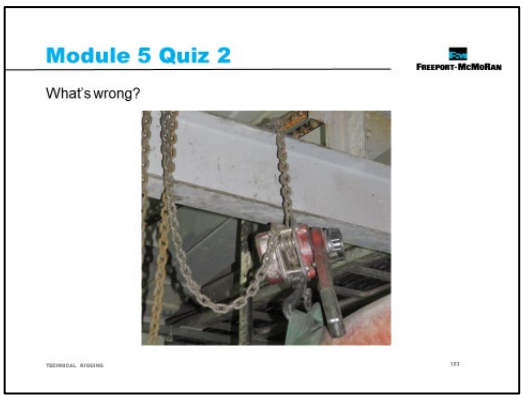
Quiz Answers

- Answers: The chain is not in alignment with the actual hoist, i.e. not in a straight line pull.

  The hoist is tip loading the hook. Tip loading reduces the capacity of the hook by as much as 60%.

MODULE 5 QUIZ 2

PPT slide 183, SG page 96



Instruction

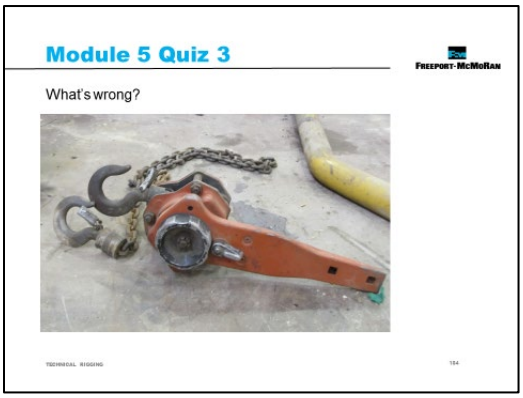
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

- Answer: The sling is not completely seated in the hook, and the chain is over the sharp edges of the beam and needs a softener.

MODULE 5 QUIZ 3

PPT slide 184, SG page 97



Instruction

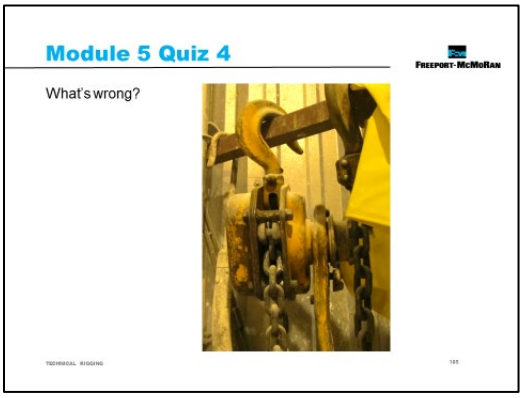
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

- Answer: The safety latches are damaged, and the handle should have a rubber covering. There are no tags, or any form of identification.

MODULE 5 QUIZ 4

PPT slide 185, SG page 97



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

- Answer: The safety latches are missing and the handle is bent. Photo shows good storage, but the hoist should actually be taken out of service.

MODULE 6: SIGNALS

This module introduces the signals used when lifting loads with cranes, and the responsibilities of the signaler. It also illustrates all standard mobile crane and overhead crane hand signals.

LEARNING OBJECTIVES

Upon completion of module, students will be able to:

- Understand the responsibilities of a signaler.
- Identify and recall the different crane hand signals.
- Recall signal regulations and apply safe rigging practices.
- Understand crane dynamics.

ACTIVITIES

Quizzes:

- 4 quiz questions at the end of the module.

FACILITATION

This module contains an introduction to types of signals and signal regulations. Each standard hand signal is then discussed on an individual slide, along with crane dynamics.

- Demonstrate the signal and have the students practice.

FACILITATION TIP

According to the Law of Primacy, it is imperative for important tasks to be taught the first time correctly. The instructor needs to slow down and approach this part of the presentation in a deliberate manner.

During this portion of the presentation, the instructor should keep in mind the first three steps of the Demonstration Performance Technique: Explain; Demonstrate; Practice. Be sure to give the students time to practice the skill.

As the student's practice these skills keep in mind the law of effect. People learn better from a positive situation versus a negative. Constant negative motivation stifles the learning process.

NOTE

The hand signals used in the course are the standard hand signals according to OSHA, (and MSHA) ASME, and CIA.

Slide 189 lists Hand, Electronic and Voice signal regulations on one slide towards the beginning of the module, followed by the poster regulation, and each individual hand signal. However, the student guide follows the order of the regulations: The hand signal regulation, the poster regulation, each individual hand signal, and then Electronic Signals, and finally Voice Signals.

PPT slide 186, SG page 101

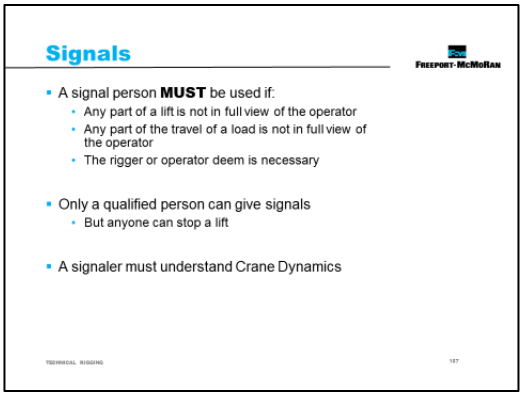
Instruction

Go over the Learning Objectives for the module:

Upon completion of this module, students will be able to:

- Understand the responsibilities of a signaler.
- Identify and recall the different crane hand signals.
- Recall signal regulations and apply safe rigging practices.
- Understand crane dynamics.

PPT slide 187, SG page 102



Instruction

- Although the crane operator is operating the crane:
  - The signal person is directing the lift, and therefore the crane.
  - The signaler is therefore the most important part of a lift!

- A signal person must be used in each of the following situations:
  - If any part of the lift, travel of the load, or placement of the load is not in full view of the operator.
  - When the load is traveling, if any part of the direction of travel is obstructed.
  - If the rigger and / or operator deem it necessary.

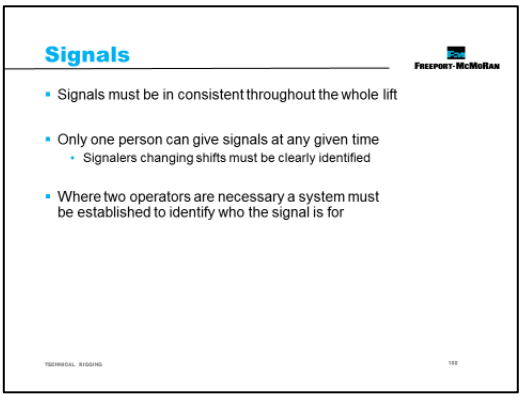
- Only a person who is qualified can give hand signals.
  - A signaler must be trained and evaluated through a written and practical test.

Note: ALL persons working near cranes must understand how to stop a lift when they see a problem - by giving the Emergency Stop or Stop signals.

- As well as knowledge of signals, the signaler must understand Crane Dynamics:
  - Crane Dynamics is the behavior of the crane in response to the actions of the operator.
  - Any sudden movement, such as stopping the crane abruptly, can cause shock loading.
    - Shock loading is when a sudden intense force is placed on a crane, and the crane cannot handle the pressure.
    - This will damage the rigging
    - And cause structural damage to the crane itself.

[29] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Subpart CC Cranes & Derricks in Construction, 1926.1419 Signals – general requirements

PPT slide 188, SG page 102

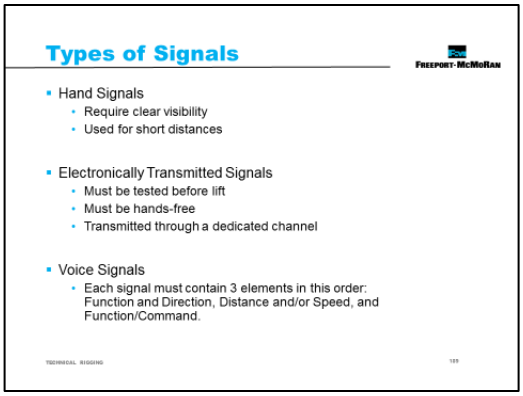


Instruction

- Signaling must be consistent throughout the whole operation.
    - If the operator is unable to receive signals at any point, they must stop the operation until communication is restored.
- Only one person may give signals at any given time.
    - Except for the Stop or Emergency Stop Signals.
    - Anyone who sees a safety problem must alert the operator or signal person by giving the stop or emergency stop signal.
- If signalers are changing shifts, the one in charge should wear a clearly visible badge of authority.
    - This could be a colored hard hat; highly visible gloves, or a unique vest.
- Where loads are picked at one point and lowered at another, two signalers are required:
    - One to direct the lift and one to direct the descent.
    - Where a signaler is in communications with more than one operator, a system must be used to identify who each signal is for.

[29] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Subpart CC Cranes & Derricks in Construction, 1926.1419 Signals – general requirements

PPT slide 189, SG page 103, 107 & 108



Instruction

- Signals to operators must be by;
    - hand,
    - or voice,
    - or audible, (radio, telephone or other electronic transmission).
- Site conditions will determine the type of signal chosen.
- The signal always remains the same.
- The method of signaling will depend upon the conditions.

- Hand Signals (SG page 103)
    - Should only be used where there is clear visibility,
    - and the distance between the operator and the signaler is not great.
    - When using hand signals, the Standard Method must be used.

- Electronic Signals (SG page 107)
    - (radio, telephone or other electronic transmission)
    - Devices must be tested before beginning the operation to ensure the signal is effective, clear, and reliable.
    - The operator must be able to receive signals via a hand a hands-free system.
    - Transmission must be through a dedicated channel.
        - Except where a signaler is in communication with more than one operator e.g. where two cranes are being used, multiple operators can share a dedicated channel for coordination purposes.

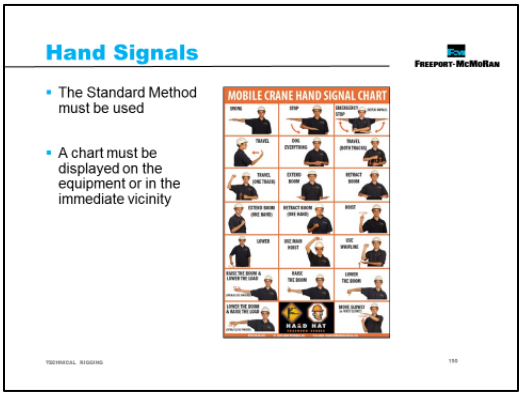
[31] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Subpart CC Cranes & Derricks in Construction, 1926.1420 Signals--radio, telephone or other electronic transmission of signals.

Continued on next page

- Voice Signals (SG page 108)
    - The operator and signaler must contact each other prior starting an operation and agree on the voice signals that will be used.
    - They must be able to effectively communicate in the language used.
    - Each voice signal must contain the following three elements given in the following order:
        - Function and Direction (such as hoist, boom, *etc*.).
        - Distance and/or Speed.
        - Function: Stop command.

[32] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Subpart CC Cranes & Derricks in Construction, 1926.121 Signals--voice signals--additional requirements.

PPT slide 190, SG page 103, 104



Instruction

- Hand signals should only be used where there is clear visibility and the distance between the operator and the signaler is not great.
- When using hand signals, the Standard Method must be used.
- A hand signal chart must be posted either on the equipment or in the immediate vicinity of the hoisting operations. [30]
- The poster shown was produced by Hard Hat Training and illustrates the Standard Hand Signals used across sites, as approved by OSHA, MSHA, and ASME.

[30] United States Department of Labor, Occupational Safety & Health Administration, 1926 Safety and Health Regulations for Construction, Subpart CC Cranes & Derricks in Construction, 1926.1422 Signals--hand signal chart

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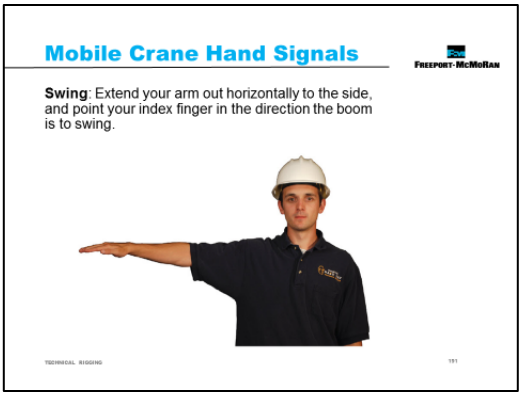
PPT slide 191, SG page 103



Instruction

Swing:

- Extend your arm out horizontally to the side, and point your index finger in the direction the boom is to swing.

Crane Dynamics:

- When swinging, centrifugal force will affect the load, and attempt to make it swing out.
- This extends the load radius and decreasing capacity.
- When stopping the swing, the load will want to continue to swing and will pass the point you want it to stop, begin slowing the load before it gets to the point you actually want it to stop.

PPT slide 192, SG page 103

Instruction

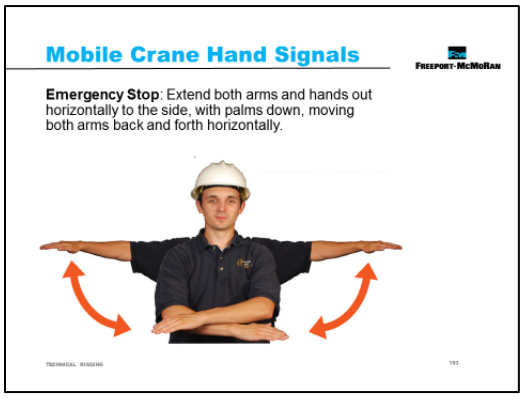
Stop:

- Extend your arm and hand out horizontally to the side, with your palm down, moving your arm back and forth horizontally.

Crane Dynamics:

- Stopping the load suddenly can shock load the crane.
- Shock loading will damage the rigging and cause structural damage to the crane.

PPT slide 193, SG page 103



Instruction

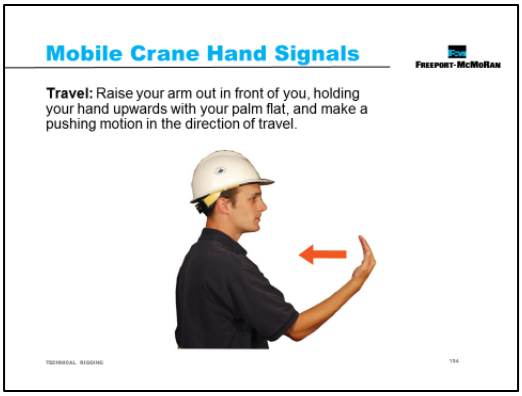
Emergency Stop:

- Extend both arms and hands out horizontally to the side, with palms down, moving both arms back and forth horizontally.

Crane Dynamics:

- Stopping the load suddenly can shock load the crane.
- Shock loading will damage the rigging and cause structural damage to the crane.

PPT slide 194, SG page 103



Instruction

Travel:

- Raise your arm out in front of you, holding your hand upwards with your palm flat, and make a pushing motion in the direction of travel.

PPT slide 195, SG page 105

Instruction

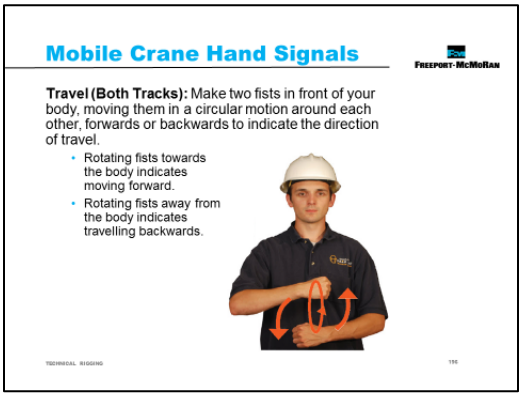
Dog Everything:

- Clasp your hands together in front of body at waist level.

Crane Dynamics:

- This signal is telling the operator to set all brakes.

PPT slide 196, SG page 105

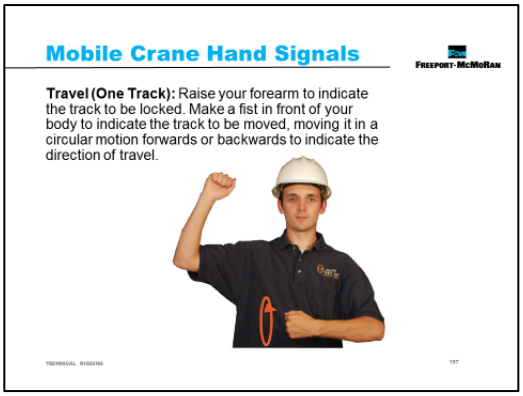


Instruction

Travel (Both Tracks):

- Make two fists in front of your body, moving them in a circular motion around each other, forwards or backwards to indicate the direction of travel.
    - Rotating fists towards the body indicates moving forward.
    - Rotating fists away from the body indicates travelling backwards.

PPT slide 197, SG page 105

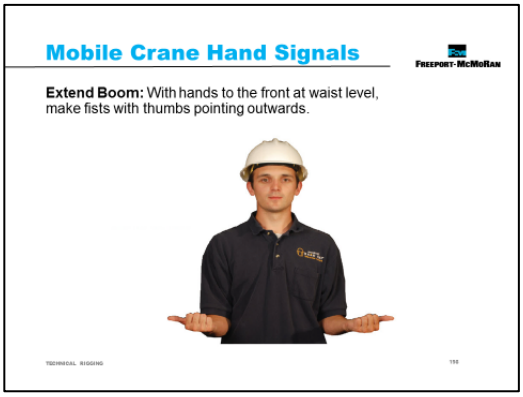


Instruction

Travel (One Track):

- Raise your forearm to indicate the track to be locked. Make a fist in front of your body to indicate the track to be moved, moving it in a circular motion forwards or backwards to indicate the direction of travel.

PPT slide 198, SG page 105



Instruction

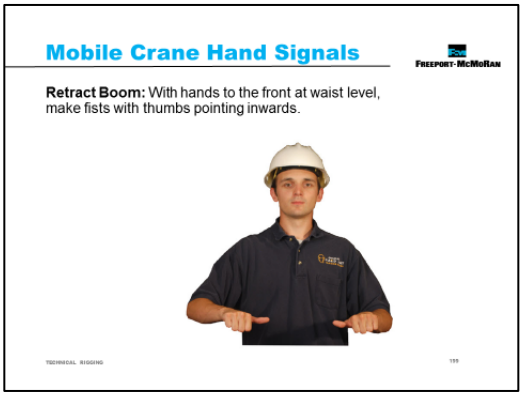
Extend Boom:

- With hands to the front at waist level, make fists with thumbs pointing outwards.
- Note: Always refer to the operator's manual.

Crane Dynamics:

- Extending the boom will increase the load radius, and decrease the capacity of the crane as the load is moving away from the crane and up away from the ground.

PPT slide 199, SG page 105



Instruction

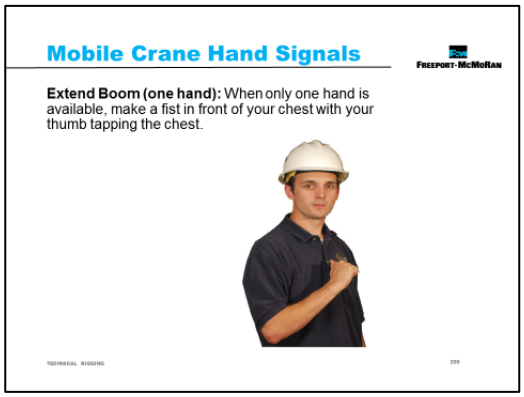
Retract Boom:

- With hands to the front at waist level, make fists with thumbs pointing inwards.
- Note: Extending and retracting of hydraulic booms is prohibited due to boom deflect - always refer to the operator's manual.

Crane Dynamics:

- When retracting the boom, the load radius will decrease, increasing the capacity of the crane as the load is moving closer to the crane and downward toward the ground.

PPT slide 200, SG page 105



Instruction

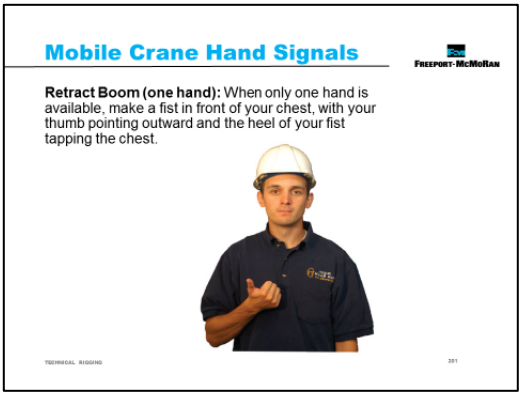
Extend Boom (one hand):

- When only one hand is available, make a fist in front of your chest with your thumb tapping the chest.
- Note: Always refer to the operator's manual.

Crane Dynamics:

- Extending the boom will increase the load radius, therefore decreasing the capacity of the crane and making it less stable as the load is moving away from the crane and up away from the ground.

PPT slide 201, SG page 105



Instruction

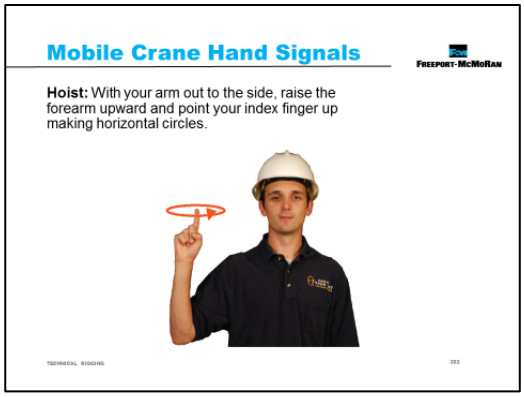
Retract Boom (one hand):

- When only one hand is available, make a fist in front of your chest, with your thumb pointing outward and the heel of your fist tapping the chest.
- Note: Extending and retracting of hydraulic booms is prohibited due to boom deflect - always refer to the operator's manual.

Crane Dynamics:

- When retracting the boom, the load radius will decrease, increasing the capacity of the crane and making it more stable as the load is moving closer to the crane and downward toward the ground.

PPT slide 202, SG page 105



Instruction

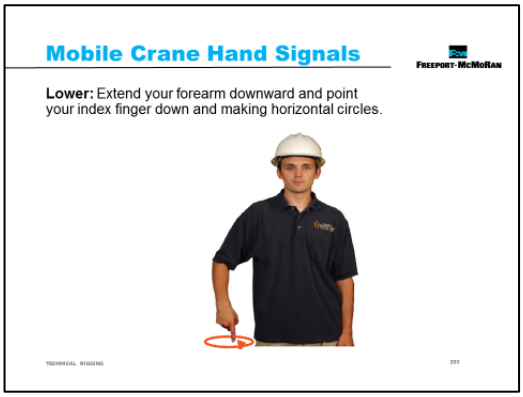
Hoist:

- With your arm out to the side, raise the forearm upward and point your index finger up making horizontal circles.

Crane Dynamics:

- When hoisting a load from the ground it is important to remember that the boom will deflect (bend) some before the load comes clear of the ground.
- To prevent this from swinging the load out from under the boom tip and increasing the load radius, the boom should be retracted as the hoist is raised to keep the boom tip directly above the load.

PPT slide 203, SG page 106



Instruction

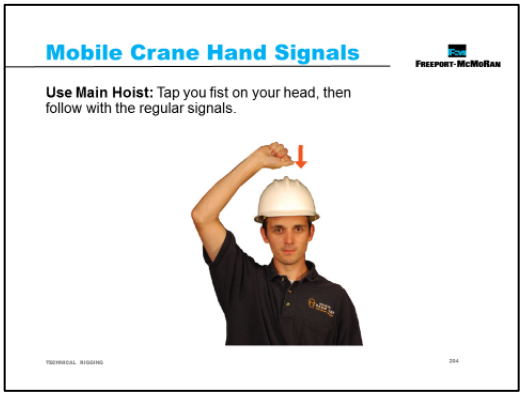
Lower:

- Extend your forearm downward and point your index finger down and making horizontal circles.

Crane Dynamics:

- This signal will lower the load/hoist.
- Care should be taken so the load is not lowered at a speed which would shock load the crane in the event of an emergency stop or a stop.

PPT slide 204, SG page 106

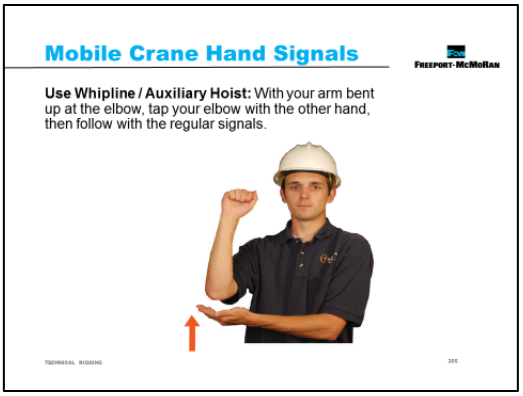


Instruction

Use Main Hoist:

- Tap you fist on your head, then follow with the regular signals.

PPT slide 205, SG page 106

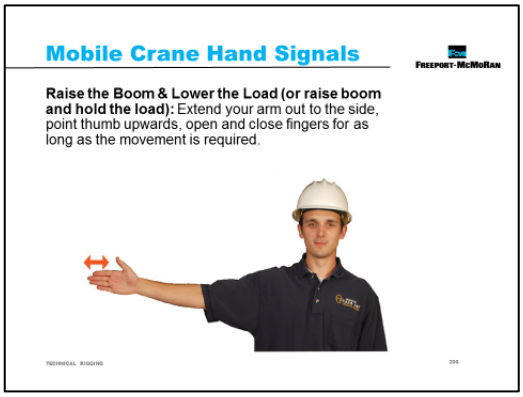


Instruction

Use Whipline / Auxiliary Hoist:

- With your arm bent up at the elbow, tap your elbow with the other hand, then follow with the regular signals.

PPT slide 206, SG page 106



Instruction

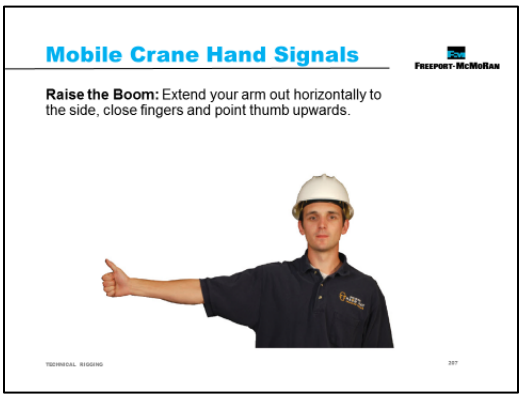
Raise the Boom & Lower the Load (or raise boom and hold the load):

- Extend your arm out to the side, point thumb upwards, open and close fingers for as long as the movement is required.

Crane Dynamics:

- This signal increases capacity and makes the crane more stable as the load is moving closer to the crane and should be remaining at the same height as the load is lowered at the same time the boom is raised.

PPT slide 207, SG page 106



Instruction

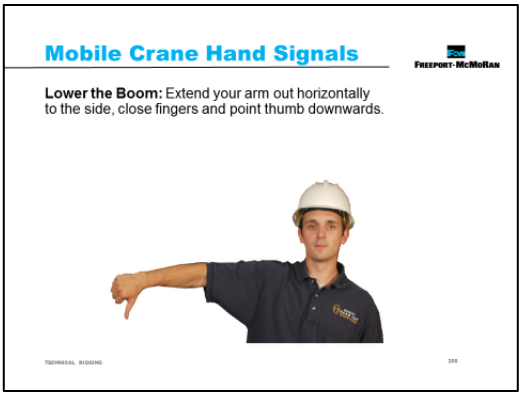
Raise the Boom:

- Extend your arm out horizontally to the side, close fingers and point thumb upwards.

Crane Dynamics:

- Raising the boom will bring the load closer to the crane increasing stability and capacity of the crane.

PPT slide 208, SG page 106



Instruction

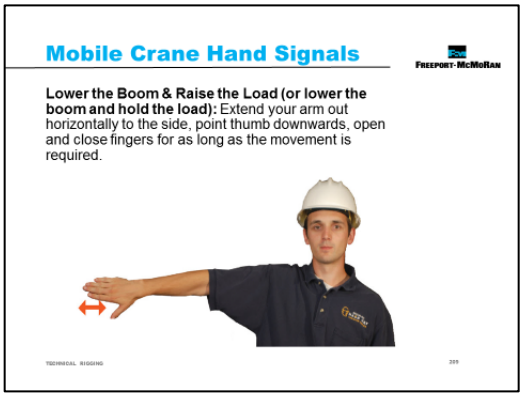
Lower the Boom:

- Extend your arm out horizontally to the side, close fingers and point thumb downwards.

Crane Dynamics:

- Lowering the boom will move the load further from the crane decreasing stability and capacity.

PPT slide 209, SG page 106



Instruction

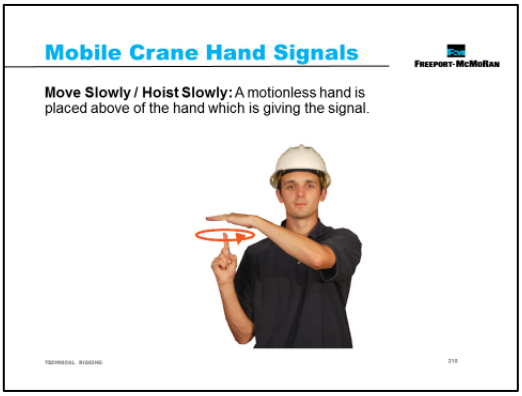
Lower the Boom & Raise the Load (or lower the boom and hold the load):

- Extend your arm out horizontally to the side, point thumb downwards, open and close fingers for as long as the movement is required.

Crane Dynamics:

- This signal will move the load away from the crane and should stay the same height.
- This will decrease the capacity of the crane and make it less stable.

PPT slide 210, SG page 106

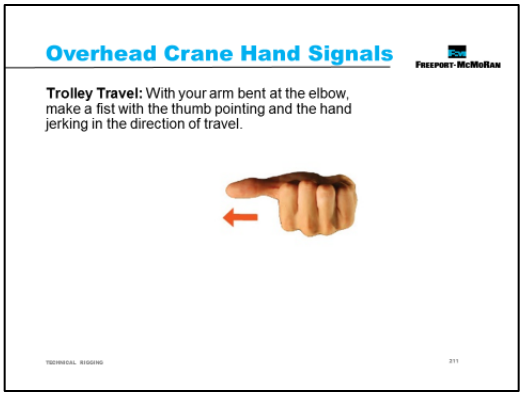


Instruction

Move Slowly / Hoist Slowly:

- A motionless hand is placed above of the hand which is giving the signal.

PPT slide 211, SG page 107

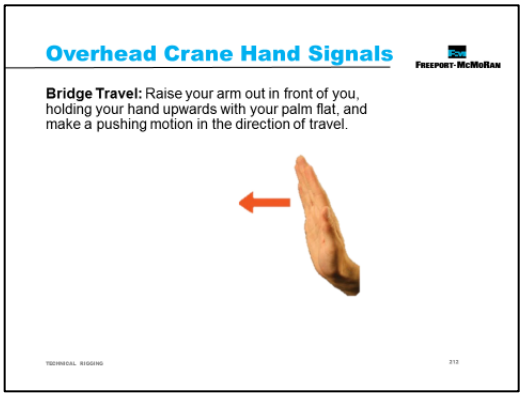


Instruction

Trolley Travel:

- With your arm bent at the elbow, make a fist with the thumb pointing and the hand jerking in the direction of travel.

PPT slide 212, SG page 107

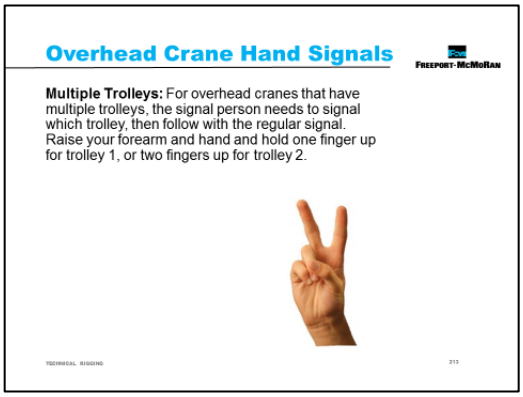


Instruction

Bridge Travel:

- Raise your arm out in front of you, holding your hand upwards with your palm flat, and make a pushing motion in the direction of travel.

PPT slide 213, SG page 107

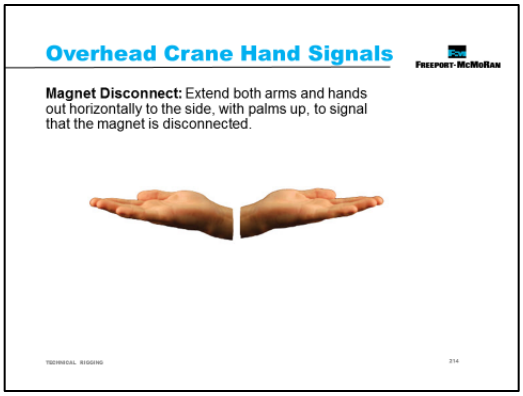


Instruction

Multiple Trolleys:

- For overhead cranes that have multiple trolleys, the signal person needs to signal which trolley, then follow with the regular signal.
- Raise your forearm and hand and hold one finger up for trolley 1, or two fingers up for trolley 2.

