Task Title: Millwright Hoisting and Rigging

OALCF Cover Sheet – Learner Copy

Learner Name:_____

Date Started (m/d/yyyy):_____

Date Completed (m/d/yyyy): _____

Successful Completion: Yes ☐ No ☐

Goal Path:		Employment	☐	Apprenticeship	☐
Secondary School	☐	Post Secondary	☐	Independence	☐

Task Description:

The learner will read text and interpret documents and charts to make calculations related to hoisting and rigging duties required of a millwright.

Main Competency / Task Group / Level Indicator:

- Find and Use Information/Read continuous text/A1.2
- Find and Use Information/Interpret documents/A2.2
- Understand and Use Numbers/Use Measures/C3.3

Materials Required:

- Pen/pencil and paper and/or digital device
- Scientific Calculator

Learner Information

Millwrights determine the correct equipment to use when performing a lift. This will include calculating weight measures and the capacity of components such as eyebolts, slings and shackles using charts available through the manufacturer or employer.

Read **Understanding Working Load Limits for Hoisting and Rigging** including the formulas and charts.

Understanding Working Load Limits for Hoisting and Rigging

A safe rigging operation requires the rigger to know

• the weight of the load and rigging hardware

• the capacity of the hoisting device

• the working load limit of the hoisting rope, slings, and hardware.

When the weights and capacities are known, the rigger must then determine how to lift the load so that it is stable.

A minimum of three components are used for Hoisting and Rigging. They include the Eyebolts, Shackles and Slings. There may be more components used depending on the lift. Additionally, more than one of each of the components may be used for the lift.

Factors that affect hoisting safety include working load limits, defective components, questionable equipment, hazardous wind conditions, weather conditions, electrical contact and the hoist line not being plumb.

- **Working Load Limit** (WLL) - is used to determine the maximum strength that a component such as the eyebolt, shackle and sling can safely lift the weight of the load.

The design factor is a crucial safety concept in rigging, ensuring that slings can withstand more than the loads they're designed to carry. The design factor is the ratio between the minimum breaking strength (MBS) of a sling and its permissible working load (WLL). If a sling has a design factor of 5:1, it means that the sling's breaking strength is five times its WLL. Design factors are determined by the manufacturer of the sling and should never be exceeded.

The example below is for wire rope of Improved Plow steel with a design factor of 5, but there are many types of slings used for hoisting. The following formula can be used to compute the working load limit of a wire rope in tons (2,000 pounds).

Formula for Working Load Limit

WLL = DIAMETER x DIAMETER x 8
(where DIAMETER = nominal rope diameter in inches)
OR
WLL = D^2 x 8

SINGLE VERTICAL HITCH Example:

1/2-inch diameter rope
WLL = 1/2 x 1/2 x 8 = 2 tons

Sling Angles

The Single Vertical Hitch supports a load by a single vertical part or leg of the sling. The total weight of the load is carried by a single leg; the sling angle is 90° (sling angle is measured from the horizontal) and the weight of the load can equal the working load limit of the sling and fittings.

The total weight that you can pick up with a set of slings is reduced when the slings are used at angles (formed the with horizontal). For instance, two slings used to lift 1000 pounds will have a 500-pound force on each sling (or leg) at a sling angle of 90 degrees. The force on each leg increases as the angle goes down. For example, at 30 degrees the force will be 1000 pounds on each leg.

Keep sling angles greater than 45 degrees whenever possible. Using any sling at an angle lower than 30 degrees is extremely hazardous. In such cases, an error of 5 degrees in estimating the sling can be very dangerous. Low sling angles also create large, compressive forces on the load that may cause buckling— especially in longer flexible loads.

Slings - Safe Load in Tons

Nominal Size	 Single	 Choker	 U-sling	 Basket	 60- deg	 45-deg	 30-deg
¼”	.5	.3	.7	.6	.57	.5	.3
5/16”	.8	.6	1.1	1.0	.9	.7	.6
3/8”	1.1	.8	1.5	1.4	1.3	1.1	.8
½”	2.0	1.4	2.7	2.4	2.3	1.9	1.3
5/8”	2.9	2.1	4.2	3.8	3.7	3.0	2.1
¾”	4.1	3.0	6.0	5.4	5.2	4.2	3.0
7/8”	5.6	3.8	7.7	6.8	6.7	5.4	3.8
1”	7.2	5.0	10.0	9.3	8.7	7.1	5.0
1 1/8”	9.0	5.6	11.2	10.5	9.7	7.9	5.6

Drop Forged Steel Shoulder-type Eyebolts

Size			
1/4"	300 lb	30 lb	40 lb
1/2"	1,300 lb	140 lb	150 lb
3/4"	3,000 lb	250 lb	300 lb
1"	6,000 lb	500 lb	600 lb
1 1/4"	9,000 lb	800 lb	900 lb
1 1/2"	13,000 lb	1,200 lb	1,300 lb
2"	23,000 lb	2,100 lb	2,300 lb
2 1/2"	37,000 lb	3,800 lb	4,300 lb

Anchor Shackles

Nominal Size	Tons Safe Load	Dimensions		
		A	B	C
3/8”	.8	1 1/2	1 1/16	7/16
½”	1.4	2	7/8	5/8
5/8”	2.2	2 3/8	1 1/16	3/4
¾”	3.2	2 7/8	1 1/4	7/8
7/8”	4.3	3 1/4	1 3/8	1
1”	5.6	3 5/8	1 11/16	1 1/8
1 1/8”	6.7	4 1/4	1 7/8	1 1/4
1 ¼”	8.2	4 3/4	2	1 3/8
1 ½”	11.8	5 1/2	2 1/4	1 5/8
2”	21.1	7 3/4	3 1/4	2 1/4

Dimensions refer to the size of the shackle.

A - Height

B - Width

C- Pin diameter

Work Sheet

Task 1: List the three components used for hoisting and rigging.

Answer:

Task 2: Hoisting and rigging loads are measured in tons. Calculate the tons for 2489 pounds (lbs) using the formula below.

Formula: pounds ÷ 1 ton (2000 lbs) = weight in tons

Answer:

Task 3: According to the Slings - Safe Load in Tons chart, what is the nominal size for a 60-degree sling with a load of 5.2 tons.

Answer:

Task 4: Use the Drop Forged Steel Shoulder-type Eyebolts chart to locate the weight load for an eyebolt size of 1 inch at a 90-degree angle.

Answer:

Task 5: Use the Anchor Shackles chart to locate the height, width and pin diameter of a shackle with a nominal size of 7/8 inches.

Answer:

Task 6: Calculate the working load limit (WLL) for 5/8-inch diameter rope.

Answer:

Task 7: What is the load on each sling for Minimum Recommended lift?

Answer: