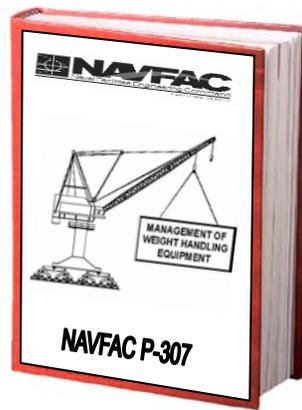




Navy Crane Center



NAVFAC P-307 Training

CATEGORY 3 (NON CAB) CRANE SAFETY WEB BASED TRAINING STUDENT GUIDE NCC-C3CS-02

Naval Facilities Engineering Command
Navy Crane Center
Norfolk Naval Shipyard, Bldg. 491
Portsmouth, VA 23709-5000
Comm. Phone: 757.967.3803, DSN: 387
Fax: 757.967.3808
<https://portal.navfac.navy.mil/ncc>

TABLE OF CONTENTS

INTRODUCTION TO CATEGORY 3 CRANE SAFETY	15
NAVIGATING THROUGH THIS COURSE	15
KNOWLEDGE CHECKS	15
FILL-IN-THE-BLANK.....	15
DRAG-AND-DROP	16
MULTIPLE CHOICE – SINGLE ANSWER	16
MULTIPLE CHOICE – MULTIPLE ANSWER.....	16
TRUE AND FALSE	17
EXAM DIRECTIONS	17
NAVFAC P-307	19
PURPOSE	19
APPLICABILITY	19
NAVFAC P-307 CONTENTS	19
WEIGHT HANDLING REQUIREMENTS	19
WHE MAINTENANCE AND INSPECTION.....	19
CERTIFICATION POSTING	20
NAVFAC P-307 COVERED EQUIPMENT	20
NAVFAC P-307 OVERVIEW SECTION 1.....	20
CATEGORY 1 CRANES	20
CATEGORY 1 CRANE EXAMPLES	21
MOBILE BOAT HOIST	21
MOBILE BOAT HOIST - LCRU	22
RUBBER TIRE GANTRY CRANE	22
CATEGORY 2 AND 3 CRANES.....	22
CATEGORY 2 AND 3 CRANE CAPACITY.....	22
CATEGORY 4 CRANES	23
MOUNTING.....	23
BOOMS.....	23
PEDESTAL MOUNTED - CAPACITY	23
SPECIAL CONSIDERATIONS	23
CATEGORY 4 CRANE TYPES	24
CATEGORY 4 CRANE COMPONENTS	24
LICENSING (SECTIONS 6, 7, AND 8).....	25

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

NAVFAC P-307 SECTION 12: CRANE AND RIGGING ACCIDENTS..... 25

NAVFAC P-307 SECTION 13: TRAINING..... 25

NAVFAC P-307 SECTION 14: RIGGING GEAR 25

NAVFAC P-307 SUMMARY 26

NAVFAC P-307 MODULE EXAM QUESTIONS & ANSWERS 28

CATEGORY 3 CRANE TYPES 31

 OVERHEAD CRANES 31

 GANTRY CRANES 31

 WALL CRANES 31

 JIB CRANES 31

 PILLAR JIB CRANES 31

 PILLAR CRANES 32

 MONORAIL CRANES 32

 OVERHEAD HOISTS 32

 PEDESTAL MOUNTED COMMERCIAL BOOM ASSEMBLIES 32

CRANE PRE-USE CHECKS..... 35

 PRE-USE INSPECTION: PURPOSE 35

 DOCUMENTED INSPECTION 35

 OPERATOR’S DAILY CHECK LIST 35

 WALK AROUND INSPECTION..... 36

 AREA SAFETY 37

 STRUCTURAL INTEGRITY..... 37

 LEAK CHECKS..... 37

 POWER SOURCE 38

 WARNING TAGS 38

 DANGER TAGS 38

 CAUTION TAGS 39

 OUT-OF-SERVICE TAGS..... 39

 LOCKOUT TAGS..... 39

 WHO CAN REMOVE WARNING TAGS?..... 39

 CONTROLLERS..... 40

 CHECKING BUTTONS 40

 NO-LOAD OPERATIONAL TEST 40

 CONTROLLER ACTION..... 40

 CONTROLLER OPERATION 40

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

SAFETY DEVICES	41
SAFETY GUARDS AND PLATES	41
UPPER LIMIT SWITCH	41
UPPER LIMIT SWITCH TEST	41
LOWER LIMIT SWITCH TESTING	41
LOWER LIMIT - MINIMUM WRAPS	42
EMERGENCY STOP TEST	42
TESTING BRIDGE AND TROLLEY FUNCTIONS	42
TESTING BRAKES	42
WIRE ROPE OR CHAIN INSPECTION	43
CHAIN INSPECTION	43
HOOK BLOCK INSPECTION	43
HOOK INSPECTION	43
BOOM TRUCK INSPECTION	44
FINDING DEFICIENCIES	44
CRANE PRE-USE CHECKS MODULE EXAM QUESTIONS & ANSWERS	46
DETERMINING LOAD WEIGHT	49
LOAD WEIGHT	49
DETERMINING LOAD WEIGHT: ACCEPTABLE METHODS	49
DETERMINING LOAD WEIGHT: UNACCEPTABLE METHODS	49
DETERMINING LOAD WEIGHT: BASIC RULES.....	49
STANDARD MATERIAL WEIGHT	49
FINDING WEIGHT.....	50
CALCULATING WEIGHT BY AREA.....	50
CALCULATING WEIGHT BY VOLUME	50
CALCULATING AREA	50
CALCULATING THE AREA OF A TRIANGLE	51
CALCULATING THE AREA OF A CIRCLE	51
CALCULATING THE WEIGHT OF COMPLEX SHAPES.....	51
CALCULATING AREA - EXAMPLE	52
CALCULATING WEIGHT OF A TRIANGLE - EXAMPLE	53
CALCULATING THE AREA OF A CIRCLE - EXAMPLE	53
CALCULATING VOLUME	54
VOLUME OF A CYLINDER	54
CALCULATING THE VOLUME OF A CYLINDER - EXAMPLE	55

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

DETERMINING LOAD WEIGHT MODULE EXAM QUESTIONS & ANSWERS.....	57
LOAD WEIGHT DISTRIBUTION	59
BALANCING POINT.....	59
CENTER OF GRAVITY.....	59
IMPORTANCE OF CENTER OF GRAVITY.....	59
FINDING THE BALANCING POINT	59
PINPOINTING THE CENTER OF GRAVITY	60
CENTER OF GRAVITY REVIEW	61
WEIGHT DISTRIBUTION	61
A WRONG ASSUMPTION	62
HOW MANY LEGS REALLY CARRY THE LOAD?	62
A SAFE ASSUMPTION	62
HOW DO WE KNOW HOW MUCH WEIGHT IS IN EACH LEG?	62
EQUAL WEIGHT DISTRIBUTION	63
(UNEQUAL) WEIGHT DISTRIBUTION.....	63
INFORMATION NEEDED TO CALCULATE WEIGHT DISTRIBUTION.....	63
WEIGHT DISTRIBUTION - EXAMPLE	63
RIGGING GEAR MARKING AND RECORD REQUIREMENTS	65
NAVFAC P-307 SECTION 14.....	65
THE TEST AND INSPECTION PROGRAM.....	65
WHY TEST AND INSPECTION?	65
COVERED EQUIPMENT.....	65
EQUIPMENT NOT COVERED	66
EQUIPMENT MARKINGS.....	66
SPECIAL ROUNDSLING MARKINGS	66
SPECIFIC USE ENDLESS WIRE ROPE SLING MARKINGS.....	66
MARKINGS ON CHAIN SLINGS.....	67
MARKINGS ON LASHING	67
MARKINGS ON BELOW-THE-HOOK LIFTING DEVICES	67
MULTIPLE PART EQUIPMENT	67
MARKINGS ON MULTI-LEG SLING ASSEMBLIES.....	67
WLL MARKINGS FOR MULTI-PART SLINGS	68
HARD TO READ OR MISSING MARKINGS.....	68
REQUIRED RECORDS.....	68
RECORDS MUST INCLUDE... ..	68

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

IDENTIFYING GEAR TO ITS RECORD	69
RIGGING GEAR MARKING AND RECORD REQT'S MODULE EXAM QUESTIONS & ANSWERS.....	71
RIGGING GEAR INSPECTION.....	73
TYPES OF INSPECTIONS.....	73
PRE-USE INSPECTION.....	73
PERIODIC INSPECTION.....	73
ANNUAL INSPECTION	73
BIENNIAL INSPECTION.....	73
INSPECTION EVERY 3 MONTHS	74
SLING REJECTION CRITERIA - KNOTS	74
INSPECTING CHAIN SLINGS	74
CHAIN LINK WEAR.....	74
CHAIN LINK STRETCH	75
INSPECT HAMMER LINK.....	75
WIRE ROPE SLING REJECTION CRITERIA	75
MEASURING WIRE ROPE.....	76
BROKEN WIRES	76
STRAND LAID WIRE ROPE SLINGS.....	76
BRAIDED WIRE ROPE SLING REJECTION CRITERIA	76
CABLE LAID WIRE ROPE SLINGS	77
WIRE ROPE END FITTINGS.....	77
METAL MESH SLINGS	77
REMOVE FROM SERVICE	77
SYNTHETIC SLING REJECTION CRITERIA.....	77
SYNTHETIC ROPE SLING REMOVAL CRITERIA.....	78
TYPES OF HARDWARE DAMAGE	79
AREAS TO INSPECT FOR HARDWARE DAMAGE.....	79
10% WEAR REDUCTION	79
5% WEAR REDUCTION	79
AREA TO INSPECT FOR HARDWARE DAMAGE.....	80
INSPECTING MOVING PARTS	80
TACKLE BLOCKS	80
BELOW-THE-HOOK LIFTING DEVICES.....	80
HOISTS, CRANES, A-FRAMES, GANTRIES.....	80
PORTABLE LOAD INDICATING DEVICES.....	81

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

REPAIRS AND ALTERATIONS.....	81
AUTHORIZED HARDWARE REPAIR.....	81
NON-DESTRUCTIVE TEST	81
RIGGING GEAR INSPECTION MODULE EXAM QUESTIONS & ANSWERS.....	83
RIGGING GEAR GENERAL USE	85
SECTION 14 OF THE P-307	85
RIGGING MANUALS.....	85
GENERAL SAFETY RULES	85
NEVER USE HOMEMADE GEAR.....	85
SELECTING RIGGING EQUIPMENT	85
HAZARDS TO RIGGING GEAR.....	86
PROTECTIVE MATERIALS	87
USING CHAFING GEAR.....	87
HOIST AND CRANE REFERENCES	87
USING HOISTS AND CRANES	88
USING HOISTS TO DISTRIBUTE SLING LOADING	88
BELOW-THE-HOOK LIFTING DEVICES.....	88
SLING USE	91
WIRE ROPE SLING USE	91
WIRE ROPE TEMPERATURE RESTRICTION.....	91
ROPE SLING RESTRICTIONS.....	91
CHAIN SLING USE	91
CHAIN SLING TEMPERATURE RESTRICTIONS	92
METAL MESH TEMPERATURE RESTRICTIONS	92
TYPES OF SYNTHETIC SLINGS.....	92
USING SYNTHETIC SLINGS	92
SYNTHETIC WEB SLING USE	92
USING SHACKLES WITH WEB SLINGS.....	93
WEB SLING TEMPERATURE RESTRICTIONS	93
MINIMUM D/D RATIO FOR SYNTHETIC ROPE SLING USE.....	93
SYNTHETIC ROPE TEMPERATURE RESTRICTIONS	93
ROUND SLING USE.....	93
ROUND SLING TEMPERATURE RESTRICTIONS	94
COMMON SLING USE RULES	94
EYE LENGTH VS. HOOK DIAMETER	94

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

ATTACHING GEAR TO HOOK..... 94

CORRECT USE OF SLING ON HOOKS 95

INCORRECT USE OF SLING ON HOOKS 95

ATTACHING LEGS TO HOOKS 95

INSIDE AND OUTSIDE SLINGS 96

3 TYPES OF HITCHES..... 96

WLL OF VERTICAL HITCHES..... 96

USE 2 LEGS FOR VERTICAL HITCHES..... 96

CHOKER HITCHES 97

WLL OF CHOKER HITCHES 97

WIRE AND SYNTHETIC SLING CHOKER HITCH RATED LOADS..... 97

WLL OF BASKET HITCH 97

SLING USE MODULE EXAM QUESTIONS & ANSWERS 99

SLING ANGLE STRESS..... 101

WHAT IS SLING ANGLE STRESS? 101

SLING ANGLE STRESS ILLUSTRATION 101

SLING ANGLE STRESS 90 DEGREES 101

SLING ANGLE STRESS 45 DEGREES 101

SLING ANGLE STRESS 30 DEGREES 101

CHOOSING YOUR GEAR..... 102

WHAT DOES IT AFFECT? 102

MINIMIZING SLING ANGLE STRESS..... 102

SLING ANGLE STRESS SUMMARIZED 102

EFFECTS OF SLING ANGLE STRESS..... 103

WHY MUST WE ACCOUNT FOR IT? 103

SELECTING MINIMUM RATED CAPACITY 103

DETERMINING MINIMUM RATED CAPACITY 103

USING AN ANGLE FACTOR CHART 104

ANGLE FACTOR CHART EXAMPLE..... 104

WHAT IS ANGLE FACTOR? 104

HOW TO FIND HEIGHT 104

FINDING HEIGHT 105

FINDING ANGLE FACTOR..... 105

SOLVING SLING ANGLE STRESS MATHEMATICALLY..... 105

60 DEGREE SLING ANGLE..... 105

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

SELECTING APPROPRIATE SLING LENGTHS FOR A 60 DEGREE SLING ANGLE 106

SELECTING MINIMUM RATED CAPACITIES FOR A 60 DEGREE SLING ANGLE..... 106

SELECTING MINIMUM RATED CAPACITIES FOR A 60 DEGREE SLING ANGLE..... 106

NOT LEVEL NOR EQUAL DISTANCE FROM CG..... 106

RIGGING HARDWARE..... 109

 USING RIGGING HARDWARE 109

 SIDE LOADING SHACKLES 109

 EYEBOLT TYPES..... 109

 NON-SHOULDERED EYEBOLTS 109

 SHOULDERED EYEBOLTS 110

 USING EYEBOLTS, SWIVEL HOIST & LIFTING RINGS 110

 MINIMUM THREAD ENGAGEMENT..... 110

 INSTALLING SHOULDERED EYEBOLTS 110

 EYEBOLTS 110

 ALIGN EYE WITH THE PLANE OF THE PULL..... 111

 SHIMS MAY BE USED TO ALIGN EYE 111

 DETERMINING SHIM THICKNESS 111

 INCORRECT USE OF SHIMS TO ALIGN EYE..... 111

 SIDE PULLS 112

 SWIVEL HOIST RING REQUIREMENTS..... 112

 SWIVEL HOIST RINGS 112

 SELECTION AND USE OF TURNBUCKLES..... 113

 NEVER (THREADED ATTACHMENTS) 113

 EYENUTS 113

 RIGGING HARDWARE MODULE EXAM QUESTIONS & ANSWERS..... 115

HOISTS..... 117

 HOIST USE 117

 HOIST USE 117

 MARKING AND INSPECTION 117

 VISUAL INSPECTION..... 117

 OPERATIONAL INSPECTION 118

 SAFE OPERATION AND USE..... 118

 IMPROPER OPERATION 119

 CHAIN POSITION AND SCAFFOLDING..... 120

 ATTACHMENT AND TWO-BLOCKING 120

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

SECURING HOISTS 120

HOISTS MODULE EXAM QUESTIONS & ANSWERS 122

CRANE COMMUNICATIONS 125

 RADIO AND HAND SIGNALS 125

 HAND SIGNALS..... 125

 SIGNALERS 125

 RADIO 125

 HOOK AND TROLLEY SIGNALS 126

 AUXILIARY HOOK..... 126

 MAIN HOIST 126

 MULTIPLE TROLLEY 126

 HOIST SIGNALS 127

 HOIST UP 127

 HOIST LOWER 127

 HOIST UP SLOWLY..... 127

 BOOM SIGNALS 128

 BOOM RAISE (BOOM UP) 128

 LOWER BOOM (BOOM DOWN) 128

 RAISE THE BOOM – LOWER THE LOAD 128

 LOWER THE BOOM – RAISE THE LOAD 129

 BOOM EXTEND..... 129

 BOOM EXTEND ONE HANDED..... 129

 BOOM RETRACT 129

 BOOM RETRACT ONE HANDED..... 129

 DIRECTIONAL SIGNALS 130

 TRAVEL DIRECTION 130

 TROLLEY DIRECTION 130

 ROTATE (SWING) DIRECTION 130

 MAGNET SIGNALS 130

 MAGNET DISCONNECTED..... 131

 STOP SIGNALS 131

 STOP..... 131

 EMERGENCY STOP 131

 DOG EVERYTHING 131

 REVIEW AND SUMMARY 132

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

CRANE COMMUNICATIONS MODULE EXAM QUESTIONS & ANSWERS.....	134
COMPLEX AND NON-COMPLEX LIFTS.....	137
NON-COMPLEX LIFTS	137
COMPLEX LIFTS	137
COMPLEX LIFT CATEGORIES	137
IDENTIFICATION, PROCEDURES, AND OVERSIGHT	137
COMPLEX LIFT EXCEPTIONS	138
LIFT REQUIREMENTS FOR HAZARDOUS MATERIALS	138
LIFT REQUIREMENTS FOR COMPLEX GEOMETRIC SHAPES	138
LIFT REQUIREMENTS FOR PERSONNEL LIFTS	138
LIFT REQUIREMENTS FOR LIFTS OVER 80% CAPACITY	139
LIFT REQUIREMENTS FOR MULTIPLE CRANE LIFTS	139
REVIEW AND SUMMARY	139
COMPLEX AND NON-COMPLEX LIFTS MODULE EXAM QUESTIONS & ANSWERS.....	141
CRANE AND RIGGING GEAR ACCIDENTS	143
CRANE ENVELOPE.....	143
RIGGING GEAR ENVELOPE.....	143
CRANE ACCIDENT	143
RIGGING GEAR ACCIDENT	143
ACCIDENT EXAMPLES	144
ACCIDENT EXCEPTION.....	144
ACCIDENT CAUSES.....	144
OPERATOR RESPONSIBILITIES	144
ACCIDENT ACTIONS.....	144
REPORTING	145
NEAR MISSES	145
CRANE AND RIGGING GEAR ACCIDENTS MODULE EXAM QUESTIONS & ANSWERS.....	147
SAFE CRANE OPERATIONS	149
OPERATOR RESPONSIBILITIES	149
BEFORE OPERATING THE CRANE	149
OPERATOR SELF ASSESSMENT	149
ASSESS THE WORK AREA.....	150
ADDITIONAL HAZARDS	150
BEFORE WORKING WITH A CRANE.....	151
MULTIPLE OPERATIONS	151

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

OPERATING THE CONTROLS..... 151

CHAIN HOIST OPERATION 152

KNOW THE TOTAL WEIGHT 152

ASSESS THE LIFT 152

ESTABLISH COMMUNICATION 153

BEFORE LIFTING THE LOAD..... 153

PRIOR TO LIFTING 153

PROCEDURE FOR LIFTING LOADS 154

WHILE LIFTING LOADS 154

LOAD CONTROL 155

NEVER..... 155

GENERAL RULES FOR TRAVELING 156

SECURING THE CRANE 157

SAFE CRANE OPERATIONS MODULE EXAM QUESTIONS & ANSWERS..... 159

CATEGORY 3 CRANE SAFETY COURSE EVALUATION..... 163

[Introduction to Category 3 Crane Safety](#)

[Navigating Through This Course](#)

As you navigate through this course, you will find several tools and features that will facilitate your learning. This interactive course enables you to easily navigate and access various learning tools with the following buttons: The topic list displays the topics within this module. The next topic button allows you to move to the next screen. The previous topic button allows you to return to the previous screen. The view narration link allows you to view a text version of the audible narration. The home button returns you to the learning management system.

[Knowledge Checks](#)

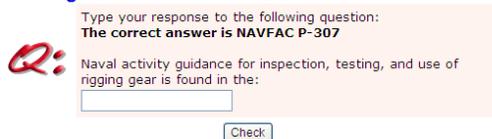
This course uses various types of questions to help you retain the material presented. As you proceed through each topic, you will be asked questions in the form of Knowledge Checks. The Knowledge Checks will help you with the course exams, which require a score of 70% to proceed to the next topic. When you have successfully completed all topics you may take the Final Exam. A score of 70% or higher is required to pass. This score will be recorded on the Navy E-Learning System. The questions will be asked during the presentation in the form of:

- Fill in the Blank
- Drag and Drop
- Multiple Choice - Single Answer
- Multiple Choice - Multiple Answer
- True/False
- Let's try a few to see how they work...

[Fill-in-the-Blank](#)

This is a 'fill-in-the-blank' type question. Type the correct answer in the space provided. In the lower left corner of the screen, note the item showing: "Tries-remaining". This

Knowledge Check - Fill in the Blank



Type your response to the following question:
The correct answer is NAVFAC P-307

Q: Naval activity guidance for inspection, testing, and use of rigging gear is found in the:

indicates the number of tries the assessment software will allow you to attempt to answer a question correctly.

Tries Remaining: 1

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

Knowledge Check - Drag and Drop



Select the name and drag it to the correct picture. Check your answer when you have dragged the names to the correct locations. **You will have 5 tries this time.**



Truck Mounted Articulating Boom
Commercial Truck Mounted
Pedestal Mounted Commercial Boom
Mobile Crane

Check Reset

Drag-and-Drop

This is a 'drag-and-drop' type question. Simply match the term to the appropriate picture or symbol. "Click & hold" the left mouse button on the term and drag it to the picture it describes; release the button. Repeat for each item.

Multiple Choice – Single Answer

This is a 'multiple choice – single answer' type question. Note the circles next to each answer choice. You are only allowed to select one answer. Choices may be very similar so select the BEST answer to the question.

Knowledge Check - Multiple Choice/Single Answer



Select the best answer to the following question and click the "Check" button. ...

The correct answer is NAVFAC P-307

The basic operational and rigging safety requirements for Cat 3 crane operations are identified in the...

- NAVFAC P-409
- NAVFAC Crane book
- NAVFAC P-307
- NAVFAC Learning Pamphlet

Check

Tries Remaining: 1

Knowledge Check - Multiple Choice/Multiple Answer



Select all that apply to the following question and press the "Check" button.

All are correct except "Maintain curriculum standards for NCC"

The purpose of the NAVFAC P-307 is to:

- Provide standards for crane operations and rigging.
- Maintain curriculum standards for NCC.
- Ensure safe crane and rigging operations.
- Ensure optimum service life.
- Maintain safety and reliability.

Check

Tries Remaining: 1

Multiple Choice – Multiple Answer

This is a 'multiple choice – multiple answer' type question. Note the squares next to each answer choice. From the list of answer choices, select all that correctly answer the question.

True and False

This is a 'true/false' type question. The circles next to each answer choice indicate that only one answer can be selected - chose either true or false.

Knowledge Check - True/False



Training can be found in Section 14 of the NAVFAC P-307.
The correct answer is False

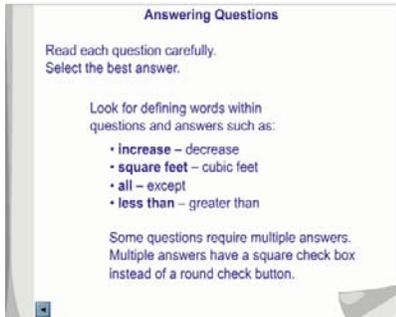
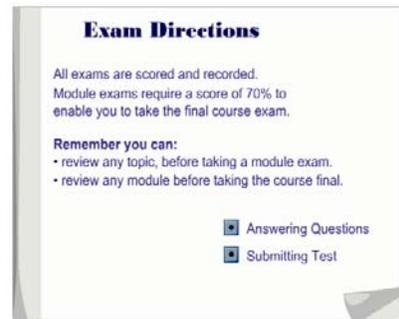
- True
- False

Check

Tries Remaining: 1

Exam Directions

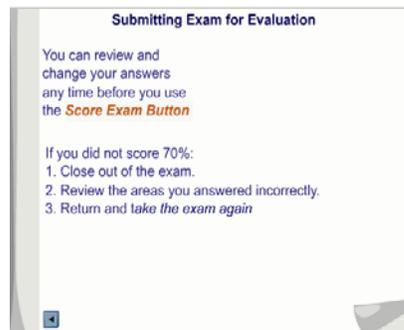
When taking exams, keep the following in mind...some questions require multiple answers and have check boxes next to the choices. Single answer questions have circles next to the choices. Look for defining words within the questions and answers such as:



increase/decrease, square feet/cubic feet, all/except, and less than/greater than. Some exams require additional materials. For example, Category 1 Crane Safety and Load Test Director require the use of the load chart packages and Certifying Official may require the bridge and/or mobile crane certification packages, all of which are located in the Reference section. If you score less than 70% on a module quiz, review the necessary content, and return to take the quiz again. You can go back and review any content prior to taking a quiz or final

exam. You can review and change your answers any time before you select the 'Score Exam' button. A score of 70% or higher is required to pass. The final exam score will be recorded in the Navy eLearning system and completion certificate. If you fail a course, you enroll and retake the course.

on your can re-



NOTES

[NAVFAC P-307](#)

[Purpose](#)

The overall purpose of NAVFAC P-307 is to maintain the level of safety and reliability that was originally built into the equipment, ensure optimum service life, provide uniform standards for weight handling equipment operator licensing, and ensure safe weight handling operations. Weight Handling Equipment includes both cranes and the rigging gear used for lifting operations.

[Applicability](#)

NAVFAC P-307 applies to Navy shore activities, naval construction forces, including the Naval construction training centers, and naval special operating units. NAVFAC P-307 meets, or exceeds, all OSHA regulations that apply to the operation of cranes.

[NAVFAC P-307 Contents](#)

For an overview of NAVFAC P-307, review this table of contents

Section	Contents
1	General Overview
2	Maintenance
3	Certification
4	Crane Alterations
5	Equipment History File
6	Operator Licensing Program
7	Operator Qualification and Testing
8	Licensing Procedures and Documentation
9	Operator Checks
10	Operation Safety
11	Additional Requirements
12	Investigation and Reporting of Crane and Rigging Gear Accidents
13	Training and Qualification
14	Rigging Gear and Miscellaneous Equipment

[Weight Handling Requirements](#)

NAVFAC P-307 provides requirements for Weight Handling Equipment including maintenance (repairs and alterations), inspection, test, certification, operations, training, licensing, and rigging gear use.

[WHE Maintenance and Inspection](#)

NAVFAC P-307 provides requirements for documentation of maintenance and inspection, including: types and frequency of inspection; deficiencies to load bearing parts, load controlling parts, and operational safety devices; repairs and alterations made to cranes; and minimum requirements for record keeping retention.

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

CRANE NO. 12345-7	TYPE CRANE OET	TEST LOAD (lbs.) 12,500	TEST PROCEDURE APPENDIX E
MAIN HOIST RATED CAPACITY 10,000 lbs.	MARK HOIST	ADJ HOIST 5,000 lbs.	WRP HOIST
TYPE SERVICE AUTHORIZED GPS	SPECIAL PURPOSE SERVICE OR GENERAL PURPOSE SERVICE		
CERTIFICATION DATE 1 July 20xx	CERTIFICATION EXPIRATION DATE 30 JUNE 20xx 1 YEAR		
SIGNATURE OF TEST DIRECTOR John Q. Tester	DATE 1 Ju	Certification Includes: • Crane Number • Crane Capacity • Certification • Expiration Date	
OPERATOR AND LICENSE NUMBER Pat Operator	#123456		

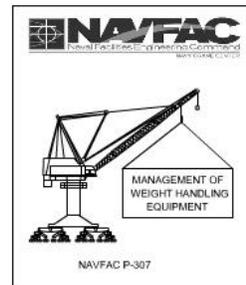
Certification Posting

The crane identification number, certified capacity and certification expiration date must be posted on or near the crane. Posting a copy of the actual certification, crane test cards, stickers or signs, are all acceptable methods

provided they include the required information

NAVFAC P-307 Covered Equipment

NAVFAC P-307 covers category 1, 2, 3, and 4 cranes, as well as rigging gear. Detailed descriptions of the cranes are included in Section 1. Illustrations of individual crane types can be found in Appendix B. Rigging gear is covered in Section 14.



NAVFAC P-307 Overview Section 1

Section 1 describes cranes and crane-related equipment and lists types of cranes and related equipment used at Naval Shore activities by category.

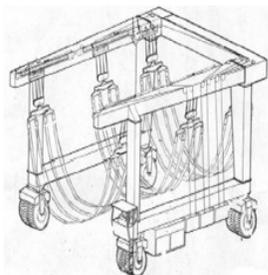
- Portal Cranes
- Hammerhead Cranes
- Locomotive Cranes
- Derricks
- Floating Cranes
- Tower Cranes
- Container Cranes
- Mobile Cranes
- Aircraft Crash Cranes
- Mobile Boat Hoists
- Rubber Tire Gantry Cranes

Category 1 Cranes

This is a list of category 1 cranes. All category 1 cranes require a license to operate

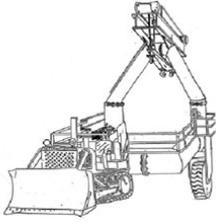
Category 1 Crane Examples

These are examples of Category 1 cranes



Mobile Boat Hoist

The mobile boat hoist consists of a steel structure of rectangular box sections, supported by four sets of dual wheels capable of straddling and carrying boats.

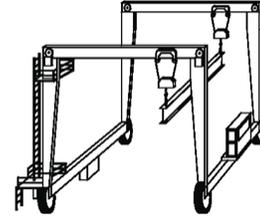


Mobile Boat Hoist - LCRU

The landing craft retrieval unit is a type of mobile boat hoist with self propelled or towed carriers consisting of a wheeled steel structure capable of straddling and carrying boats.

Rubber Tire Gantry Crane

The rubber tire gantry crane shown is a Cat 1 crane as described in NAVFAC P-307.



- Bridge Cranes
- Rail Mounted Gantry
- Pillar Jib
- Wall cranes
- Jib cranes
- Monorail
- Fixed overhead hoists
 - Manual
 - Powered

Portable hoists are defined in:
Section 14 of NAVFAC P-307

The activity may, however, treat them as Cat 2 or 3 cranes.