PPT slide 214, SG page 107



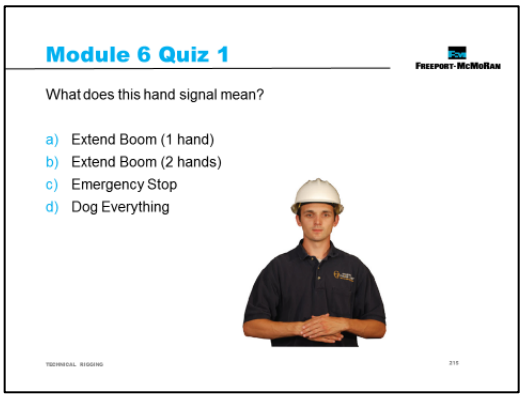
Instruction

Magnet Disconnect:

- Extend both arms and hands out horizontally to the side, with palms up, to signal that the magnet is disconnected.

MODULE 6 QUIZ 1

PPT slide 215, SG page 109



Instruction

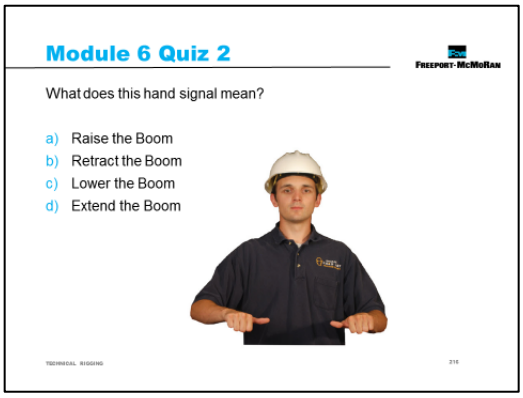
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

- Answer: D. Dog Everything

MODULE 6 QUIZ 2

PPT slide 216, SG page 109



Instruction

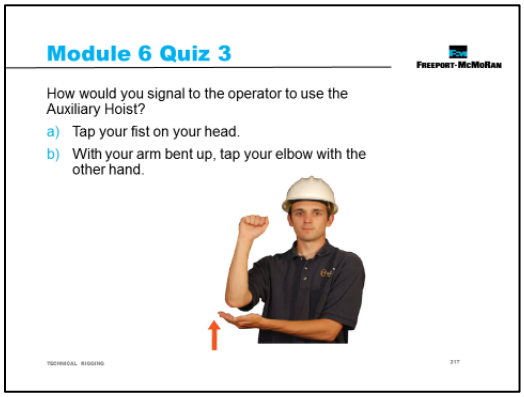
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*
- *Note: This is question 20 on the pre-course test.*

Quiz Answers

- Answer: B. Retract the Boom

MODULE 6 QUIZ 3

PPT slide 217, SG page 109



Instruction

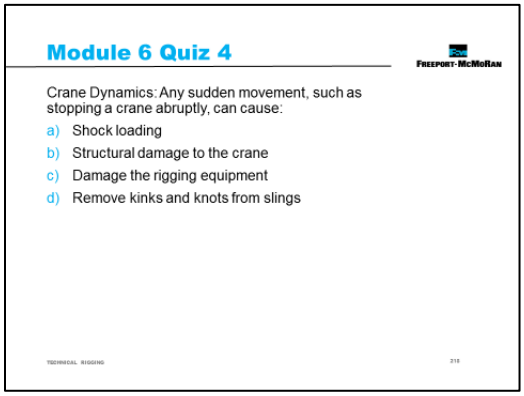
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*
- *Note: This is question 21 on the pre-course test.*

Quiz Answers

- Answer: B. With your arm bent up, tap your elbow with the other hand.

MODULE 6 QUIZ 4

PPT slide 218, SG page 109



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*
- *Note: This is question 22 on the pre-course test.*

Quiz Answers

- Answer: A, B and C - Any sudden movement of a crane, such as stopping a crane abruptly, can cause shock loading, and structural damage to the crane and rigging equipment.

MODULE 7: WEIGHTS

This module contains information on how to calculate the area, volume and weight of loads.

LEARNING OBJECTIVES

Upon completion of module, students will be able to:

- Calculate the area and volume of loads.
- Use weight tables to calculate the weight of loads.

ACTIVITIES

Quizzes:

- 1 quiz question at the end of each item, not at the end of the whole module.

MATERIALS

Throughout this module students will need:

- Calculators

FACILITATION

This module contains a brief introductory slide explaining weight tables, then discusses each type of calculation in detail. The module is specifically laid out to aid students understanding, each calculation has an explanation, example, and practice:

- Explanation – explain the concept to them.
- Example – run through the example with them.
- Practice – get them to do the quiz question on their own, and then run through the answer with them.

Each item in the module follows this format:

- Weight – explanation, example, practice.
- Volume & Load Weight – explanation, example, practice.
- Area of a Circle – explanation, example, practice.
- Weight of a Cylinder – explanation, example, practice.
- Weight of a Pipe – explanation, example, practice.

Work slowly through each item: Explain the concept, run through the example with them, then get the students to do the quiz themselves, and finally run through the answer with them. Take it slowly – you can always speed up, but if you have to go back over the item they are already lost.

FACILITATION TIP

Explain to the students that this module consists of calculations. Stress that each item is explained thoroughly, the class will run through an example together, then the student will complete the quiz on their own, and then they will run through the answer together. This will prepare the students for the module material.

FACILITATION TIP

According to the Law of Primacy, it is imperative for important tasks to be taught the first time correctly. The instructor needs to slow down and approach this part of the presentation in a deliberate manner.

During this portion of the presentation, the instructor should keep in mind the first three steps of the Demonstration Performance Technique: Explain; Demonstrate; Practice. Be sure to give the students time to practice the skill.

As the student's practice these skills keep in mind the law of effect. People learn better from a positive situation versus a negative. Constant negative motivation stifles the learning process.

NOTE

The calculations are based on the weight table shown in slide 220.

Use other tables if you have them available, and explain to the students that weights may differ on different tables, and that they should use the highest weight per sq. / cu. ft.

STANDARDIZATION / FLEXIBILITY

You may have another way to calculate an item. Always use the formula in the course, but adding another example aids understanding.

PPT slide 219, SG page 113

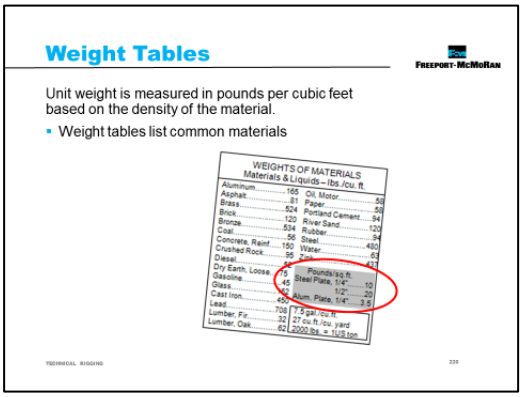
Instruction

Go over the learning objectives for the module.

Upon completion of this module, the students will be able to:

- Calculate the area and volume of loads.
- Use weight tables to calculate the weight of loads.

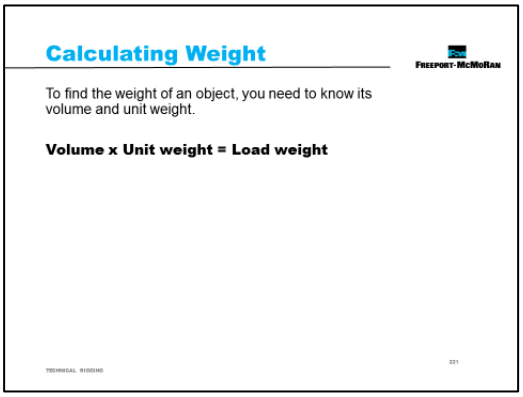
PPT slide 220, SG page 114



Instruction

- Unit weight is measured by pounds per cubic feet, or pounds per square foot, based on the density of the material.
- Weight tables, like the example shown, list common materials and their unit weight.
- Many shops / tool rooms have lists or books containing weights of objects that might be handled often, e.g. Pulleys, Liners, Mantles, and Main Shafts.
- It is a good idea to have similar “cheat sheets” for materials that you handle frequently. Having weight tables will save time when making calculations.
- Explain that different weight tables may have different figures for certain materials, and that they should always make calculations using the highest figure.

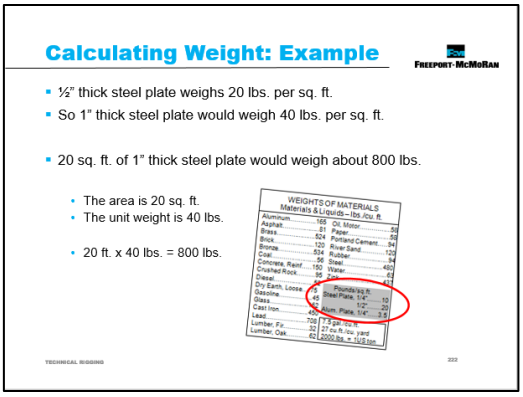
PPT slide 221, SG page 114



Instruction

- To calculate the weight of an object, you need to know its volume and unit weight.
- Volume x Unit Weight = Load Weight

PPT slide 222, SG page 114



Instruction

- The Weight Table pictured lists steel weights in lbs. per square ft.
- We can use this table to calculate the weight of steel plates and beams.

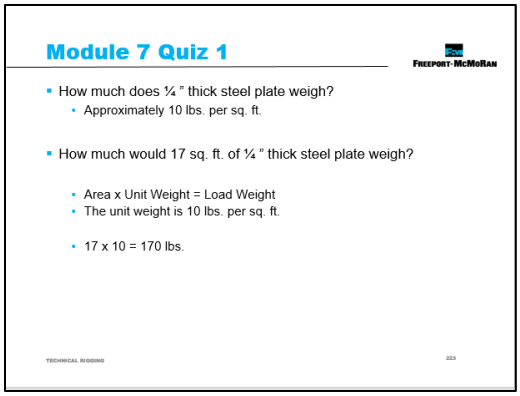
Example

- ½" thick steel plate weighs 20 lbs. per sq. ft.
- Therefore a 1" thick steel plate would weigh around 40 lbs. per sq. ft.

- 20 sq. ft. of 1" thick steel plate would weigh approximately 800 lbs.
    - Area x Unit Weight = Load Weight
    - 20 ft. x 40 lbs. = 800 lbs.

MODULE 7 QUIZ 1

PPT slide 223, SG page 115



Instruction

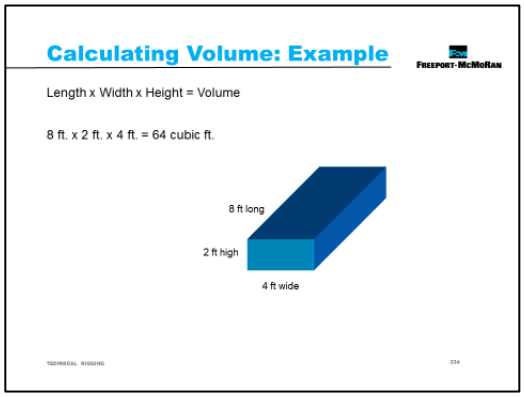
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*
- *Note: This is question 23 on the pre-course test.*

Quiz Answers

- How much does ¼" thick steel plate weigh per sq. ft.?
    - Approximately 10 lbs. per sq. ft.

- How much would a 17 sq. ft. of ¼" thick steel plate weigh?
    - Area x Unit Weight = Load Weight
    - 17 ft. x 10 lbs. = 170 lbs.

PPT slide 224, SG page 116



Instruction

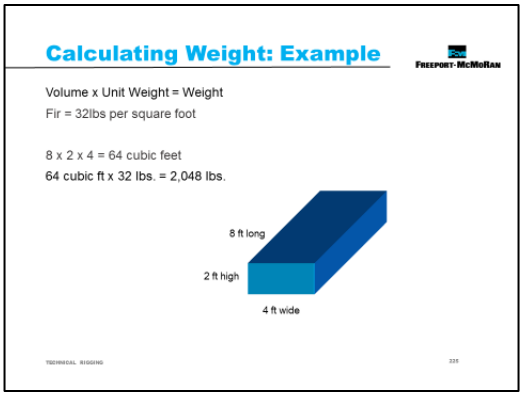
- Load weight can be determined from manufacturer's documents, approved calculations, scales (dynamometer), bill of lading, blueprints, etc.
- Sometimes written or stamped on the load, data plates or on the equipment.
- But when all else fails – do the calculations!
- To practice conversions (feet to inches, etc.), make up problems to have participants convert feet into inches, or vice-versa.
- In order to find the weight of an object you must know its volume and unit weight:
    - Volume x Unit Weight = Load Weight

- To calculate the volume of an object multiply its length by its width, by its height.
    - Length x Width x Height = Volume

Example

- A block of wood that is 8ft. long, by 4ft. wide, and 2ft. high has a volume of 64 cu. ft.
    - Length x Width x Height = Volume
    - 8 x 4 x 2 = 64 cu. ft.

PPT slide 225, SG page 117



Instruction

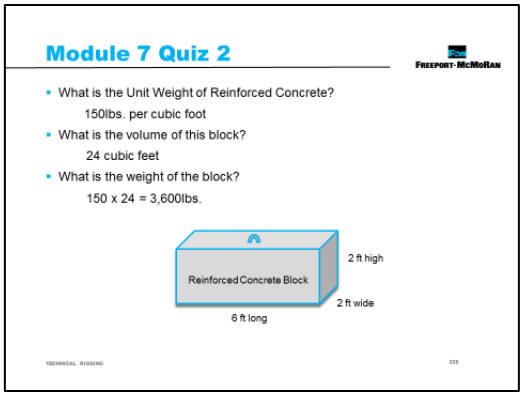
- To calculate the weight of a cube you multiply its volume by its unit weight.
- Volume x Unit Weight = Load Weight

Example

- A block of fir that is 8 ft. x 4 ft. x 2 ft. has a volume of 64 cu. ft.
    - Fir weighs 32 lbs. per cu. ft.
    - Volume x Unit Weight = Load Weight
    - 64 x 32 = 2,048 lbs.

MODULE 7 QUIZ 2

PPT slide 226, SG page 118



Instruction

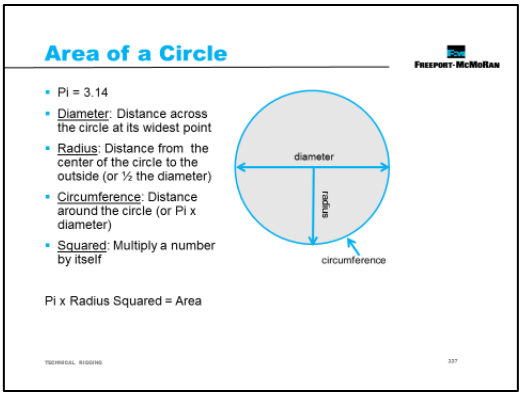
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

- What is the unit weight of reinforced concrete? Check your Weight Tables.
    - The unit weight is 150 lbs. per cu. foot
- What is the volume of this block?
    - The volume is 2’ x 2’ x 6’ = 24 cu. feet
- What is the weight of the block?
    - The estimated weight is therefore 3,600 lbs. - 150 lbs. x 24 cu. feet = 3,600 lbs.

- In the real world, you would need to consider that the block could actually weigh a lot more, or a lot less:
    - Depending on the amount of rebar in the block.
    - Or how many chunks have been knocked out of it.
- But this calculation did get you in the ball park, and it is better to estimate over the actual weight than under it.

PPT slide 227, SG page 119

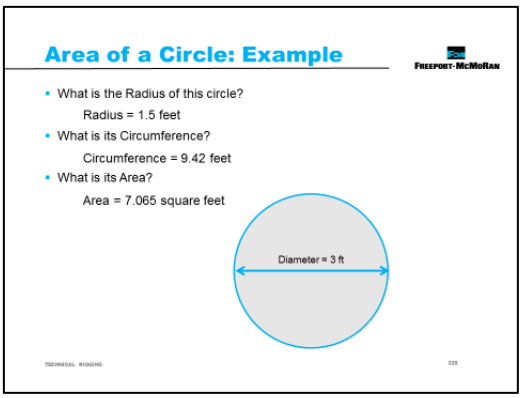


Instruction

- Determining the area of a circle is easy, but it does require knowledge of mathematical terms:
  Pi, Radius, Diameter, Circumference and Squared
- *Run through bullet points*

- The area of a circle is calculated by multiplying the radius squared x Pi
- Pi (3.14) x Radius Squared = Area

PPT slide 228, SG page 119

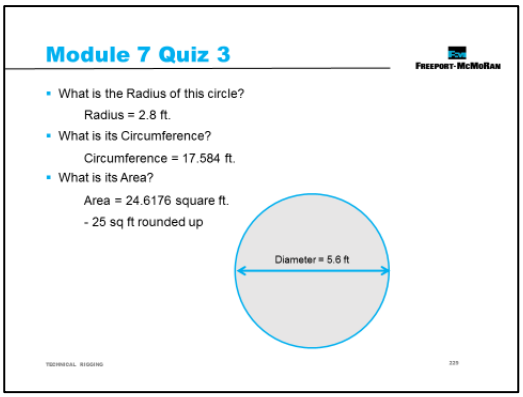


Example

- If the diameter of the circle is 3 ft.
- What is the radius of this circle if its diameter is 3 feet?
  - The radius of a circle is half of its diameter = 1.5 feet
- What is its circumference?
  - Circumference is Pi x diameter: 3 x 3.14 = 9.42 ft.
- What is its area?
  - Area is Radius squared x Pi
  - Radius squared is 1.5 x 1.5 = 2.25
  - 2.25 x 3.14 = 7,065 sq. ft.