Category 2 and 3 Cranes

This is a list of Category 2 and Category 3 cranes. Portable manual and powered hoists are covered in Section 14 of the NAVFAC P-307. The activity may, however, treat them as Category 2 or 3 cranes.

Category 2 and 3 Crane Capacity

The certified capacity of these cranes determines the category. Category 2 cranes have a certified capacity of 20,000 lbs. and **greater**. Category 3 cranes are those with a certified capacity of **less than** 20,000 lbs.

Category 4 Cranes

All Category 4 cranes require a licensed operator.

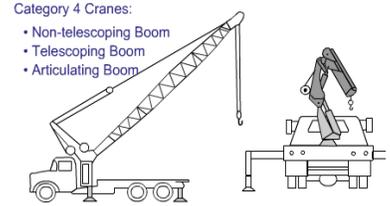


Mounting

Category 4 cranes may be attached to stake beds, trailers, flat bed trucks, rail cars, or may be stationary mounted on piers, barges, etc.

Booms

Category 4 Cranes may have a non-telescoping, telescoping, or articulating boom.



Pedestal Mounted - Capacity

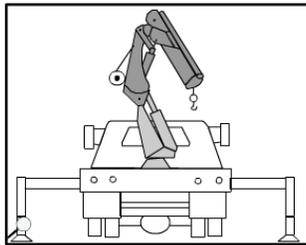
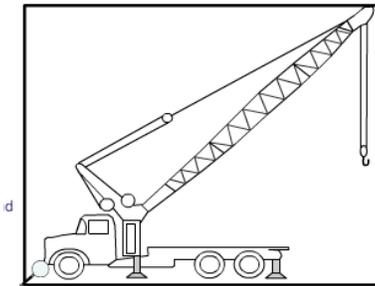
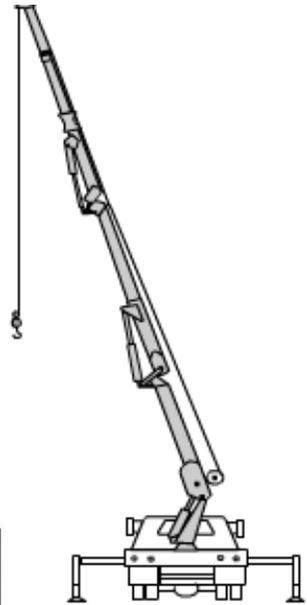
Pedestal mounted commercial boom assembly cranes of with less than 2,000 lbs. capacity are considered Category 3 cranes. Capacities greater than 2,000 lbs. are Category 4 cranes and require a licensed operator.

Special Considerations

Commercial truck mounted cranes [described in ASME B30.5] and articulating boom cranes [described in ASME B30.22] of all capacities are Category 4 cranes and require a licensed operator - even if the crane is down rated for administrative purposes.

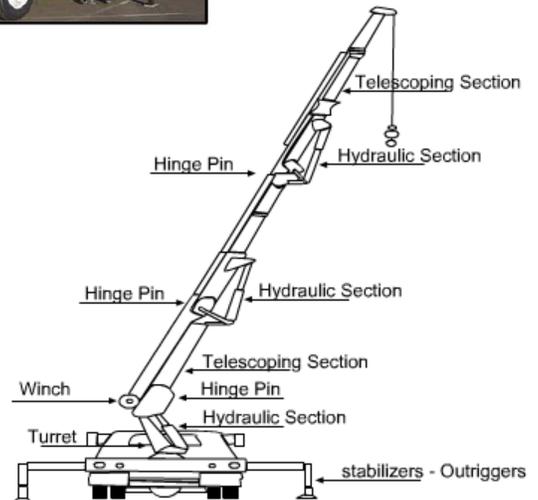
Category 4 Crane Types

These are examples of Category 4 cranes.



Category 4 Crane Components

Using your mouse, explore these Category 4 crane components



[Licensing \(Sections 6, 7, and 8\)](#)

NAVFAC P-307 provides uniform standards for crane operator licensing. Cat 1, Cat 2, cab-operated Cat 3, and Cat 4 operators must be trained and licensed according to Sections 6, 7, and 8. Licenses are not required to operate non-cab operated Cat 3 cranes. However, training and a demonstration of ability to operate safely is required



[NAVFAC P-307 Section 12: Crane and Rigging Accidents](#)

In the event of an accident, activities shall investigate and report the accident in accordance with NAVFAC P-307 Section 12, as well as OPNAV Instructions 5102.1. Crane and Rigging Gear Accident definitions can be found in Section 12.

Rigging Gear Accident Defined

A rigging gear accident occurs when any of the elements of the operating envelope fails to perform correctly during weight handling operations resulting in the following:

- Personnel injury or death.
Minor injuries that are inherent in any industrial operation, including strains and repetitive motion related injuries, shall be reported by the normal personnel injury reporting process of the activity in lieu of these requirements.
- Material or equipment damage that requires the damaged item to be repaired because it can no longer perform its intended function.
- Dropped load
- Two-blocking or cranes and powered hoists covered by section 14 (Rigging Gear and Miscellaneous Equipment)
- Overload

Crane Accidents Defined

A crane accident occurs when any of the elements of the operating envelope fail to perform correctly during operations, including operation during maintenance or testing resulting in the following:

- Personnel Injury or death
Minor injuries that are inherent in any industrial operation, including strains and repetitive motion related injuries, shall be reported by the normal personnel injury reporting process of the activity in lieu of these requirements.
- Material or equipment damage
- Dropped load
- Derailment
- Two-blocking
- Overload
- Collision including unplanned contact between the load, crane, and/or other objects.

[NAVFAC P-307 Section 13: Training](#)

Personnel training requirements are found in section 13 of NAVFAC P-307.

[NAVFAC P-307 Section 14: Rigging Gear](#)

Section 14 of NAVFAC P-307 provides maintenance, inspection, and test requirements for rigging gear and miscellaneous equipment not covered in sections 2 through 11.

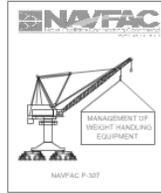


CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

[NAVFAC P-307 Summary](#)

Review the information presented in this summary.

NAVFAC P-307 Summary



Overview

- NAVAC P-307 Requirements
- Table Of Contents

Crane Categories

- Category 1
- Category 2 and Category 3
- Category 4

Use the focus buttons to review NAVFAC P-307 information.

NOTES

[NAVFAC P-307 Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. The purpose of NAVFAC P-307 is to:

- A. maintain safety & reliability
- B. ensure optimum service life
- C. provide standards for crane operations and rigging
- D. ensure safe crane and rigging operations
- E. ensure all of the above

2. Select the best answer. NAVFAC P-307 provides guidance to shore based naval activities for management of weight handling equipment.

- A. True
- B. False

3. True or False. There is no difference in capacity between category 2 and category 3 cranes.

- A. True
- B. False

4. Select the best answer. What is the category of this crane?

- A. Category 1
- B. Category 2
- C. Category 3
- D. Category 4



5. Select the best answer. What is the category of a mobile crane with a 10,000 pound capacity?

- A. Category 1
- B. Category 2
- C. Category 3
- D. Category 4

6. Select the best answer. What is the category of this crane?

- A. Category 1
- B. Category 2
- C. Category 3
- D. Category 4

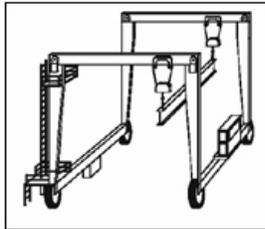


7. Select the best answer. What section of NAVFAC P-307 is the rigging gear section?

- A. Section 1
- B. Section 14
- C. Section 8
- D. Section 12

8. Select the best answer. What is the category of this crane?

- A. Category 1
- B. Category 2
- C. Category 3
- D. Category 4



9. True or False. A pedestal mounted articulating boom assembly is a Category 3 crane as long as its rated capacity is less than 2,000 pounds.

- A. True
- B. False

Category 3 Crane Types

Overhead Cranes

There are many types of Category 3 cranes. Remember, all Category 3 cranes have rated capacities less than 20,000 pounds. Category 3 cranes are primarily non-cab operated or floor operated. Floor operated means that you operate the crane from the ground and do not board it in any fashion in order to operate it. The cranes you are viewing on this slide are pendant-controlled Overhead Traveling Cranes, sometimes referred to as Overhead Electric Traveling or OET Cranes.



Gantry Cranes

This is a Gantry Crane. One or both travel trucks are supported by ground-level rails or tracks.



Wall Cranes

Wall Cranes are supported by a set of elevated rails attached to a building or structure.

Jib Cranes

Here are two jib cranes. They are usually mounted to a column or wall. The jib crane closest to the front of this graphic is mounted to a column. The jib crane in the background on the right side is wall mounted.



Pillar Jib Cranes

Pillar Jib Cranes are supported by a pedestal and can generally rotate 360 degrees.



Pillar Cranes

Shown here is a Pillar Crane. Pillar Cranes are different from Pillar Jib Cranes in that they have a tension member that supports the jib.

Monorail Cranes

Monorail cranes and hoists are mounted to a trolley that travels a rail or beam.



Overhead Hoists

Overhead hoists, including chain hoists, which are designated for use at the same location on a continuing basis, are Category 3 Cranes.

Pedestal Mounted Commercial Boom Assemblies

Pedestal mounted commercial boom assemblies, whether they are fixed length or telescoping, can be attached to trucks, trailers, flatbeds, railcars, or stationary mounted to piers. Having a capacity of less than 2,000 pounds places them as Category 3 Cranes. Pedestal mounted commercial boom assemblies with a rated capacity of 2,000 pounds or greater are classified as Category 4 Cranes and require a licensed operator. The American Society of Mechanical Engineers, ASME, writes many industrial and manufacturing standards. The ASME standard B30.5 describes capacities for Commercial Truck Mounted Cranes and ASME standard B30.22 describes the capacities for articulation boom cranes.



NOTES

Crane Pre-use Checks

Pre-use Inspection: Purpose

A very important part of operating a crane is inspecting it before it is used each day. The inspection, known as the Pre-Use Inspection, is vital to establishing that the crane is safe to use before beginning work. All category 3 cranes must have a pre-use inspection before they are used to perform work! This pre-use inspection must include a walk around visual inspection for obvious damage or deficiencies, and a "no load" operational test. "No load" refers to the crane being operated without anything connected to the hook. Three types of category 3 cranes must have proof of these inspections.



Wall



Bridge



Gantry

Documented Inspection

A documented monthly inspection is required for Wall, Bridge, and Gantry cranes. This documented inspection must be performed at least once each calendar month that the crane is in use.

Operator's Daily Check List

Here are the requirements as listed in Section 9.2 of NAVFAC P-307 for the category 3 types of cranes that require documented inspections: "For bridge, wall, and gantry cranes, a documented pre-use check shall be performed at least once each calendar month the crane is in use. The pre-use check shall be in accordance with paragraph 9.1.2, except that the pre-use check may be from the ground. The checklist shall be completed and signed by a qualified operator. The operator shall forward the checklist to the supervisor for review." The current and previous month's inspection reports must be retained. Cranes that are idle for more than 6 months require a condition inspection before use. This is required according to Section 3.6 of NAVFAC P-307 and is done by a trained inspector. Remember: the monthly documented inspections are not required for jib, pillar, monorail, and overhead hoist cranes.

Area Safety

When checking the area, make sure you find all obstacles and hazards. Look for anything that may interfere with the safe operation of the crane. Be sure that exact locations of obstacles or hazards are known. Hazards to look for include:

- Rail stops
- Personnel
- Other cranes
- Forklifts
- Machinery



Be aware of the potential for forklifts or other mobile equipment to enter the crane work area.

Structural Integrity

During the walk around visual check you must also inspect the structural integrity. Look for signs of obvious physical damage such as: Loose or missing hardware, bent structure, evidence of deformation like chipped paint, cracked welds, bolts, nuts,

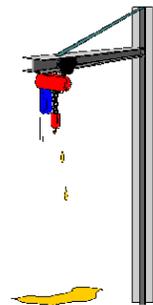


brackets, missing or loose cover plates and safety guards, wire crossed on drum, and fouled or twisted chain. Areas that are not accessible will be given as thorough an inspection as possible without ascending the crane. Never try to ascend the crane to inspect it. Granted, some items are not accessible for a close inspection. Visually inspect these areas to the maximum extent possible. Do not use the crane and do not try

to fix the crane if any damaged or missing component is found. Contact your supervisor if you see something out of place. Your supervisor can then take appropriate action.

Leak Checks

There are many types of category 3 cranes with different power sources. You must check the hydraulic lines, where you will look for puddles on the ground, or structure, and for evidence of leaks or seepage near fittings. Also check pneumatic lines, where you will listen for a "hissing." On Truck Mounted Category 3 hoists, you must check under the engine for puddles of coolant and the fuel lines for drips or the smell of fuel. Report even the smallest of leaks. They may be an indication of a much bigger problem.





Power Source

Your walk around should also include finding the location of the power source of your crane. Ensure the power source is accessible in case emergency shutdown is needed. A minimum of three feet of open space must exist in front of the panel at all times.

Power Source

Normally certification is done every year at the time of the annual maintenance inspection. Notice the dates on the sample card, they are exactly one year apart. Certification can be required in between the certification period if repairs have been made to critical crane components or if the crane has been overloaded. There are several ways to post the required information, but the crane number, certification expiration date, and crane capacity must be posted on the crane. This may be done by having a copy of the certification papers or Crane test card posted or by using signs, stickers, or stenciling/painted on the crane or wall. Activities may use any of these methods to post certification information.

CRANE INFORMATION CARD			
CRANE NO.	TYPE/CAPACITY	TEST LOAD (lbs.)	TEST PROCEDURE
12345-7	OET	12,500	APPENDIX E
	MAN HOIST	AUX HOIST	WIP HOIST
RATED CAPACITY	10,000	ES.	N/A
TYPE SERVICE AUTHORIZED C/P	SPECIAL PURPOSE SERVICE OR GENERAL PURPOSE SERVICE		
CERTIFICATION DATE	CERTIFICATION EXPIRATION DATE		
1 JULY 20XX	30 JUNE 20XX - 1 YEAR		
I certify inspection and test has actually been performed according to specified requirements.			
SIGNATURE OF TEST DIRECTOR		DATE	
<i>Director C. Fests</i>		1 JULY 20XX	
OPERATOR AND LICENSE NUMBER			
<i>Smooth Operator #123456</i>			

Warning Tags

Look for warning tags during your walk around visual check. You may find warning tags posted with the certification card. Warning tags are general hung on the pendant controller or other types of crane controls. They may also be found at the power source of the crane. Warning - do not operate any crane which has evidence that a tag was on the crane, such as a tie wrap, wire band, empty pouch, etc. If warning tags are posted on any component of the crane you must investigate the tag before continuing with operation.



Danger Tags

The red danger tag prohibits operation by anyone. If you find one, never energize a crane with a danger tag attached! Energizing equipment with a danger tag attached may result in personnel injury or equipment damage. Inform your supervisor if you find the crane has a danger tag attached

Caution Tags

The yellow caution tag generally gives some type of warning, precaution, or special instructions to the operator of the crane. Most caution tags inform of hazardous conditions such as rail stops, swing interference, crane clearance problems, etc.



Always read and follow the written instructions on the reverse side of this tag before operating the crane. If you do not understand the instructions, ask your supervisor for clarification. Occasionally a yellow caution tag will state "No Production Lifts."



Out-of-Service Tags

Another tag you may find is an "Out of Service" tag. These may vary in color and makeup from one activity to another. An Out of Service tag is installed to perform maintenance, testing, or inspection. Only crane maintenance personnel, or the person who hung the tag, are authorized to remove an Out of Service tag. When you find this tag, do not use the crane.



Lockout Tags

Another tag you may see is a "Lock Out" tag. These may vary in color and makeup from one activity to another. A Lockout Tag is installed to inform you the energy has been locked out because personnel are working on the crane. Only the person who hung the tag is authorized to remove a Lock Out Tag. When you find this type of tag, do not energize the crane.

Who Can Remove Warning Tags?

Only authorized personnel may install or remove warning tags. Who are the authorized personnel? The person who applied the tag and sometimes his or her supervisor.





Controllers

The condition of the crane controllers must be checked before operating the crane. Check the controllers for damaged or exposed wires, loose fasteners, and a cracked or damaged casing.

Checking Buttons

The buttons on controllers must be checked to ensure they function correctly. The first check must be done with the power off. Ensure buttons operate freely. Depress and then release the button. The buttons should spring back to the neutral position. Buttons that stick are a crane accident waiting to happen. Always ensure the controllers operate properly before energizing the crane.



No-Load Operational Test

Go through every motion or function of the crane to assure the crane is operating properly. Check control action, brakes, safety devices, wire rope, chain, and the block and hook.

Controller Action

After you have ensured the buttons operate freely it is time for the no load operational test. Check for positive and proper actions of all controls. This test ensures that the crane operates correctly before you put it to work. Check controls through a range sufficient to ensure that they operate freely and that the corresponding component actuates properly when controls are activated. Check hoist controls through full speed range. Remove your hand from the controller functions during this test and assure that the functions stop while operating at the slowest possible speed. Some cranes are equipped with indicator and/or warning lights. These must be working properly. Check all indicator and warning lights to ensure none are broken or missing.



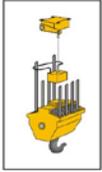
Controller Operation

A word of warning about controllers: To avoid the risk of electrical shock, never stand in water or oil when holding the controller of an electric hoist.



Safety Devices

Controller and button checks must be completed prior to testing the safety devices. All safety devices shall be tested beginning with the upper limit switch, which is the most common type, the lower limit switch if so equipped, and the emergency stop if so equipped. Checking of limit switches shall be performed at the slowest possible speed, or the hoist shall be inched into the switches. Emergency stops shall also be checked while operating a motion or function at the slowest possible speed.



Safety Guards and Plates

Check all safety guards. Ensure they are in place and properly attached. Look for missing or damaged guards or plates.



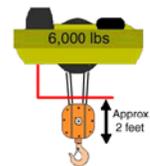
Upper Limit Switch

The first check should be testing the upper limit switch. The upper limit switch may be the most important safety device of all. It is a safety switch designed to prevent "two-blocking" by shutting off the power to the hoisting motor. Two-blocking occurs when the hook block makes contact with the drum or sheaves. Two-blocking is a serious condition that can lead to broken wire rope and dropping the hook. The upper limit switch is activated when the hoist block is raised into a weighted switch or arm located between the hook block and drum. It is never to be used as an operating switch. The only time this switch is to be activated is during the pre-use test.



Upper Limit Switch Test

To test the upper limit switch, hoist the hook block approximately two feet below the switch and stop. Slowly raise, or inch, the hook block from this point until the upper limit switch activates. Ensure hoisting stops even though you still have the "hoist up" button depressed, but do not allow the hook and drum to two-block if the switch fails. Release the button immediately as soon as you see evidence of switch failure! Remember: when performing this test, operate the hoist at the slowest possible speed or inch the hoist into the limit switch. Never stand under the hook or allow anyone else to. Two-blocking could result in injury or death.



Lower Limit Switch Testing

Lower limit switches must be tested when the possibility of activating the switch may occur during lifting operations. When testing the lower limit switch, be extremely alert. To test it, slowly lower the hook to the point where the switch should activate (at the slowest possible speed). The hoist motor should stop if it is working correctly. Do not use the crane if it fails the test. Do not allow the hook to set down on anything!

Lower Limit - Minimum Wraps

The minimum number of wraps (of wire rope) for grooved drums is 2 full wraps and for non-grooved drums it is 3 full wraps. Do not allow less than the minimum number of wraps to remain on the drum.



Emergency Stop Test

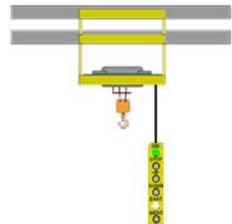
Emergency stop devices are used if the crane malfunctions and sticks in an operating mode. Some cranes may have built in emergency stop devices. Sometimes pendant controllers are equipped with an emergency stop button. It is generally red in color. Other cranes may have a switch or valve. You must identify the type of emergency stop device and its location before operating the crane and test the emergency stop device to ensure it works properly. To test it, activate the device while some function of the crane is operating (At the slowest possible speed!).



The operation should stop immediately and completely. Rail stops are not to be used as emergency stops.

Testing Bridge and Trolley Functions

A good time to test the bridge and trolley function is right after testing the upper limit switch. The hook will not swing as much when it is under the upper limit switch. Check the bridge and trolley functions in both directions. This is also a good time to get familiar with the type of controls the crane has. Check the operation of these functions in both directions. Depress the button slowly. After the crane begins to move, depress the button further. If it has a proportional (or variable) control button you will likely hear the speed change in the motor and notice the crane pick up speed.