MODULE 7 QUIZ 3

PPT slide 229, SG page 120



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

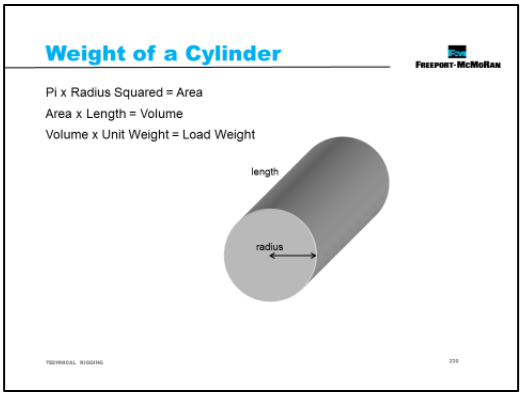
Quiz Answers

- What is the radius of this circle if its diameter is 5.6 ft.?
    - The radius of a circle is half of its diameter: 2.8 ft.

- What is its circumference?
    - Circumference is Pi x diameter: 5.6 x 3.14 = 17.584

- What is its area?
    - Area is Radius squared x Pi
    - Radius squared is 2.8 x 2.8 = 7.84
    - 7.84 x 3.14 = 24.6176 sq. ft.
    - Which can be rounded up to 25 sq. ft.

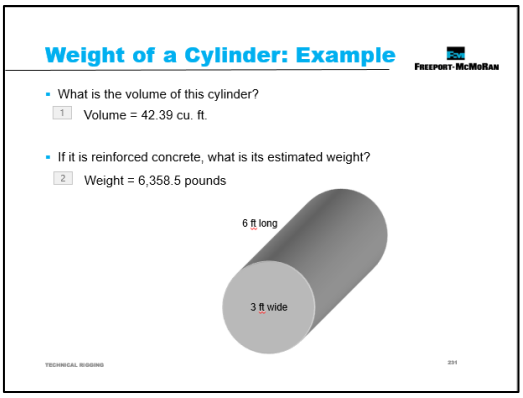
PPT slide 230, SG page 121



Instruction

- Determining the weight of a cylinder is easy once you know how to find the area of a circle:
  - Pi x Radius Squared = Area
- Then you multiply the area of the circle by the length of the cylinder:
  - Area x Length = Volume
- Then to find the weight, multiply the volume by its unit weight:
  - Volume x Unit Weight = Load Weight

PPT slide 231, SG page 121

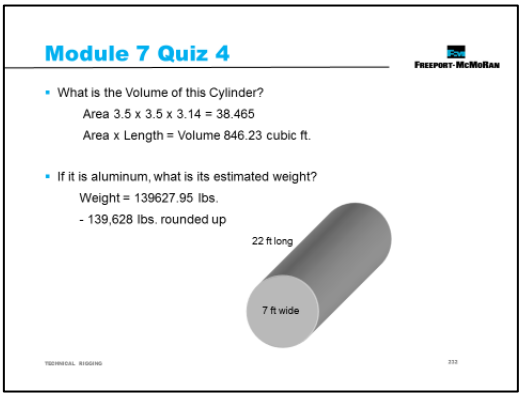


Example

- If a cylinder is 3ft. wide by 6ft. long and is made of reinforced concrete, what does it weigh?
- What is the volume of this cylinder?
  - The area of the circle is the radius squared x Pi
    - The radius is half the diameter = 1.5
    - Radius squared is 1.5 x 1.5 = 2.25
    - 2.25 x 3.14 = 7.065 sq. ft.
  - The volume of the cylinder is the area of the circle x the length
    - 7.065 sq. ft. x 6 ft. long = 42.39 cu. feet
- If it is reinforced concrete, what is its estimated weight?
  - The unit weight of concrete is 150 lbs. per cu. foot.
  - 42.39 cu. feet x 150 lbs. = 6,358.5 lbs.

MODULE 7 QUIZ 4

PPT slide 232, SG page 122



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

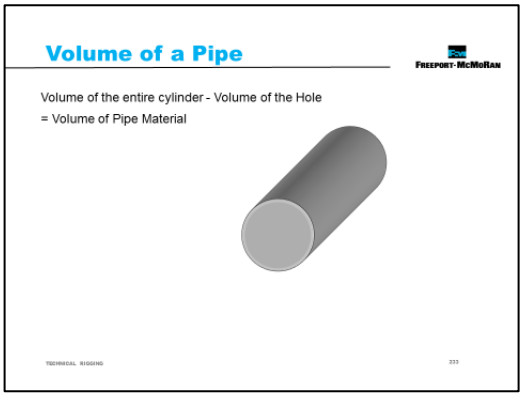
Quiz Answers

- The area of the circle is the radius squared x Pi:
  - Radius squared is 3.5 x 3.5 = 12.25
  - 12.25 x 3.14 = 38.465 sq. ft.

- The volume is the area x length:
  - 38.465 sq. ft. x 22 ft. long = 846.23 cu. ft.

- If the cylinder is made of aluminum, what is its estimated weight?
  - The unit weight of aluminum is 165 lbs. per cu. ft.
  - 846.23 cu. ft. x 165 lbs. = 139,627.95 lbs.
  - 139,628 lbs. rounded up

PPT slide 233, SG page 123



Instruction

- We are only interested in the volume of the actual material of the pipe, and not the empty space inside it. To determine the volume of a pipe:
    - Determine the volume of the pipe as if it were a solid cylinder, then determine the volume of the hole, and subtract this from the volume of the pipe.
        - Volume of solid pipe - Volume of hole = Volume of the pipe

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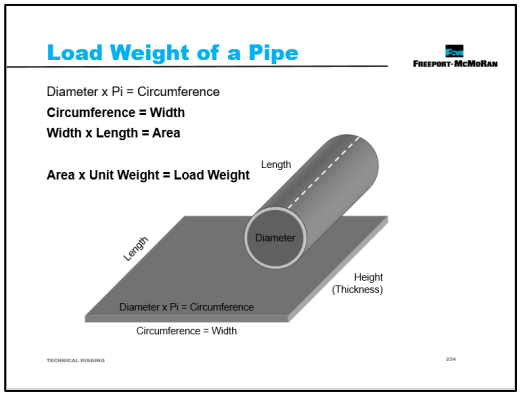
PPT slide 234, SG page 123



Instruction

- An easier way to determine the volume is to imagine the pipe split down its length, and flattened it out into a rectangle. The circumference is now its width.
    - Diameter x Pi = Circumference

Circumference = Width

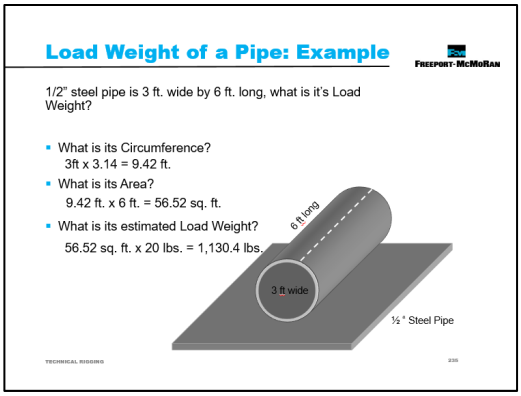
- Multiplying its width by its length gives you its area.

Width x Length = Area

- Multiplying the area by the unit weight gives you the volume of the pipe.
- Area x Unit Weight = Load Weight

- Note: Where the unit weight is not specified in plate thickness, e.g. ½" steel plate weighs 20 lbs. per sq, ft, you must calculate the volume, and multiplying its width, by its length, by its height (or thickness).
- Note: For rigging purposes, though not exact, "Volume of Pipe" and "Load Weight" are considered equal.
    - Width x Length x Height = Volume
    - Volume x Unit Weight = Load Weight

PPT slide 235, SG page 124



Example

- If a ½" steel pipe is 3ft. wide by 6ft. long, what is its load weight?

- Circumference = Pi x Diameter
  - 3.14 x 3 ft. = 9.42 ft.

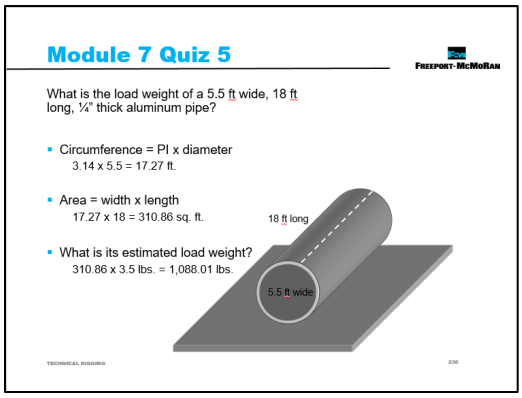
- Area = Circumference x Length (Note: width = circumference)
  - 9.42 ft. x 6 ft. = 56.52 sq. ft.

- Load Weight = Area x Unit Weight
  - If this is ½" steel pipe then according to the weight table it is 20 lbs. per sq. ft.
  - 56.52 sq. ft. x 20 lbs. = 1,130.4 lbs.

- This is not the actual weight, but you will be within a few percentage points.
- It is much better than just guessing!
- Knowing the weight now allows you to determine if the crane has enough capacity to make the pick.
- And allows you to choose the proper slings and rigging gear for the lift.

MODULE 7 QUIZ 5

PPT slide 236, SG page 125



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

- What is its Circumference?
  - Pi x Diameter = Circumference
  - 3.14 x 5.5 ft. = 17.27 ft.

- What is its Area?
  - The Circumference is now its width.
  - Width x Length = Area
  - 17.27 ft. x 18 ft. = 310.86 sq. ft.

- What is its Estimated Load Weight?
  - Unit Weight x Area = Load Weight
  - 3.5 lbs. x 310.86 sq. ft. = 1,088 lbs.

MODULE 8: CENTER OF GRAVITY & LOAD ANGLE FACTORS

This module contains introductory information on load angle factors and center of gravity, and their effect on slings and loads.

LEARNING OBJECTIVES

Upon completion of module, students will be able to:

- Understand the effect the Center of Gravity and sling angles have on loads.
- Calculate sling angle tension and load angle factors, and apply safe rigging practices.
- Calculate Center of Gravity and sling tension, and apply safe rigging practices.

ACTIVITIES

Quizzes:

- 4 quiz questions at the end of the module.

MATERIALS

Throughout this module students will need:

- Calculators

FACILITATION

This module contains a brief introductory slide explaining COG and Load Angle Factors, then the module is split into two sections: Load Angles and COG.

After a brief introductory slide, simple illustrations - one per slide, illustrate how angled slings increase tension on slings. The load angle factor chart is then introduced, and how to calculate a load angle factor. The second part of the module explains how an offset COG can increase tension, and tension on individual slings. Examples illustrate the different tensions on vertical slings, and then the different increased tensions on angled slings.

The module is specifically laid out to aid students understanding, each calculation has an explanation, example, and practice:

- Explanation – explain the concept to them.
- Example – run through the example with them.
- Practice – get them to do the quiz questions on their own, and then run through the answers with them

The concepts (and four quiz questions at the end) illustrate a lift becoming more complicated:

- Calculating Sling Angle Tension - with a known Load Angle Factor.
- Calculating the Load Angle Factor, then the Sling Angle Tension.
- Calculating Center of Gravity and Sling Angle Tension – Vertical Slings
- Calculating Center of Gravity and Sling Angle Tension – Angled Slings

Work slowly through each item: Explain the concept, then run through the example with them. Take it slowly – you can always speed up, but if you have to go back over the item they are already lost. At the end of the module get the students to do the quizzes themselves, and run through the answers with them.

FACILITATION TIP

Explain to the students that this module consists of calculations. Stress that each item is explained thoroughly and the class will run through an example together. At the end of the module the student will complete the quizzes on their own, and then the class will run through the answers together. This will prepare the students for the module material.

FACILITATION TIP

According to the Law of Primacy, it is imperative for important tasks to be taught the first time correctly. The instructor needs to slow down and approach this part of the presentation in a deliberate manner.

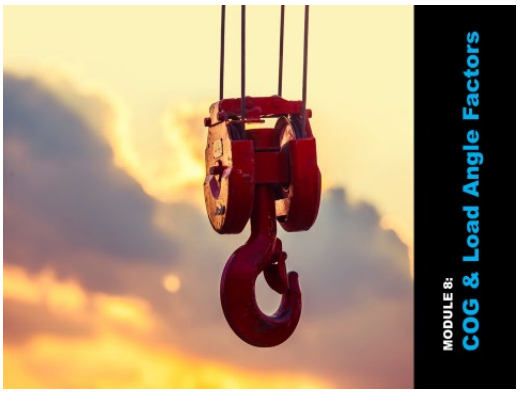
During this portion of the presentation, the instructor should keep in mind the first three steps of the Demonstration Performance Technique: Explain; Demonstrate; Practice. Be sure to give the students time to practice the skill.

As the student's practice these skills keep in mind the law of effect. People learn better from a positive situation versus a negative. Constant negative motivation stifles the learning process.

STANDARDIZATION / FLEXIBILITY

You may have another way to calculate an item. Always use the formula in the course, but adding another example aids understanding.

PPT slide 237, SG page 129



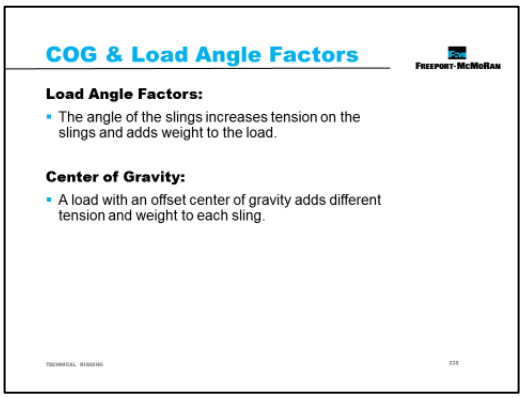
Instruction

Go over the learning objectives for the module.

Upon completion of this module, the students will be able to:

- Understand the effect the Center of Gravity and sling angles have on loads.
- Calculate sling angle tension and load angle factors, and apply safe rigging practices.
- Calculate Center of Gravity and sling tension, and apply safe rigging practices.

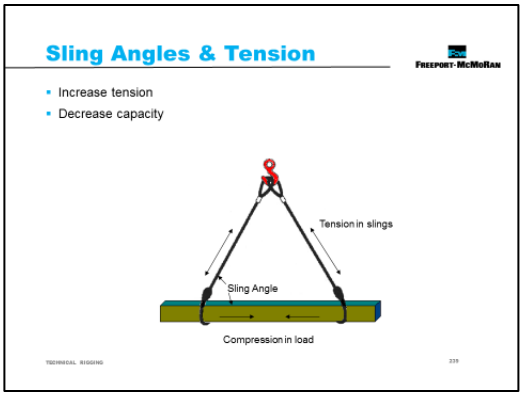
PPT slide 238, SG page 130



Instruction

- Riggers must understand
  - The effect of the angle of the slings.
  - The effect an unbalanced load will have on the individual sling.
- The angle of the slings increases the tension on the slings.
- A load with an offset center of gravity adds different tension to each sling.

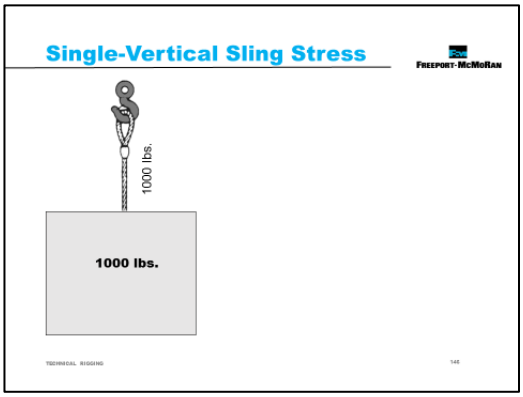
PPT slide 239, SG page 130



Instruction

- When slings are used at an angle, the capacity of the sling is reduced.
- The amount of reduction depends on the angle of the sling.
    - The lower the angle, the higher the tension, and the lower the capacity
- No one should be allowed to rig loads without knowing the stresses that are put on slings when lifting at angles.
- When rigging you must take into account not only the weight of the load, but also the angle of the sling, and the capacity reduction or tension caused by the angle.

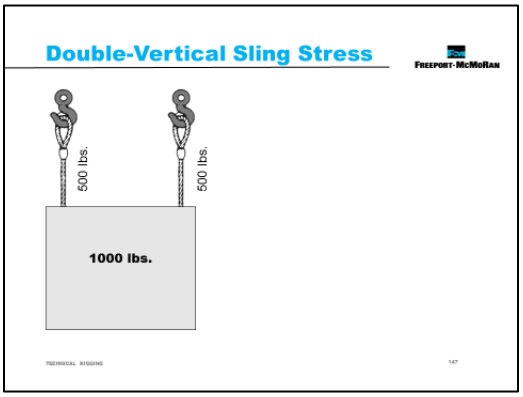
PPT slide 240, SG page 130



Instruction

- When a 1,000 lb. load is lifted with one sling in the vertical we know that there will be 1,000 lbs. of tension on that sling.

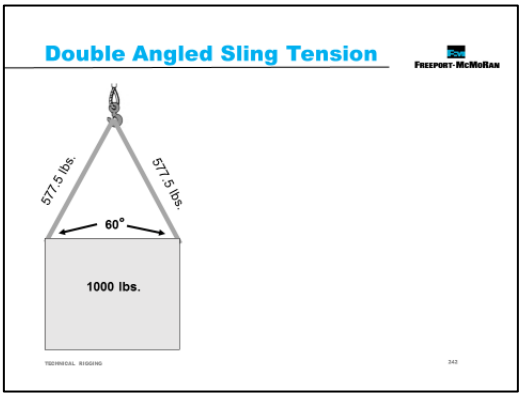
PPT slide 241, SG page 131



Instruction

- When a 1,000 lb. load is lifted with two slings in the vertical then each sling will see exactly half the load or 500 lbs.

PPT slide 242, SG page 131



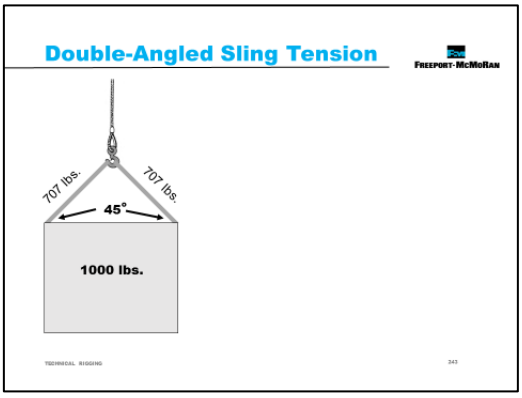
Instruction

- When two slings are used together on a hook, shackle or master ring, the load is shared equally.
- However, the angle adds tension above the 500 lbs. of the vertical (90°) sling, therefore, the sling capacity is reduced.
- As you increase tension you must increase sling capacity by selecting a sling which has equal or greater capacity than the load weight PLUS the tension.
    - The amount of reduction will depend on the angle.
    - In the example shown each sling picks up an additional 78 lbs. of tension at a 60˚ angle.

Note: The ideal angle is 60˚ as there is a minimum capacity reduction.

To determine whether you have sling legs at 60˚, lay one sling down between the pick points on the load. If it is equal to or extends longer than the distance between the pick points then you have an angle that is equal to or greater than 60˚.

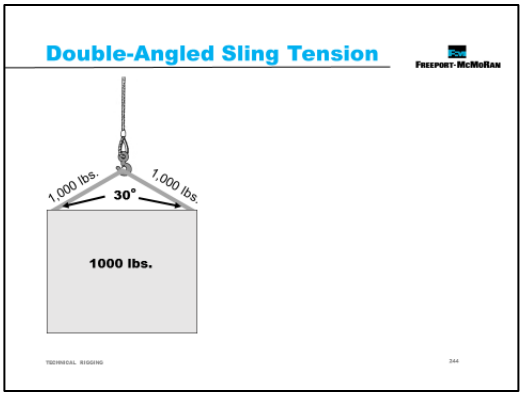
PPT slide 243, SG page 132



Instruction

- At a 45˚ angle the capacity is reduced even further.
- Each sling will see an additional 207 lbs. of tension!

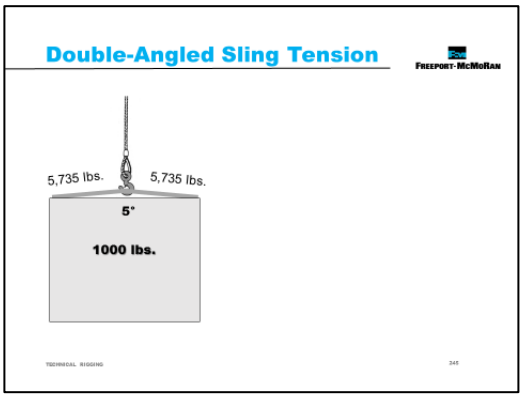
PPT slide 244, SG page 132



Instruction

- At 30˚ each sling will see the equivalent of the whole load.
- An additional 1000 lbs. of tension on each sling!

PPT slide 245, SG page 132

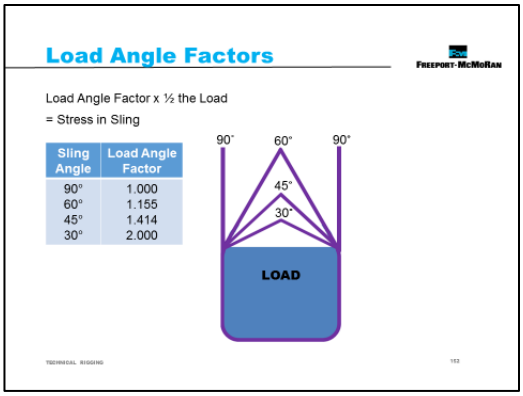


Instruction

- When the angle is decreased to 5˚ there is an astounding 5,735 lbs. of tension on each leg of the sling!
- Two slings whose capacities are 1,000 lbs. in the vertical, (or even at an angle of 60°), would be plenty to pick up a 1,000 lb. load.
- There is a very good chance that these slings will fail if we use them at this 5˚ angle.

Note: The ideal lift does not use extreme sling angles. Slings should not be used at an angle below 30˚! If in doubt, stop work, and seek advice from someone who is more qualified.

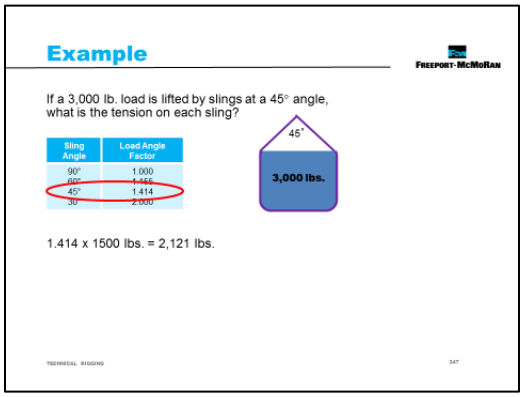
PPT slide 246, SG page 133



Instruction

- To calculate the amount of tension placed on the slings, you must determine the load angle factor, and then multiply that by ½ the load.
- Load Angle Factor x ½ the load = Tension on the sling
- The load angle factor can be calculated, or for some simple angles, refer to the chart shown.

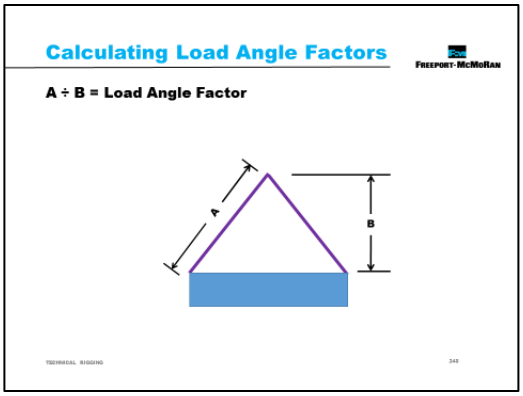
PPT slide 247, SG page 133



Example

- If a 3,000 lb. load is lifted by slings at a 45° angle, what is the tension on each sling?
- Load Angle Factor x ½ the Load = Tension on Sling
  - 45° Load Angle Factor = 1.414
  - 1.414 x 1,500 lbs. (half of 3,000 lbs.)
  - 2,121 lbs. tension on each sling

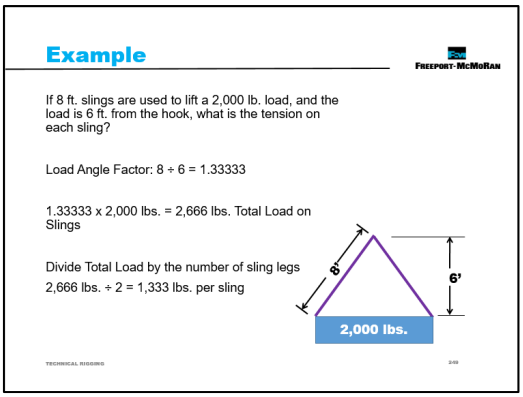
PPT slide 248, SG page 134



Instruction

- Most likely, you will not know the angle of the sling. Therefore will need to calculate it.
- To calculate the load angle factor:
    - Divide the length of the sling by the vertical distance of the hook to the load.

PPT slide 249, SG page 134



Example

- If 8 ft. slings are used to lift a 2,000 lb load, and the load is 6ft. from the hook, what is the tension on each sling?

- A ÷ B = Load Angle Factor
- Load Angle Factor x Load = Total load on Slings
- Divide Total by the number of Sling Legs
    - Load Angle Factor: 8 ÷ 6 = 1.33333
    - 1.33333 x 2,000 lbs. = 2,666 lbs. Total load on Slings
    - 2,666 lbs. ÷ 2 Sling Legs = 1,333 lbs. tension on each sling

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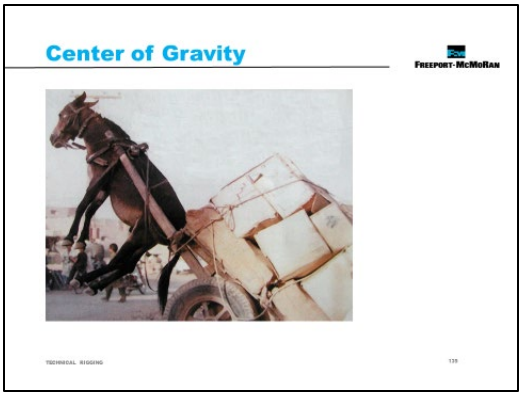
PPT slide 250, SG page 135

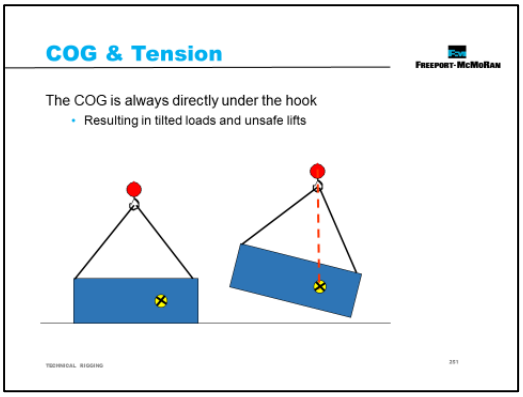


Instruction

- It might seem silly that someone would overload a cart to the point that it could lift a donkey off of the ground.
- But overloading equipment is not unheard of in the industry.
    - How many times have you seen pictures or videos of cranes tipped over on their side?
- The center of gravity is the point in a load where the weight is concentrated.
- This is not necessarily the center of the shape of the load!
- When the weight of a load is not distributed evenly, the tension on each sling is not distributed evenly.
- We should never rig loads without knowing the center of gravity of a load, and the tensions on the individual slings.

- All of the factors and formulas on the previous pages are good for regular shaped loads with equally distributed weight. But what if you are lifting an irregular shaped / weighted load?

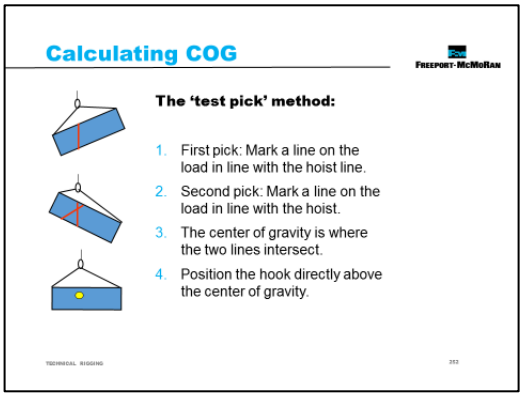
PPT slide 251, SG page 135



Instruction

- When a load is rigged and lifted, the center of gravity will always end up directly under the hook.
- This can result in tilted loads and unsafe lifts.
- If a load tilts more than 5° after it is lifted, it should be landed, the center of gravity calculated, and the load rigged over again.
- If the load is lifted abruptly, it will swing past the center of gravity an equal distance and then continue swinging back and forth.
    - This can result in dangerous load shifting and additional stress on lifting hardware and rigging.

PPT slide 252, SG page 136



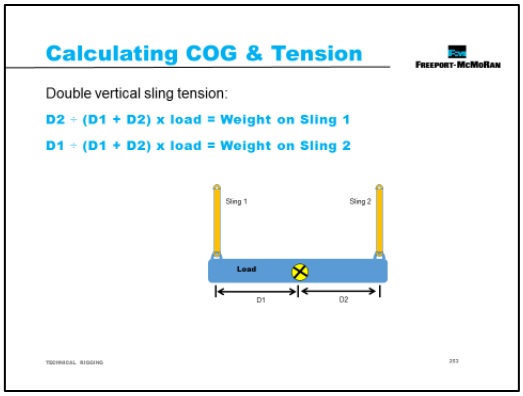
Instruction

Use the "test pick" method to find the Center of Gravity:

1. On the initial pick, the load tilts to one side. Mark a line on the load in line with the hoist.
2. On the second pick, select slings of unequal length which will tilt the load in the opposite direction. Mark a line on the load in line with the hoist.
3. Where the two lines intersect is the Center of Gravity in the horizontal (east/west).
4. Position the hook directly above the Center of Gravity.

Note: The load should only be lifted a few inches off the ground!

PPT slide 253, SG page 136

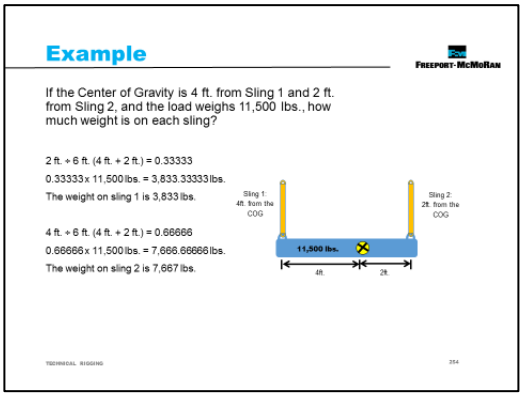


Instruction

- This formula is used to determine the weight on each sling when picking up a load using vertical slings attached to a spreader bar or lifting beam.
- The key to determining the weight on each vertical sling is knowing:
    - The total weight of the load.
    - Where its center of gravity is.
    - The distance between the two attachment points of the slings.

Note: The distance between the two attachment points NOT the length of the load.

PPT slide 254, SG page 137



Example

- If the Center of Gravity is 4 ft. from Sling 1 and 2 ft. from Sling 2, and the load weighs 11,500 lbs., how much weight is on each sling?

- D2 ÷ (D1 + D2) x load = Weight on Sling 1
    - 2 ft. ÷ 6 ft. (4 ft. + 2 ft.) = 0.3333
    - 0.3333 x 11,500 lbs. = 3,832.95 lbs.
    - The weight on sling 1 is 3,833 lbs.
- D1 ÷ (D1 + D2) x load = Weight on Sling 2
    - 4 ft. ÷ 6 ft. (4 ft. + 2 ft.) = 0.6666
    - 0.6666 x 11,500 lbs. = 7,665.9 lbs.
    - The weight on sling 2 is 7,666 lbs.

Note: The sling closest to the center of gravity carries the most weight.

Note: The two sling tensions added together equal the total weight. To check that your figures are correct, add the sling tensions together, to see if the equal the total weight. However, this is only true of vertical slings - using angled slings adds weight above the total weight.

Note: There are alternate formulas to find the same information. There is no right or wrong formula for determining the weight on each sling; it is personal preference. Strongly suggest all three are presented to allow the participant to decide which one they feel most comfortable with in the field.

Teaching Point: Put the two alternate formulas on the white board and have participants calculate the weight on each sling using all formulas. This will allow participants to see all three formulas at the same time.