Testing Brakes

You must check all brake actions during the no-load operational checks and whenever you are working with the crane. The crane does not have a brake pedal or even a brake button. The brakes automatically apply whenever the control button or chain is released. While you are operating the crane ensure the brakes are functioning normally. There should be no slippage, chatter, excessive play, or binding. Any evidence of slippage, chatter, or binding is unsatisfactory and must be reported. Check the brakes every time you lift a load. Lift the load slightly and stop, release the controller. Immediately set the load back down if there is any slippage. Secure the crane and report it to your supervisor.

Wire Rope or Chain Inspection



The best time to check the wire rope or chain is when you are lowering the hook block for inspection. Lower the hook, observing the sections of wire rope or chain not visible during the walk around inspection. Inspect the wire rope for: proper reeving, crossed wires on the drum, unusual wear, fraying, corrosion and kinks. When wire rope is crossed on the hoist drum it is called "a bird's nest." This is generally caused when the hook is set down on something and the tension in the crane wires is relieved. Never touch the wire rope when the crane is in operation. Grabbing the block or the chain or wire rope may cause serious injury.

Chain Inspection

Lower the hook, observing the sections of chain not visible during the walk around check. Check all load chain for nicks, gouges, twists, bends, corrosion, wear, cracks, heat damage and broken and/or deformed links. Never try to check the chain when the crane is in operation. Grabbing the block or the chain may cause serious injury.



Hook Block Inspection



In order to check the hook block, lower the hook until it is just below eye level. Inspect the condition of the block for obvious damage by looking for new scrapes in the paint, cracks, nicks, or gouges. These may be evidence of a recent accident and may warrant further investigation by your supervisor. Check for missing nuts, bolts, and retaining pins and ensure the wire rope or load chain is reeved properly in the sheaves. Where practical, inspect the condition of the sheaves to determine that they move freely and are not cracked or chipped. Be extremely careful when inspecting the sheaves. Never grasp the wire rope or load chain when the block is moving.

Hook Inspection

You must also check the hook. The hook must freely rotate 360 degrees. It will not spin like a top, but it must rotate smoothly, without binding. Look for visible signs of bending or twisting. Also check the safety latch. It must be in place and operating correctly. The safety latch must completely close the throat opening so that it will retain the rigging in the hook. The latch should be tested to ensure it will snap back and remain shut.



Boom Truck Inspection

Before operating any category 3 Boom Truck, check the boom or jib for straightness and evidence of damage such as cracks, bends, dents and deformation of components or welds. Check tires for proper inflation, serious cuts, and excessive wear. Check the wheels to ensure that they are not loose or damaged. Always thoroughly read the Operator's Manual for any category 3 Boom Truck that you may operate.



Finding Deficiencies

Follow these standard procedures anytime a deficiency is found. Stop work immediately, secure the crane from further operation, secure the crane's power source and apply a tag. Describe the deficiency on the tag and hang the tag on the controller or at the power source. Notify your supervisor of any deficiency you have found. The supervisor will report the deficiency to the Crane Inspection Organization for diagnosis and initiation of corrective repair. Do not use the crane or hoist until all reported deficiencies have been evaluated and corrected and the crane is returned to service by the Crane Inspection Organization

NOTES

[Crane Pre-Use Checks Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. What is the most important reason to do a pre-use check?

- A. To make sure the crane has adequate capacity
- B. To make sure the crane operates smoothly
- C. To make sure the crane is in service
- D. To make sure the crane is safe to use

2. Fill in the Blank. From the following list of answers, select the correct term to fill in the blank. Part of the no-load operational check is to ensure the proper _____ of all controls.

- A. function
- B. form
- C. fit
- D. damage
- E. deficiency

3. Fill in the Blank. From the following list of answers, select the correct term to fill in the blank. There must always be _____ full wraps of wire on grooved drums.

- A. one
- B. two
- C. three
- D. four
- E. five

4. Fill in the Blank. From the following list of answers, select the correct term to fill in the blank. Part of the walk around check is to look for _____.

- A. function
- B. dirt
- C. hiding places
- D. extra rigging gear
- E. deficiencies

5. Fill in the Blank. From the following list of answers, select the correct term to fill in the blank. The number of wraps of wire required for non-grooved drums is _____.

- A. one
- B. two
- C. three
- D. four
- E. five

6. Fill in the Blank. From the following list of answers, select the correct term to fill in the blank. The crane must not be operated if a _____ is found.

- A. function
- B. loose tool
- C. birds nest
- D. newspaper
- E. deficiency

7. Select all that apply. Documented checks are required for which of the following category 3 cranes?

- A. Gantry cranes
- B. Jib cranes
- C. Wall cranes
- D. Boom trucks
- E. Pillar Jib cranes
- F. Fixed Overhead Hoists
- G. Bridge cranes

8. Place the steps listed in the correct order to test the Upper Limit Switch on a hoist.

_____ slowly raise the hook block into the switch

_____ ensure the hoist stops with the button depressed

_____ raise the hoist approximately two feet below the switch and stop

9. You must secure the crane and notify your supervisor when you find a deficiency.

- A. True
- B. False

CATEGORY 3 (NON CAB) CRANE SAFETY STUDENT GUIDE

10. It is the operator's responsibility to report a deficiency to the Crane Department.

- A. True
- B. False

11. Deficiencies are required to be reported by the end of the shift.

- A. True
- B. False

12. You are not to lift loads with the crane if a deficiency has been found.

- A. True
- B. False

Determining Load Weight

Load Weight

Load weight determines the size and capacity of the crane and rigging gear required. Load weight must be verified or calculated whenever it is estimated to exceed 50% of the crane's hook capacity or 80% of the rigging gear capacity.

Determining Load Weight: Acceptable Methods

Load-indicating devices, label plates, engineering evaluation and calculation are all acceptable methods of determining load weight.

- Load indicating device
- Label plates
- Documentation
- Engineer Evaluation
- Approved calculations



Determining Load Weight: Unacceptable Methods

Never take word of mouth to establish load weight.

Determining Load Weight: Basic Rules

When determining the weight of an object you can always round up the dimensions and the weight, but never round down. Never mix feet and inches and double-check your answers.

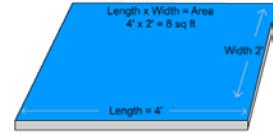
Material	Weight per cubic foot	Weight per square foot per inch of thickness
Ash	44	
Birch	47	
Cedar	34	
Cherry	38	
H	34	
Hemlock	29	
Maple	29	
Oak	50	
Pine (white)	25	
Walnut	40	
Concrete		150
Sand	100	
Steel	490	
Aluminum	165	
Brass	543	
Aluminum	14.5	
Brass	41.5	
Bronze	40.2	
Copper	48.3	
Iron	47.5	
Lead	39.2	
Monel	48.3	
Nickel	44.8	
Silver	54.7	
Steel	49.0	
Steel (stainless)	47.8	
Tin	35.3	
Zinc	38.7	

Standard Material Weight

This is a standard chart showing the weights of various materials per square foot, per inch of thickness and weight per cubic foot of volume. This chart is used as an aid when calculating load weights.

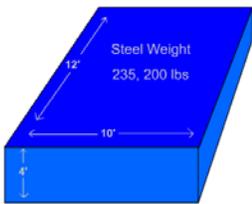
Finding Weight

Weights may be calculated using either area or volume. Find the weight of two-dimensional objects such as plates by multiplying the area in square feet by the material weight per square foot, for a given thickness. To find the weight of three-dimensional objects multiply volume in cubic feet by the material weight per cubic foot. Which calculating method you use, will depend on the item. You may need to use both methods for complex objects.



Calculating Weight by Area

To calculate the weight of this plate, we must find the area and multiply it by the material weight per square foot. Here, we have a steel plate, 4 feet by 2 feet by 1 inch thick. The area is 8 square feet. To calculate the weight, we need to find the unit weight, or weight per square foot for the material. Using the standard material weight chart, we find steel weighs 40.8 pounds per square foot per inch of thickness. The math can be simplified by rounding to 41 pounds. Multiplying 8 square feet by 41 pounds per square foot gives us 328 pounds.

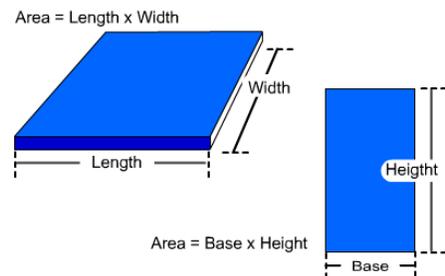


Calculating Weight by Volume

Volume is always expressed in cubic units, such as cubic inches, cubic feet, and cubic yards. Let's calculate the volume of this box. The formula is length, times width, times height. The length is 12 feet. The width is 10 feet. The height is 4 feet. When we multiply 12 times 10, times 4, the volume is 480 cubic feet. Now we can use the standard materials weight chart and multiply the standard weight by the volume.

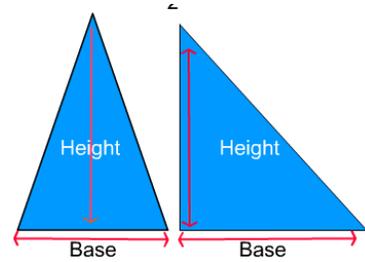
Calculating Area

The area of a square or rectangular shaped object is determined by multiplying length times width or base times height. It is always expressed in square units such as square feet or square inches, even when the object is circular.



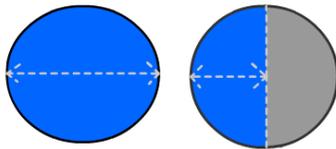
Calculating the Area of a Triangle

To calculate the area of a triangle multiply the base of the triangle by the height of the triangle and then divide by 2.



Calculating the Area of a Circle

To calculate the area of a circle, multiply Pi, which is 3.14, by the radius squared. Find the radius of the circle by dividing its diameter in half. To square the radius, multiply the radius by itself. For example, if a circle has a diameter of 3 feet, the radius will be 1.5 feet. 1.5 feet times 1.5 feet equals 2.25 square feet.

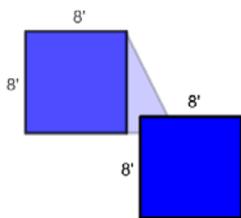
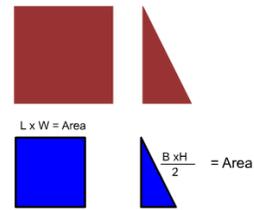


Therefore, the radius squared is 2.25 square feet. Pi times the radius squared would be 3.14 times 2.25 square feet, or 7.065 square feet.

Calculating the Weight of Complex Shapes

Most complex shapes can be broken down into a series of simple shapes.

Step1: To calculate the area of this complex shape, calculate the area of the square using the formula length times width. Next, calculate the area of the triangle using the formula base times the height divided by 2. Then add the areas together to get the total area of the complex shape.

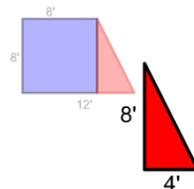


Calculating the Weight of Complex Shapes - 2

The first step is to calculate the area of the rectangle, or square, as shown in this example. The formula for the area of a rectangle is, length times width. The length is 8 feet and the width is 8 feet. 8 feet, times 8 feet, equals 64 square feet.

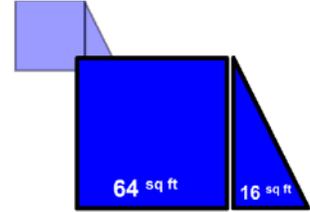
Calculating the Weight of Complex Shapes - 3

Next, find the area of the triangle. The formula for the area of a triangle is, base times height divided by 2. The base is 4 feet and the height is 8 feet. 4 feet times 8 feet equals 32 ft². 32 ft² divided by 2 equals 16 ft².



Calculating the Weight of Complex Shapes - 4

Now that we have found the area of the two sections, all we have to do is add the area of the square to the area of the triangle to find the total area of the object. 64 square feet, plus 16 square feet, equals 80 square feet. If we know what the material is and how thick it is, we can find its weight with one more calculation.

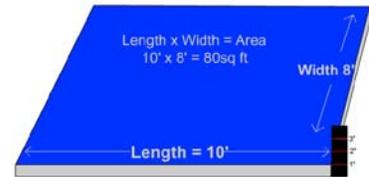


Calculating Area - Example

Step 1: To calculate the weight using area, we must find the material weight per square foot based on its thickness. Then, we simply multiply the base weight by the area of material. The area of this steel plate is 80 square feet.

Calculating Area – Step 2

Now we need to know the plate's thickness. According to the ruler, it is 1 inch thick

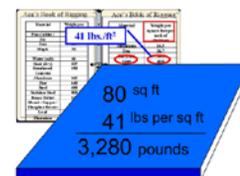


Calculating Area – Step 3

We can find the weight of common materials listed in several reference books available from various industry sources. Here, in “Ace’s Book of Rigging”, we find these tables. Material weight per cubic foot is in the left table. In the right table, unit weights are listed by weight per square foot, per inch of material thickness. We will use the table on the right since the material weights here are based on the thickness of material. We find steel listed in the “Materials” column. The unit weight is 40.8 pounds per square foot, per inch thickness of steel plate. Now let’s apply the rule we learned earlier in the lesson to make the math easier and give us a safety margin in our calculations. What was the rule on rounding that we should apply to this unit of weight? Round up! So, 40.8 pounds per square foot is rounded up to 41 pounds per square foot.

Calculating Area – Step 4

To calculate the weight of the plate: Multiply the area, 80 square feet by the unit weight of 41 pounds per square foot. The weight of the plate is 3,280 pounds. If 1-inch thick steel plate weighs 41 pounds per square foot, a 2-inch thick steel plate would weigh 82 pounds per square foot. What would 1/2 inch thick steel plate weigh per square foot? It would weigh 20.5 pounds.





Calculating Weight of a Triangle - Example

In this example, we have a triangular shape. How do we find the area of this plate?

Step 1: Multiply the base times the height and divide by 2. 12 times 5, divided by 2. The area of this plate is 30 square feet.

Calculating Weight of a Triangle – Step 2

To find the weight of this plate, we have to multiply the area (30 square feet) by the unit weight of the material per inch of thickness. The material is brass, and the thickness is 3 inches. To find the total weight of the material we need to reference a table or chart to obtain the unit weight.

Material	Weight per cubic foot	Material	Weight per square foot per inch thickness
Pine (white)	25	Aluminum	14.5
Ply	34	Zinc	56.7
Oak	40	Tin (lead)	58.5
Maple	39	Steel	49.0
Water (solid)	62.5	Brass (yellow)	44.5
Lead (solid)	110	Brass (red)	44.5
Resin (solid)	150	Monel / Copper	44.5
Copper	120	Phosphor Bronze	54.7
Aluminum	168	Lead	110
Steel	490		
Brass (yellow)	520		
Brass (red)	520		
Monel / Copper	550		
Phosphor Bronze	570		
Lead	110		
Paraffin	130		

44.5 lbs./ft²
Rounded up 45 lbs.

Calculating Weight of a Triangle – Step 3

We now know that brass weighs 45 pounds per square foot, per inch of thickness. We multiply the thickness, 3 inches, by the unit weight of 45 pounds. The material weighs 135 pounds per square foot. Next, we multiply the area, 30 square feet, times the weight per square foot, 135 pounds. We find that this item weighs 4,050 pounds.

Area=30 ft²
Thickness =3"
Brass 45 lbs per inch of thickness

12' 3 x 45 lbs./ft² = 135 lbs. ft²
135 lbs./ft² x 30 ft²= 4,050 lbs.

Calculating the Area of a Circle - Example

To calculate the area of a circle, multiply Pi, 3.14, by the radius squared. This steel plate is 4 feet in diameter. Therefore, the radius is 2 feet. The plate is 1 ½ inches thick.



To find the area: multiply Pi, or 3.14 times the radius squared. 3.14 times 2, times 2 equals 12.56 square feet.

To find the weight per square foot: multiply the plate thickness, 1 ½ inches, times the weight of 1 square foot of 1-inch thick steel. 1.5 times 41 equals 61.5 pounds.

To find the weight: multiply the area, 12.56 times the unit weight of 1 ½ inch thick steel plate which is 61.5 pounds. The weight of this circular steel plate is 772.44 pounds.

Calculating the Area of a Circle

Rounding numbers make calculations easier. Always round up.

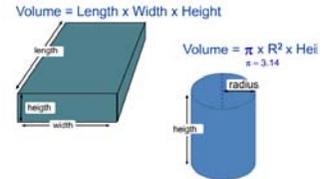
Rounding up give a larger area and heavier weight, therefore an added safety margin.



Round up the plate area and the weight. The area, 12.56 square feet, rounded is 13 square feet. The weight, 61.5 pounds, rounded is 62 pounds. 13 times 62 equals 806 pounds.

Calculating Volume

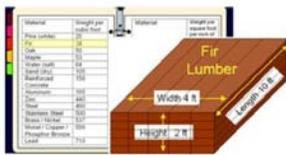
The volume of a square or rectangular object is figured as length times width multiplied by the height. The volume of a cylinder is Pi times the radius squared, times the height.



Calculating Volume - Example

To calculate weight, by volume, we need to find the unit weight, or weight per cubic foot for the material. We go back to the tables to find the weight for a cubic foot of fir wood.

This time we will use the table on the left since the material weights listed here are

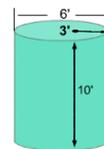


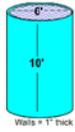
based on the weight per cubic foot of material. Using the standard material weight chart, we find that fir weighs 34 pounds per cubic foot. If the weight were listed in fractions or decimals, such as 33.8 pounds per cubic foot, we would simplify the math by rounding 33.8 up to 34 pounds. Multiplying 80 cubic feet by

34 pounds equals 2,720 pounds. This stack of lumber weighs 2,720 pounds.

Volume of a Cylinder

What is the formula for finding the volume of a cylinder? To calculate the volume we must first find the area of the circular end. The formula for area is Pi times radius squared. Once we know the area, we simply multiply it times the height or length. So the formula we use to find the volume of a solid cylinder is, Pi times radius squared times the height. If the cylinder were lying down you would use its length in place of the height.





Calculating the Volume of a Cylinder - Example

Let's calculate the volume of this cylinder. If the diameter of this object is 6 feet, what would the radius be? The radius would be 3 feet. The height is 10 feet.

We multiply Pi, which is 3.14 times 3 feet times 3 feet. The result is 28.26 square feet. Now, multiply 28.26 square feet, times the height, 10 feet. The result is the volume of this cylinder, 282.6 cubic feet. If the cylinder is hollow, we will need to calculate the volume of the cylinder and the volume of the contents separately. Calculate the volume as if the cylinder is solid. Then calculate the volume of the hollow. Subtract the volume of the hollow section from the volume of the solid cylinder.

Calculating the Volume of a Cylinder

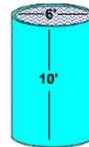
One inch steel plate weighs 40.8 pounds per square foot. The bottom plate is 6 feet in diameter, so the radius is 3 feet. 3 feet squared equals 9 square feet.

We multiply 9 square feet by 3.14. This gives us the area, 28.26 square feet.

We multiply this by the unit weight for steel plate of 40.8 pounds per square foot.

The bottom plate weighs 1,154 pounds. Calculate the cylinder wall

weight as a flat plate. Multiply Pi, (3.14) times the diameter, 6 feet, times the height, 10 feet. Multiply the area 1,884 square feet by the weight of steel plate, 40.8 pounds per square foot. The resulting weight is 7,687 pounds.



Calculating the Weight of a Cylinder and its Contents



Saltwater = 64 lbs ft³
 Materials weight x cubic feet = weight of the water
 64 lbs/ft³ x 282.6 ft³ = 18,086.4 lbs
 Rounded up = 18,087 lbs

Bottom Plate = 1,154 lbs
 Cylinder = 7,687 lbs
 Water = 18,087 lbs

Total Weight of cylinder and water = 26,928 lbs

Calculating the Volume of a Cylinder

Using the volume calculation, let's find the weight of the water contained in this thin-walled cylindrical tank. Let's calculate the weight of this cylinder full of salt-water. We need to know the weight per cubic foot of salt water.

Looking at our material weight chart we see saltwater weighs 64 pounds per cubic foot. We multiply the material weight times the cubic feet to find the weight of the water in

the cylinder. 282.6 cubic feet times 64 pounds per cubic foot equals 18,086.4 pounds.