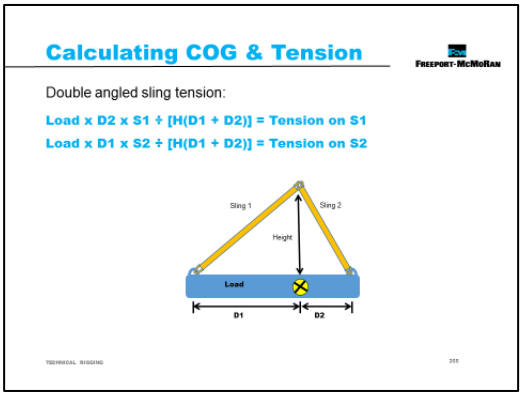
* Alternate Formula A:

D2 ÷ (D1+D2) = % of S1	2 ft. ÷ 6 ft. (4 ft. + 2 ft.) = 0.3333 or 33% of load
D1 ÷ (D1+D2) = % of S2	4 ft. ft. ÷ 6 ft. (4 ft. + 2 ft.) = 0.6666 or 66% of load
% S1 x LW = Weight on S1	.3333 x 11,500 lbs. = 3,832.95 lbs. or 3,833 lbs.
% S2 x LW = Weight on S2	.6666 x 11,500 lbs. = 7,665.9 lbs. or 7,666 lbs.

*Alternate Formula B:

LW x D2 ÷ (D1+D2) = S1	11,500 lbs. x 2 ft. ÷ 6 ft. = S1
	23,000 ÷ 6 ft. = 2,833.3333 or 2,833 lbs.
LW x D1 ÷ (D1+D2) = S2	11,500 lbs. x 4 ft. ÷ 6 ft. = S1
	46,000 lbs. ÷ 6 ft. = 7,666.6667 or 7,667 lbs.

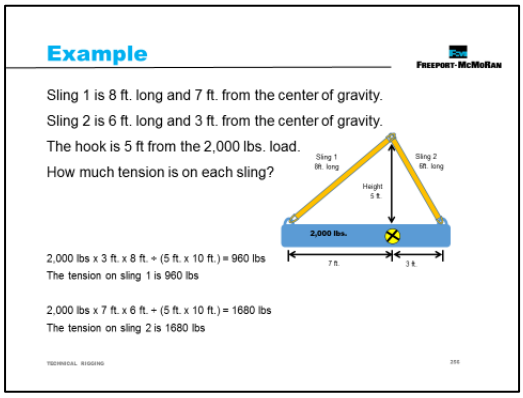
PPT slide 255, SG page 137



Instruction

- This formula is used to determine the tension on each sling when picking up a load using angled slings attached to a single hook, shackle or masterlink, etc.
- The key to determining the tension on each angled sling is knowing:
    - The total weight of the load.
    - Where its center of gravity is.
    - The distance between the two attachment points of the slings.
    - The length of the slings.

PPT slide 256, SG page 136



Example

- Sling 1 is 8 ft. long and 7 ft. from the center of gravity.
- Sling 2 is 6 ft. long and 3 ft. from the center of gravity.
- The hook is 5 ft. from the 2,000 lb. load.
- How much tension is on each sling?

- Load x D2 x S1 ÷ [H(D1 + D2)] = Weight on S1
  - 2,000 lbs. x 3 ft. x 8 ft. ÷ 50 = 960 lbs.

- Load x D1 x S2 ÷ [H(D1 = D2)] = Weight on S2
  - 2,000 lbs. x 7 ft. x 6 ft. ÷ 50 = 1,680 lbs.

Note: There are alternate formulas to find the same information. There is no right or wrong formula for determining the weight on each sling; it is personal preference. Strongly suggest all three are presented to allow the participant to decide which one they feel most comfortable with in the field.

Teaching Point: Put the two alternate formulas on the white board and have participants calculate the weight on each sling using all formulas. This will allow participants to see all three formulas at the same time.

*Alternate Formula A:

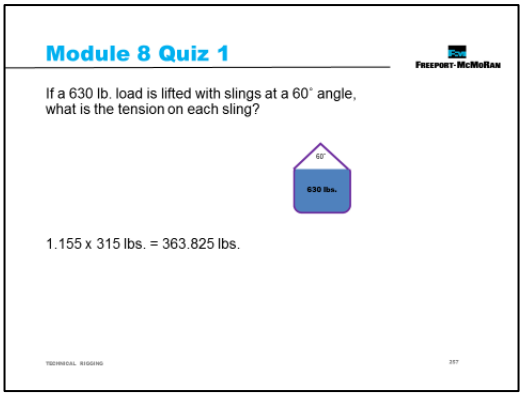
D2 ÷ (D1+D2) = % of S1	3 ft. ÷ 10 ft. = .30 or 30%
D1 ÷ (D1+D2) = % of S2	7 ft. ÷ 10 ft. = .70 or 70%
% S1 x LW = Weight on S1	.3 x 2,000 lbs. = 600 lbs. on S1
% S2 x LW = Weight on S2	.7 x 2,000 lbs. = 1,400 lbs. on S2
SL1 ÷ H = Load Angle Factor S1	8 ft. ÷ 5 ft. = 1.6 LAF S1
SL2 ÷ H = Load Angle Factor S2	6 ft. ÷ 5 ft. = 1.2 LAF S2
LAF S1 x S1 Weight = S1 Tension	1.6 LAF x 600 lbs. = 960 lbs. on S1
LAF S2 x S2 Weight = S2 Tension	1.2 LAF x 1,400 lbs. = 1680 lbs. on S2

*Alternate Formula B:

LW x D2 ÷ (D1+D2) = S1	2,000 lbs. x 3 ft. ÷ 10 ft. = 600 lbs. on S1
LW x D1 ÷ (D1+D2) = S2	2,000 lbs. x 7 ft. ÷ 10 ft. = 1,400 lbs. on S2
SL1 ÷ H = Load Angle Factor S1	8 ft. ÷ 5 ft. = 1.6 LAF S1
SL2 ÷ H = Load Angle Factor S2	6 ft. ÷ 5 ft. = 1.2 LAF S2
LAF S1 x S1 Weight = S1 Tension	1.6 LAF x 600 lbs. = 960 lbs. on S1
LAF S2 x S2 Weight = S2 Tension	1.2 LAF x 1,400 lbs. = 1680 lbs. on S2

MODULE 8 QUIZ 1

PPT slide 257, SG page 139



Instruction

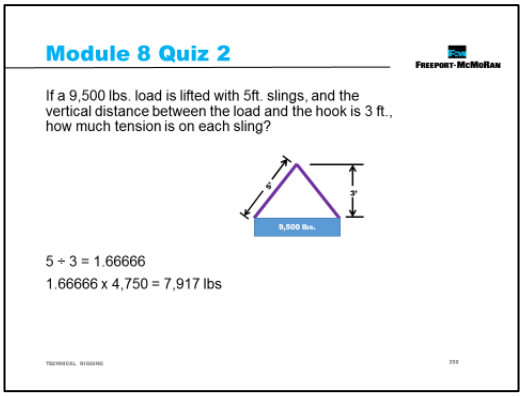
- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*
- *Note: This is question 27 on the pre-course test.*

Quiz Answer

- Answer: 1.155 x 315 lbs. = 363.825 lbs.

MODULE 8 QUIZ 2

PPT slide 258, SG page 139



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*
- *Note: This is question 27 on the pre-course test.*

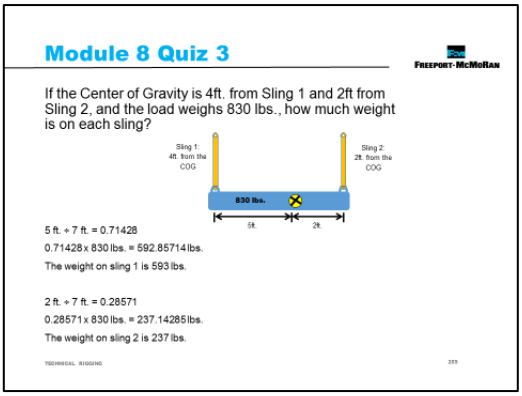
Quiz Answer

- Answer: 5 ÷ 3 = 1.66666

  1.66666 x 4,750 = 7,917 lbs.

MODULE 8 QUIZ 3

PPT slide 259, SG page 140



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

Answers:

2 ft. ÷ 7 ft. = 0.28571

0.28571 x 830 lbs. = 237.14285 lbs.

The weight on sling 1 is 237 lbs.

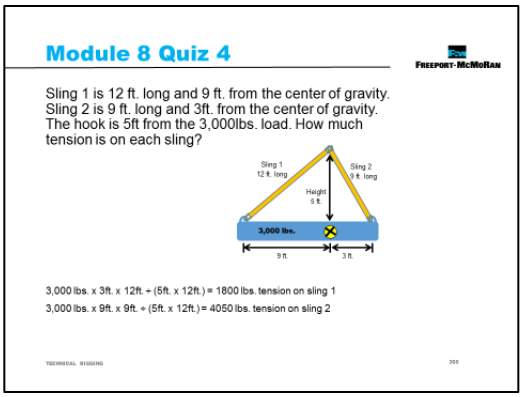
5 ft. ÷ 7 ft. = 0.71428

0.71428 x 830 lbs. = 592.85714 lbs.

The weight on sling 2 is 593 lbs.

MODULE 8 QUIZ 4

PPT slide 260, SG page 140



Instruction

- *Students will write answers to the quiz questions in the SG.*
- *Review the answers as a class.*

Quiz Answers

Answers:

3,000 lbs. x 3 ft. x 12 ft. ÷ 60 = 1,800 lbs. tension on sling 1

3,000 lbs. x 9 ft. x 9 ft. ÷ 60 = 4,050 lbs. tension on sling 2

RIGGING EXERCISES

This section of the course allows students the opportunity to practice using their Rigging Reference Guides to calculate load angle factors, slings stresses and the selection of the correct rigging equipment for the lift.

ACTIVITIES

This module consists of 20 rigging exercises.

MATERIALS

Throughout this module students will need:

- Rigging Reference Guides
  - 'Crosby Users Guide for Lifting'
  - Crane Institute of America 'Rigging Safety Reference'
- Calculators

FACILITATION

After a brief introduction about the importance of selecting the correct equipment for the job, explaining Rigging Reference Guides and how to use them, there are twenty Rigging Exercises - one per slide.

Exercise 1 & 2 are actually the same exercise. Students must determine the EIP Wire Rope size, and shackle size in exercise 1, then the eye bolt size in exercise 2. Completing the first exercise in stages is designed to aid learning:

1. Give them the load weight, sling angle and direction as to which card to use for the problem.
2. Ask them to work out the load angle factor.
3. Ask them to work out the weight on each sling. Do the calculation with them if necessary.
4. Direct them to the appropriate panel on the Crosby Card/CIA Card and ask them to determine the EIP Wire Rope size. Run through the table on the card with them if necessary.
5. Direct them to the appropriate panel on the Crosby Card/CIA Card and ask them to determine the shackle size. Run through the table on the card with them if necessary.
6. Direct them to the appropriate panel on the Crosby Card/CIA Card and ask them to determine the eye bolt size. Run through the table on the card with them if necessary.

Exercise 3 onwards: Give them the load weight and sling angle, and allow time to complete the whole exercise. Run through the answers with them. Do the calculations with them if necessary. Run through the table on the card with them if necessary.

NOTE: Students DO NOT have the load weight or sling angle in their Student Guide. The load weight and sling angle are on the slide, but not in the student guide, so that students do not jump ahead.

FACILITATION TIP

Explain that this whole module consists of exercises. Students will complete each exercise on their own, then they will run through the answer together. This will prepare the students for the module material.

PPT slide 261, SG page 142

Instruction

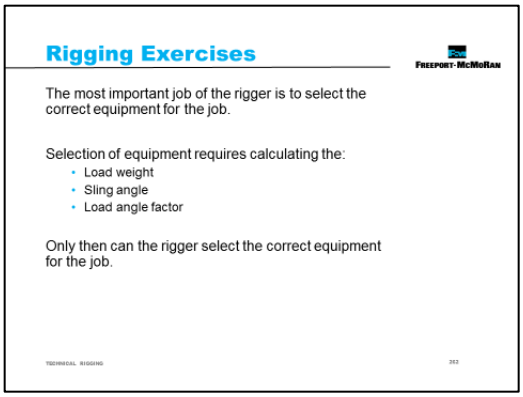
Go over the learning objectives for the module.

Upon completion of this module, students will be able to:

- Use Rigging Reference Guides to calculate the correct rigging equipment for a lift.

Explain that this section of the course offers students the opportunity to practice using their Rigging Reference Guides to calculate to calculate the correct equipment for the job.

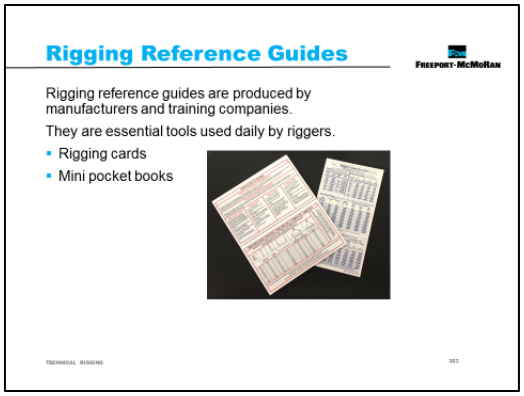
PPT slide 262, SG page 142



Instruction

- Throughout this course we have introduced you to rigging equipment, and how to safely use it.
- However, the most important job of a rigger is to select the correct equipment for the job.
- Selection of equipment requires calculating the:
  - Load weight
  - Sling angles
  - Load angle factors
- Only then can a rigger select the correct slings and hardware to conduct a safe lift.

PPT slide 263, SG page 142



Instruction

- Rigging reference guides are an essential tool used on a daily basis by riggers.
    - The Crosby Card produced by hardware manufacturer Crosby.
    - The CIA cards produced by The Crane Institute of America.
- They are durable weatherproof laminated cards that can be folded down to easily fit in a pocket or wallet.
- They are quick reference guides which include capacity charts and load angle factor lists for slings, hardware and hitches.
- They also include checklist reminders for important items such as risks, plans, and inspection criteria.
- Some hardware manufacturers and training institutes produce mini pocket books.

FACILITATION NOTE

Using 'Crosby Users Guide for Lifting', and the Crane Institute of America 'Rigging Safety Reference', students will complete the exercises on the following pages in class.

- *Explain that the Crosby Card is the main Rigging Reference Guide, but that it does not contain synthetic slings. The CIA card is used for selection of synthetic slings.*
- *Explain that some Rigging Reference Guides list weights in pounds, others in tons, and that some sections of the Crosby Card list weights in Metric Tons! A conversion chart has been provided to assist students in their calculations; see Appendix 3: Pounds/US Tons/Metric Tons Conversion Chart, page 157.*

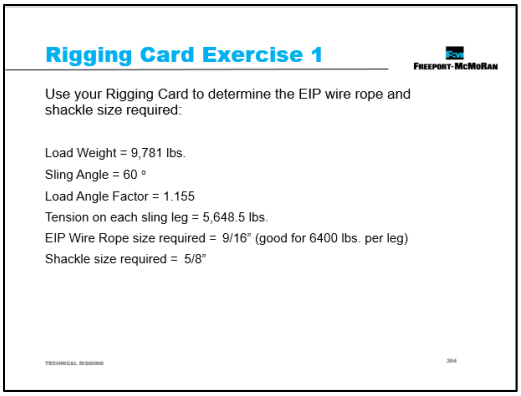
Explain that all calculations for selecting slings and hardware are based on the Single Leg Vertical columns of the Rigging Cards. The first step in each exercise is to work out the Load Angle Factor and the weight on each sling. They do not need to apply the increased tension again.

On the exercises which state "Eye Bolt / Hoist Ring": Students will look at the eye bolt WLL first and will discover that eye bolts are not suitable for this lift. Then will then select a hoist ring.

FACILITATION TIP

According to the Law of Exercise, learning is increased by repetition. The more you hear, see, or do something the greater chance of retention. This activity is a good example of using this law.

PPT slide 264, SG page 143



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 1

Load Weight = 9,781 lbs.

Sling Angle = 60°

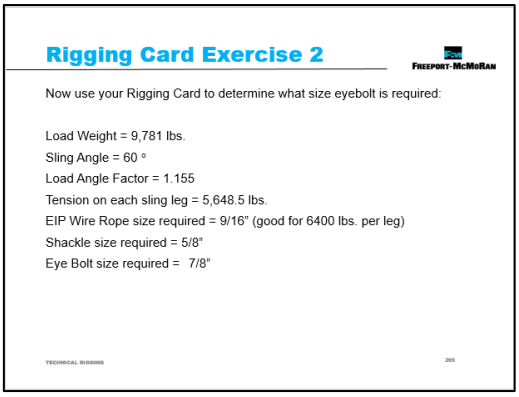
Load Angle Factor = 1.155

Tension on each sling leg = 5,648.5 lbs.

EIP Wire Rope size required = 9/16" (good for 6,400 lbs. per leg)

Shackle size required = 5/8"

PPT slide 265, SG page 143



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 2

Load Weight = 9,781 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

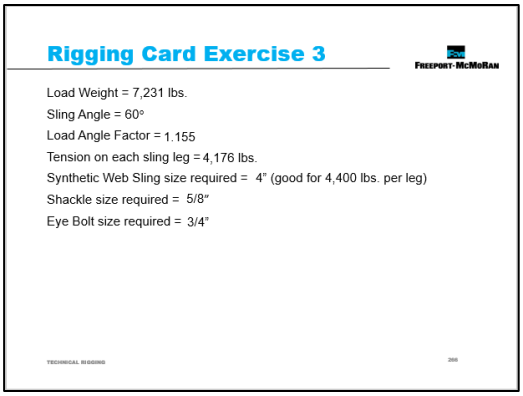
Tension on each sling leg = 5,648.5 lbs.

EIP Wire Rope size required = 9/16" (good for 6400 lbs. per leg)

Shackle size required = 5/8"

Eye Bolt size required = 7/8"

PPT slide 266, SG page 144



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 3

Load Weight = 7,231 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

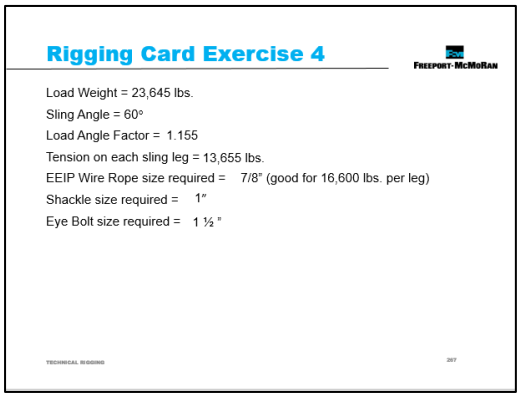
Tension on each sling leg = 4,176 lbs.

Synthetic Web Sling size required = 4" (good for 4,400 lbs. per leg)

Shackle size required = 5/8"

Eye Bolt size required = ¾"

PPT slide 267, SG page 144



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 4

Load Weight = 23,645 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

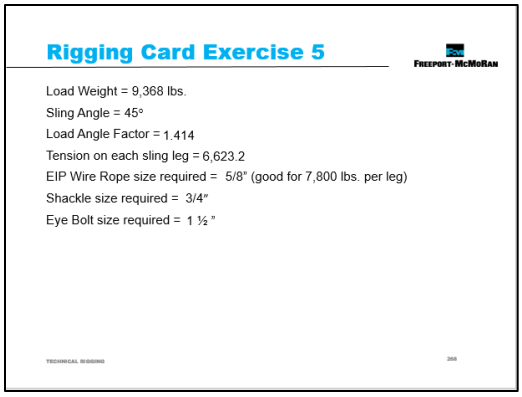
Tension on each sling leg = 13,655 lbs.

EEIP Wire Rope size required = 7/8" (good for 16,600 lbs. per leg)

Shackle size required = 1"

Eye Bolt size required = 1 ½"

PPT slide 268, SG page 145



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 5

Load Weight = 9,368 lbs.

Sling Angle = 45°

Load Angle Factor = 1.414

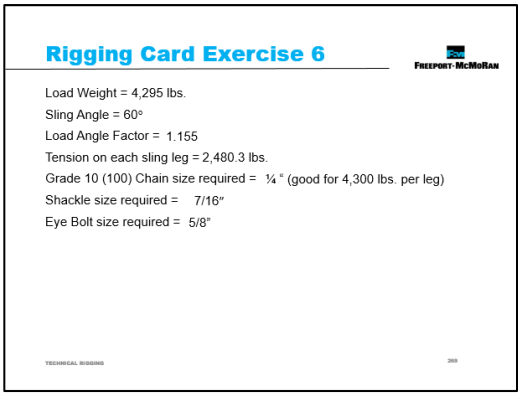
Tension on each sling leg = 6,623.2 lbs.

EIP Wire Rope size required = 5/8" (good for 7,800 lbs. per leg)

Shackle size required = ¾"

Eye Bolt size required = 1 ½"

PPT slide 269, SG page 145



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 6

Load Weight = 4,295 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

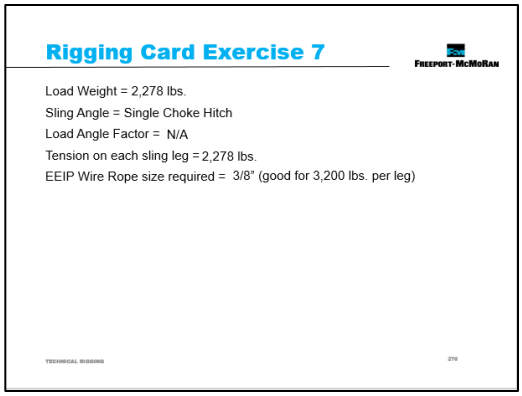
Tension on each sling leg = 2,480.3 lbs.

Grade 10 (100) Chain size required = ¼" (good for 4,300 lbs. per leg)

Shackle size required = 7/16"

Eye Bolt size required = 5/8"

PPT slide 270, SG page 146



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 7

Load Weight = 2,278 lbs.

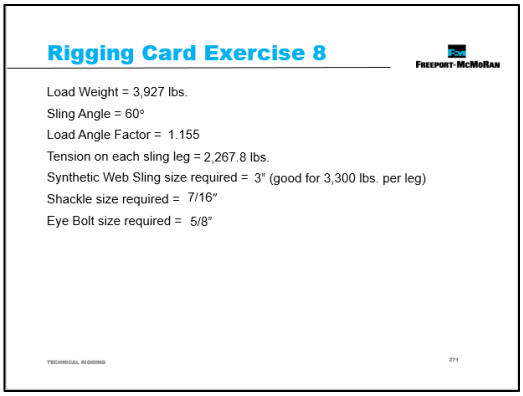
Sling Angle = Single Choke Hitch

Load Angle Factor = N/A

Tension on each sling leg = 2,278 lbs.

EEIP Wire Rope size required = 3/8" (good for 3,200 lbs. per leg)

PPT slide 271, SG page 146



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 8

Use your Rigging Card to fill in the blanks:

Load Weight = 3,927 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

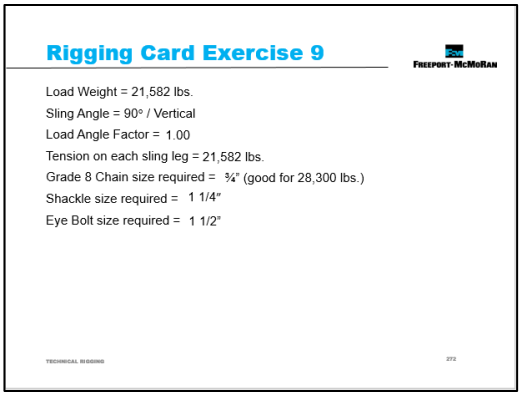
Tension on each sling leg = 2,267.8 lbs.

Synthetic Web Sling size required = 3" (good for 3,300 lbs. per leg)

Shackle size required = 7/16"

Eye Bolt size required = 5/8"

PPT slide 272, SG page 147



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 9

Use your Rigging Card to fill in the blanks:

Load Weight = 21,582 lbs.

Sling Angle = 90°/ vertical

Load Angle Factor = 1.00

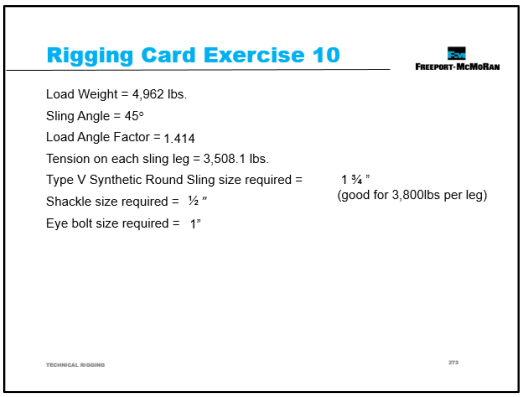
Tension on each sling leg = 21,582 lbs.

Grade 8 Chain size required = ¾" (good for 28,300 lbs.)

Shackle size required = 1 ¼"

Eye Bolt size required = 1 ½"

PPT slide 273, SG page 147



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 10

Load Weight = 4,962 lbs.

Sling Angle = 45°

Load Angle Factor = 1.414

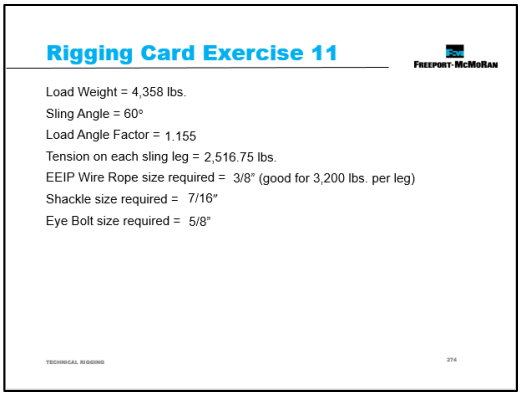
Tension on each sling leg = 3,508.1 lbs.

Type V Synthetic Round Sling size required = 1 3/4" (good for 3,800 lbs. per leg)

Shackle size required = ½"

Eye Bolt size required = 1"

PPT slide 274, SG page 148



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 11

Load Weight = 4,358 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

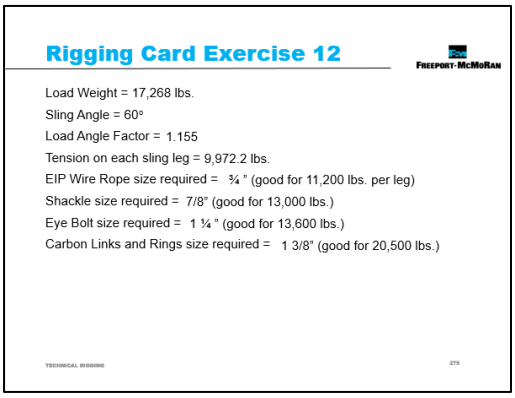
Tension on each sling leg = 2,516.75 lbs.

EEIP Wire Rope size required = 3/8" (good for 3,200 lbs. per leg)

Shackle size required = 7/16"

Eye Bolt size required = 5/8"

PPT slide 275, SG page 148



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 12

Load Weight = 17,268 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

Tension on each sling leg = 9972.2 lbs.

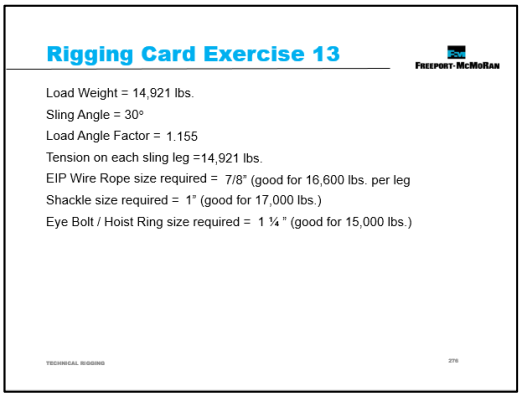
EIP Wire Rope size required = ¾" (good for 11,200 lbs. per leg)

Shackle size required = 7/8" (good for 13,000 lbs.)

Eye Bolt size required = 1 ¼" (good for 13,600 lbs.)

Carbon Links and Rings size required = 1 3/8" (good for 20,500 lbs.)

PPT slide 276, SG page 149



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 13

Load Weight = 14,921 lbs.

Sling Angle = 30°

Load Angle Factor = 1.155

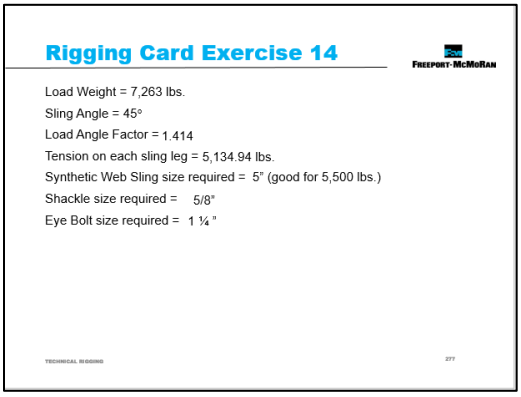
Tension on each sling leg = 14,921 lbs.

EIP Wire Rope size required = 7/8" (good for 16,600 lbs. per leg)

Shackle size required = 1" (good for 17,000 lbs.)

Eye Bolt / Hoist Ring size required = 1 ¼" (good for 15,000 lbs.)

PPT slide 277, SG page 149



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 14

Load Weight = 7,263 lbs.

Sling Angle = 45°

Load Angle Factor = 1.414

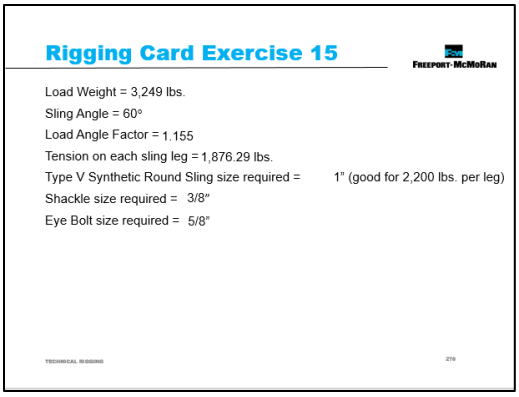
Tension on each sling leg = 5,134.94 lbs.

Synthetic Web Sling size required = 5" (good for 5,500 lbs.)

Shackle size required = 5/8"

Eye Bolt size required = 1 ¼"

PPT slide 278, SG page 150



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 15

Load Weight = 3,249 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

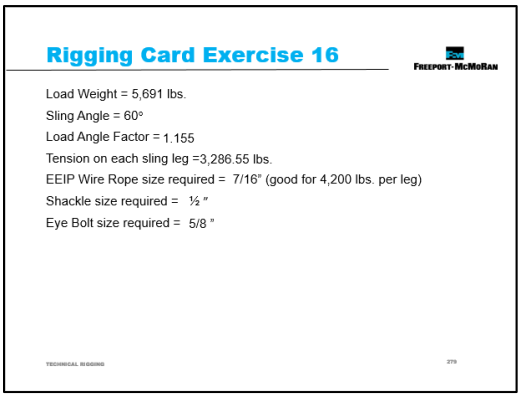
Tension on each sling leg = 1,876.29 lbs.

Type V Synthetic Round Sling size required = 1" (good for 2,200 lbs. per leg)

Shackle size required = 3/8"

Eye Bolt size required = 5/8"

PPT slide 279, SG page 150



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 16

Load Weight = 5,691 lbs.

Sling Angle = 60°

Load Angle Factor = 1.155

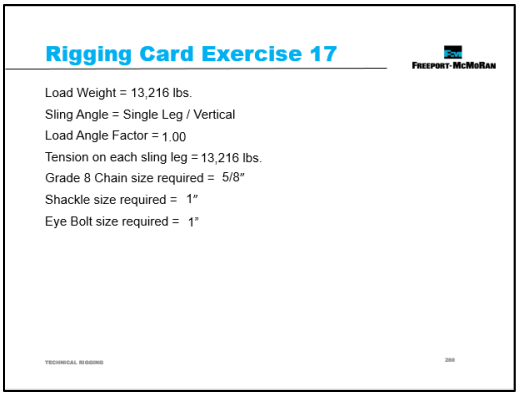
Tension on each sling leg = 3,286.55 lbs.

EEIP Wire Rope size required = 7/16" (good for 4,200 lbs. per leg)

Shackle size required = ½"

Eye Bolt size required = 5/8"

PPT slide 280, SG page 151



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 17

Load Weight = 13,216 lbs.

Sling Angle = Single Leg / Vertical

Load Angle Factor = 1.00

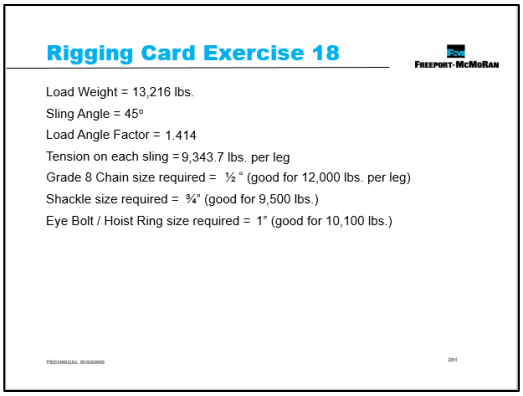
Tension on each sling leg = 13,216 lbs.

Grade 8 Chain size required = 5/8”

Shackle size required = 1”

Eye Bolt size required = 1”

PPT slide 281, SG page 151



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 18

Load Weight = 13,216 lbs.

Sling Angle = 45°

Load Angle Factor = 1.414

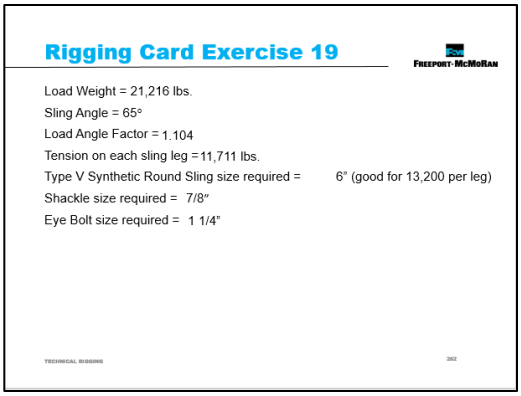
Tension on each sling leg = 9343.7 lbs. per leg

Grade 8 Chain size required = ½” (good for 12,000 lbs. per leg)

Shackle size required = ¾” (good for 9,500 lbs.)

Eye Bolt/ Hoist Ring size required = 1” (good for 10,100 lbs.)

PPT slide 282, SG page 152



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 19

Load Weight = 21,216 lbs.

Sling Angle = 65°

Load Angle Factor = 1.104

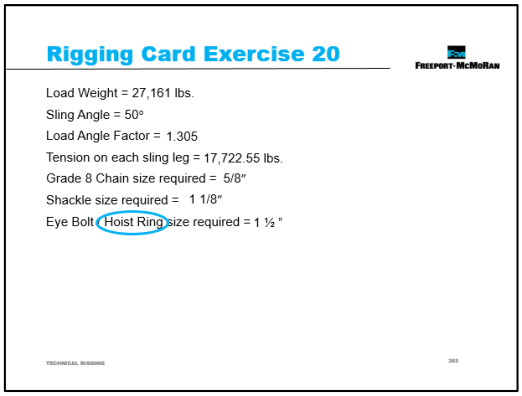
Tension on each sling leg = 11,711 lbs.

Type V Synthetic Round Sling size required = 6" (good for 13,200 per leg)

Shackle size required = 7/8"

Eye Bolt size required = 1 ¼"

PPT slide 283, SG page 152



Instruction

- Students are to use their Rigging Card to fill in the blanks.
- Students are to circle which is the better choice for the lift: Eye Bolt or Hoist Ring.
- *Students will write their answers in the SG.*
- *Review the answers as a class.*

Exercise 20

Load Weight = 27,161 lbs.

Sling Angle = 50°

Load Angle Factor = 1.305

Tension on each sling leg = 17,722.55 lbs.

Grade 8 Chain size required = 5/8"

Shackle size required = 1 1/8"

Eye Bolt/Hoist Ring size required = 1 ½"

CONCLUSION

This module concludes the course with knowledge assessments and feedback opportunities.

ACTIVITIES

- Assessment: Post Course Test
- Review: Pre & Post Course Test Review
- Assessment: Practical Assessment
- Student Feedback

MATERIALS

- Assessment 2:
  - Post Course Test Paper - 1 per student
  - Rigging Reference Guides – 1 per student
    - 'Crosby Users Guide for Lifting'
    - Crane Institute of America 'Rigging Safety Reference'
  - Calculators – I per student

- Review: Pre & Post Course Test Review
  - Graded pre course test paper
  - Graded post course test paper

- Assessment: Practical Assessment
  - Practical Assessment paper – 1 per student

  - Hardware examples including B/O items:
    - Hooks
    - Shackles
    - Eye Bolts
    - Hoist Rings
    - Turnbuckles
    - Master Links
    - Makeshift Hardware
    - Plate Clamps / Lifting Magnets
    - Lifting Beams / Spreader Bars
    - Wire Rope Clips / Thimbles
    - Rigging Blocks

  - Sling examples including B/O items:
    - Wire Rope Slings
    - Synthetic Web Slings
    - Synthetic Continuous Slings
    - Alloy Steel Chain Sling
    - Damaged / Defective Slings
    - Manufacturers Capacity Tags

        - Sling Storage Areas / Unused Slings
    - Hoist & Lifter examples including B/O items:
        - Come Alongs
        - Chain Hoists
        - I Beams
        - Beam Trolleys
        - Hoists without Straight Line Pull
    - Have a load / loads set up for students to rig:
        - Large / heavy item(s)
        - Rigging Reference Guides
        - Calculators
        - Hitches
        - Softeners

- Student Feedback
    - Student end of course questionnaire (in back of student guide).

FACILITATOR PREPARATION

Plan how you will run assessments:

- How will you run the multiple assessments?
- Do you need additional trainers to help facilitate the practical assessments?

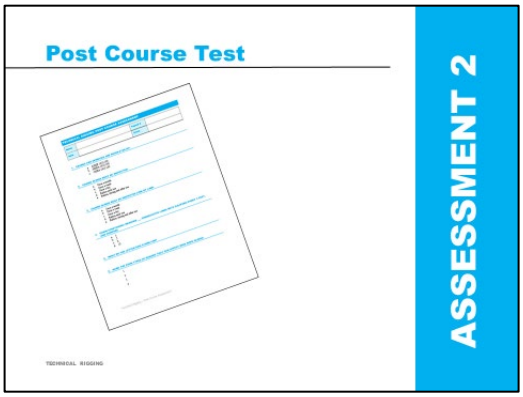
PPT slide 284

Instruction

The conclusion covers:

- Assessment
  - Post Course Test
  - Practical Assessment
- Review
  - Pre & Post Course Test Review
- Feedback
  - Student End of Course Survey

PPT slide 285



Materials

- Test Paper (make one copy per student)
- Crosby Cards

Purpose

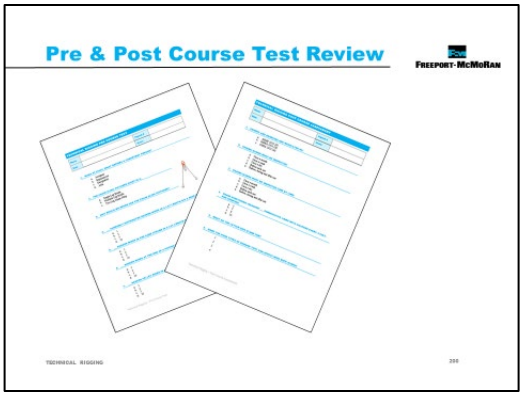
- This activity is to find out what employees have learned on the course.
- Students will be able to compare their pre and post test scores, and see firsthand what they have learned.

Instructions

1. Explain that the post course test is to see what they have learned on the course.
2. Explain that students will see their own pre and post test scores to compare their knowledge before and after the course.
3. Hand out the test paper:
   - Explain that the questions are mostly multiple choice multiple choice (where there may be multiple answers), fill in the gaps, labelling diagrams, with a few calculations.
   - Explain that they are not to look answers up in the book, however, if they know how to use Rigging Cards, they may use them for the rigging problems.
4. When the students have finished collect the papers.
5. Papers will be graded by the instructor and returned to the students for review and comparison of their pre and post course test scores.

NOTE: Students must pass 80% of all questions before a 5000-23 can be issued. Provide remediation if appropriate.

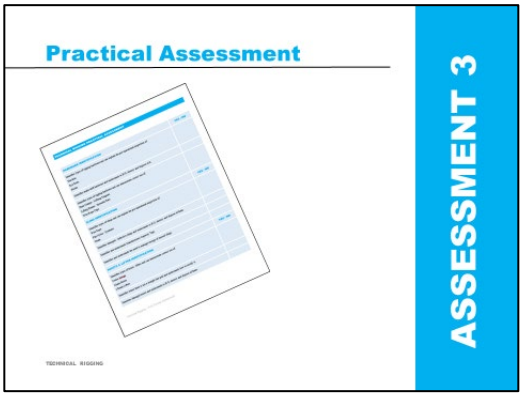
PPT slide 286



Instruction

- Return the graded Pre & Post Course test papers to the students.
- Go through the Post Course Test questions and answers with the class. (Pre Course Test questions were discussed as quiz questions throughout the course.)
- Discuss any answers where there is a difference of opinion and explain the correct answer.
- Ask students to compare their own Pre and Post Course scores, to see what they have learned during the course.

PPT slide 287



Instruction

Materials

- Practical Assessment Checklist (make one copy per student)
- Have an area set up with the following materials (good examples for students to identify, and bad examples for the students to inspect):
  - Shackles
  - Eye Bolts
  - Hooks
  - Hoist Rings
  - Turnbuckles
  - Master Links
  - Makeshift Hardware
  - Plate Clamps / Lifting Magnets
  - Lifting Beams / Spreader Bars
  - Wire Rope Clips / Thimbles
  - Rigging Blocks
  - Wire Rope Slings
  - Synthetic Web Slings
  - Synthetic Round Slings
  - Alloy Steel Chain Sling
  - Damaged / Defective Slings
  - Manufacturers Capacity Tags
  - Sling Storage Areas / Unused Slings

Continued on next page

  - Come Alongs
  - Chain Hoists
  - I Beams
  - Beam Trolleys
  - Hoists without Straight Line Pull
  - Damaged Hoists
- Have a load / loads set up so that the following can be demonstrated by students:
  - Load weight calculation
  - Load angle calculation
  - Center of Gravity calculation
  - Selection of an appropriate hitch
  - Correct use of softeners
  - Ability to remain out of the line of fire when using a tag line

Purpose

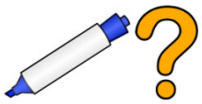
- These activities are to find out what employees have learned during this course.
- Students will be expected to identify rigging equipment

Instructions

1. Explain that the practical assessment is to see what they have learned during this course.
2. Explain that they will be required to:
   - Identify rigging equipment and explain equipment inspection.
   - Demonstrate standard Hand Signals and explain Crane Dynamics.
   - Demonstrate the correct rigging techniques to make a safe lift.

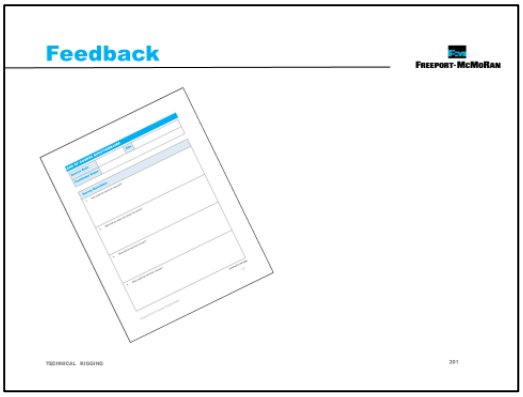
NOTE: Students must pass all items to receive their 5000-23. Provide remediation if appropriate.

PPT slide 288



Instruction

- Have students complete the Student End of Course Questionnaire (in SG).
- If you have time, discuss questions 1 to 5 with the class, writing group feedback on the flip chart or white board.
- Collect the completed questionnaires from students and hand them their 5000-23.



FACILITATION TIP

Ask them about their key learnings – their "ahas"- as these occur during the training and the "so what' – how they can use each of them. (Making Learning Stick Barbara Carnes, 2010)

KNOWLEDGE & PRACTICAL ASSESSMENT REQUIREMENTS

Proof of a passing knowledge assessment and required in-field assessments must be available for audit purposes.

Resources

RESOURCES

This section contains additional resources that could develop further knowledge on the content of the course:

- *Appendices* provide additional material that supports the content found within the course:
  - Appendix 1: Federal Regulations (Student Guide page 154)
  - Appendix 2: Hoist Operators Do's & Don'ts (Student Guide page155 & 156)
  - Appendix 3: Pounds / UD Tons / Metric Tons Conversion Chart (Student Guide page 157)

- The *Facilitator Feedback Survey* should be completed at the conclusion of the class and turned in according to the directions on the form.

APPENDICES

APPENDIX 1: FEDERAL REGULATIONS

Rigging practices are covered by regulations from several federal agencies. Your site has a library of these documents for you to access.

OSHA 1910.179 - Overhead and gantry cranes
OSHA 1910.180 - Crawler locomotive and truck cranes
OSHA 1910.181 - Derricks
OSHA 1910.184 – Slings

OSHA 1926.1400 – Cranes and Derricks in Construction

OSHA 1926.1419 - Signals

Why OSHA regulations and not MSHA? The Department of Labor has a regulation which states “if MSHA does not have a regulation which covers a specific task the OSHAct shall be applied”.

https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=standards&p_toc_level=0

ASME B30 - Covers all cranes and rigging equipment

ASME B30.5 - Covers Mobile Cranes

ASME B30.9 - Covers Slings

ASME B30.10 - Covers Hooks

ASME B30.20 – Covers Below-the-Hook Lifting Devices

ASME B30.26 – Covers Rigging Hardware

Additionally for overhead crane: B30.2 covers Overhead & Gantry Cranes

APPENDIX 2: HOIST OPERATORS DO'S & DON'TS

The hoist operator shall:

- Be familiar with operating controls, procedures, and warnings.
- Inspect the hoist regularly, keeping records of inspection.
- Immediately shut down damaged or malfunctioning hoists.
- Report damaged or worn parts identified during inspection.
- Report malfunctions or unusual performances.
- Maintain a firm footing or be otherwise secured when operating the hoist.
- Check brake function by tensioning the hoist prior to each lift or pulling operation.
- Avoid lever "fly-back" by keeping a firm grip on the lever until operating stroke is completed and the lever is at rest.
- Make sure the load is free to move and will clear all obstructions.
- Avoid swinging the load or hook.
- Protect the hoist's load chain from damage.
- Use hooks with latches, ensuring that the latches are closed and not supporting any parts of the load.

The hoist operator shall NOT:

- Operate the hoist until they have thoroughly read and understood the manufacturer's Operating Manual.
- Operate a hoist on which the safety placards or decals are missing or illegible.
- Remove or obscure the warnings on the hoist.
- Operate a damaged, malfunctioning or unusually performing hoist.
- Operate a hoist which has been modified without the manufacturer's approval or certification.
- Adjust or repair the hoist – only a qualified perform can perform such work.
- Permit more than one operator to pull on lever at the same time, causing hoist overload.
- Operate hoist when it is restricted from forming a straight line from hook to hook in the direction of loading.
- Allow the hoist to be subjected to sharp contact with other hoists, structures, or objects through misuse.
- Operate a hoist which has not been securely attached to a suitable support, to support the hoist rigging and load.
- Lift or pull more than rated load for the hoist.
- Use the hoist load limiting or warning device to measure load.

Continued on next page

- Operate with any lever extension such as a cheater bar.
- Use the hoist to lift, support, or transport people.
- Lift loads over people and make sure all personnel remain clear of the supported load.
- Operate a hoist unless all persons are and remain clear of the supported load.
- Attempt to "free-chain" the hoist while a load is applied.
- Use hoist with twisted, kinked, damaged, or worn load chain.
- Use load chain as a sling or wrap load chain around load.
- Attempt to lengthen the load chain or repair damaged load chain.
- Apply load unless load chain is properly seated in the chain wheel(s) or sprocket(s).
- Apply load if bearing prevents equal loading on all load supporting chains.
- Operate beyond the limits of the load chain travel.
- Allow the chain or hook to be used as an electrical or welding ground.
- Allow the chain or hook to be touched by a live welding electrode.
- Apply the load to the tip of the hook or to the hook latch.
- Operate a hoist unless load slings or other approved single attachments are properly sized and seated in the hook saddle.
- Lift loads that are not balanced.
- Leave load supported by the hoist unattended unless specific precautions have been taken.
- Allow your attention to be diverted from operating the hoist.

American Society of Mechanical Engineers, B30.16, Overhead Hoists (Underhung)

APPENDIX 3: POUNDS/US TONS/METRIC TONS CONVERSION CHART

POUNDS	SHORT TONS (US)	METRIC TONS
100	0.05	0.0454
200	0.1	0.0907
300	0.15	0.1361
400	0.2	0.1814
500	0.25	0.2268
600	0.3	0.2722
700	0.35	0.3175
800	0.4	0.3629
900	0.45	0.4082
1000	0.5	0.4536
1100	0.55	0.499
1200	0.6	0.5443
1300	0.65	0.5897
1400	0.7	0.635
1500	0.75	0.6804
1600	0.8	0.7257
1700	0.85	0.7711
1800	0.9	0.8165
1900	0.95	0.8618
2000	1	0.9072
3000	1.5	1.3608
4000	2	1.8144
5000	2.5	2.268
6000	3	2.7216
7000	3.5	3.1751
8000	4	3.6287
9000	4.5	4.0823
10000	5	4.5359

FACILITATOR FEEDBACK SURVEY

Course Name	
Facilitator Name	

1. What worked well in the course? Please explain.

2. Were the topics effectively sequenced? If not, please provide suggestions for change.

3. Was the content up-to-date with current processes, equipment, etc.? If not, please provide specific examples.

4. Was the content at the appropriate level of difficulty? If not, please provide examples.

5. What in the course needs improvement? Please provide specific examples.

6. Were the teaching materials (PPT, FG, etc.) of high quality? If not, please provide examples.

7. Were there any inaccuracies or missing content? If so, please provide examples.

8. Do any of the issues you've identified need to be addressed immediately? If so, please list which ones.

Please mail to: Mine Training Institute, Attention: Darrell Nielsen, 18550 S. La Canada Drive, Sahuarita, AZ 85629

Or scan and email to: DG-PHX-EvaluationFeedback@fmi.com