Now we will add up the weights. 1,154 pounds for the bottom plate, 7,687 pounds for the cylinder wall; and 18,087 pounds of water, for a total load of 26,928 pounds.

NOTES

[Determining Load Weight Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. To find the weight of a piece of aluminum plate, you would multiply...

- A. Square feet times material weight per square foot based on a specified thickness
- B. Cubic feet times material weight per cubic foot

2. Select the best answer. A box has 27 cubic feet of sand in it. Sand weighs 105 lbs. per cubic foot. The box weighs 1,200 lbs. empty. The correct equation to find the total weight is:

- A. $27 \times 105 = 2,835 + 1,200 = 4,035$ lbs
- B. $27 \times 1,200 = 32,400 + 105 = 32,505$ lbs
- C. $27 \times 105 = 2,835$ lbs

3. Select the best answer. A triangular shaped 1 inch thick metal plate has a base of 10 feet and a height of 15 feet. What is the area of the plate?

- A. 150 feet
- B. 1,500 square feet
- C. 75 square feet
- D. 1,500 ft

4. Select the best answer. A cylinder has a diameter of 12 feet, and a height of 17 feet. What is the volume of the cylinder rounded up?

- A. 204 cubic feet
- B. 1922 cubic feet
- C. 204 square feet
- D. 7,687 cubic feet

5. Select the best answer. A complex shape of 1 inch thick aluminum plate has a rectangular area of 64 square feet and triangular area of 16 square feet. If aluminum weighs 14 pounds per square foot, how much does the plate weigh (rounded up to the nearest hundred pounds)?

- A. 1,200 lbs
- B. 1,000 lbs
- C. 1,300 lbs
- D. 1,100 lbs

6. Select the best answer. A complex shape of 1 inch thick aluminum plate measures 6 feet long on the top edge, 8 feet wide on the left edge, 12 feet long on the bottom edge, ending with a 10 foot long hypotenuse connecting back to the top edge. What is the correct equation to find the area of the triangular shape?

- A. $12 \times 10 / 2$
- B. $6 \times 12 / 2$
- C. $8 \times 12 / 2$
- D. $8 \times 6 / 2$

7. Select the best answer. A cylinder is made of solid aluminum which has a unit weight of 165 lbs per cubic foot. What is the weight of this cylinder if the diameter is 4 feet and the height is 5 feet?

- A. 10,000 lbs
- B. 12,532 lbs
- C. 10,362 lbs
- D. 10,532 lbs

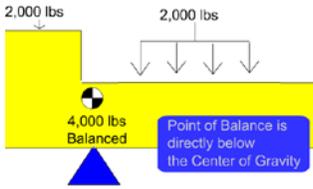
8. Select the best answer. A rectangular shaped tank has a length of 24 feet, a width of 10 feet, and a height of 12 feet. What is the volume of the tank?

- A. 2,880 square feet
- B. 2,900 feet
- C. 2,400 square feet
- D. 2,880 cubic feet

9. Select the best answer. A circular shaped 1/2 inch thick aluminum plate has a diameter of 7 feet. What is the area of the plate rounded up?

- A. 7 square feet
- B. 22 square feet
- C. 39 square feet
- D. 22 feet

Load Weight Distribution



Balancing Point

An object will rest in a state of balance when supported at its balance point. The balance point may not be located at the center of an object, but it is always directly below the center of gravity.

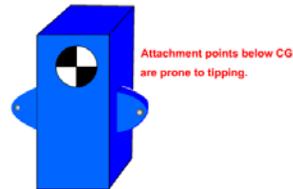
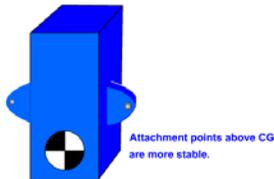
Center of Gravity

The center of gravity is the point where the entire weight of the object would balance in any direction, as if all the weight were concentrated in that one point. It is a fixed point and does not change unless the shape of the object is altered. Center of gravity is generally located in the center of symmetrical objects made of like material. For non-symmetrical objects, it must be calculated and could be located outside the object.



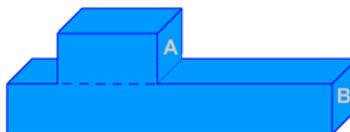
Importance of Center of Gravity

The location of the center of gravity will affect an object's reaction to movement. If the attachment points are below the center of gravity, the object will tip over more easily when moved. If the attachment points are above the center of gravity, the object is not likely to tip.



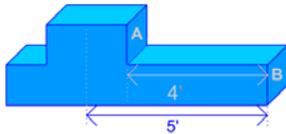
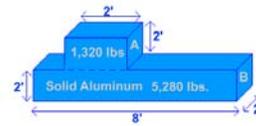
Finding the Balancing Point

Step 1: The balance point of a symmetrical object will be directly under its center. To find the balance point of a complex shape, we must first break the object into symmetrical sections or components.



Finding the Balancing Point

Step 2: The second step is to determine the weight of each section.

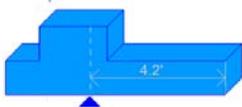
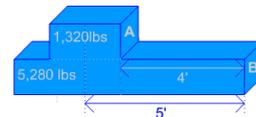


Finding the Balancing Point

Step 3: The next step is to measure from the reference end to the center of each section of the object.

Finding the Balancing Point

Step 4: Then, multiply the weight of each section, by the distance from the reference end to the center of that section. The result is called moment. Moment is an effect produced by a force at some distance from a fixed point, such as the center of gravity. Moment, like torque, is often described in foot-pounds or pound-feet.

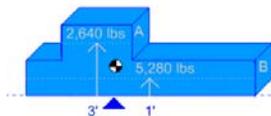


Finding the Balancing Point

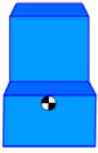
Step 5: Add the moments together and divide this number by the total weight of the object. The balance point is where the moments, measured from each end, are equal.

Pinpointing the Center of Gravity

In this example the weight of section A is 2,640 pounds. The weight of section B is 5,280 pounds. Measure the distance from the reference end to the center of each section. Multiply the weight of each section by the distance from the reference end to the center of the section to obtain from the reference line to the and the distance from the section B is one foot. The moment The moment for section B is 5,280 moments together and divide by the total weight to find the height of the center of gravity. 7,920 plus 5,280 equals 13,200 pound-feet. The weight is 2,640 plus 5,280 or 7,920 pounds. Now divide 13,200 by 7,920. The center of gravity is 1.666 feet up from the reference end. If we convert decimal feet to inches, this equals 1 foot, 8 inches.



The distance center of section A is 3 feet reference line to the center of for section A is 7,920 feet. pound feet. Add the

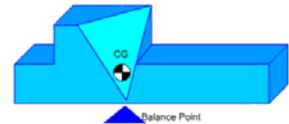


Pinpointing the Center of Gravity

To find the depth of the center of gravity, follow the five-step process using the front of the object as the reference end for step 3. In this example, the end view shows the object is symmetrical. Therefore, we can assume the center of gravity is in the center of the object –one foot from the front.

Center of Gravity Pinpointed

The object's center of gravity is always directly above the balance point. It may be helpful to measure and temporarily mark the object's center of balance before rigging.



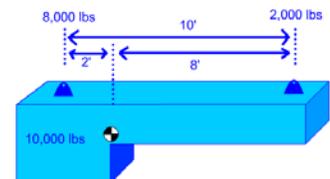
Center of Gravity Review

Remember to estimate the location of the Center of Gravity in relation to the attachment points before rigging or lifting loads. If the center of gravity is difficult to estimate, you may need engineering assistance. Loads hoisted from the bottom without restraint are susceptible to tipping. Loads should be lifted from their top, or restrained within the slings. If a load is hoisted without keeping the hook over the center of gravity, the load will shift as it clears the ground. Sometimes the rigging must be re-adjusted before making the lift.



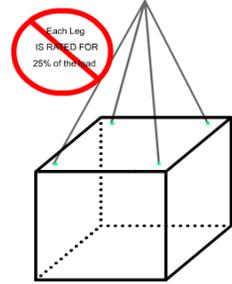
Weight Distribution

The center of gravity provides a quick reference for how the weight is distributed throughout a load. However, before planning the lift it is necessary to refine how the load weight is distributed. Weight distribution determines what each attachment point will have to carry. This information insures the selection of correctly rated rigging gear.

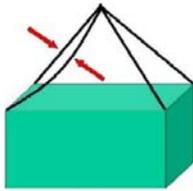


A Wrong Assumption

A common assumption is that 4 legs divide the load weight into 4 equal parts. Each leg then carries 25% of the load. Most often, this is not true.



How many legs really carry the load?



We now understand that each leg will not always carry its share of the load. In this example, one sling is longer than the others. Therefore that attachment point will not carry its share of the load. When one sling is longer than the others, the shackles or other hardware are different brands or sizes, or one attachment point is higher than the others, one or more attachments may not carry any

load at all. Never assume that all legs will carry their share of the load.

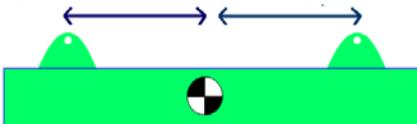
A Safe Assumption

Here is a safe assumption: At any given time, any two legs may carry the load, even if three or more legs are used. The “two-legs-carry-the-load” rule helps us to compensate for different sling lengths, attachment points at different elevations, and load flex. Gear selections should be based on two legs being able to carry the load. For example, if an object weighs 10,000 pounds then each leg would require a rated load of at least 5,000 pounds.



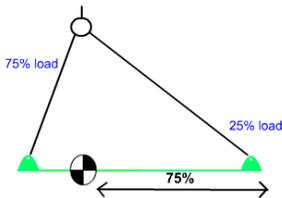
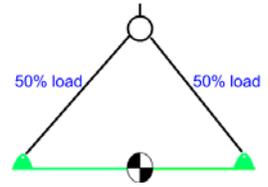
How do we know how much weight is in each leg?

Gear selection is dependent upon how much weight is carried by each leg - the load's weight distribution. Weight distribution is proportional to the distance between the object's Center of Gravity and its attachment points. The distances between the Center of Gravity and the attachment points will determine how much of the weight each attachment point will carry.



Equal Weight Distribution

This drawing represents a load. Notice the difference in weight distribution as the center of gravity changes distance from each attachment point. In this first example, each attachment carries equal weight because the center of gravity is equal distance between the attachment points. Watch the left attachment point as we move the center of gravity.

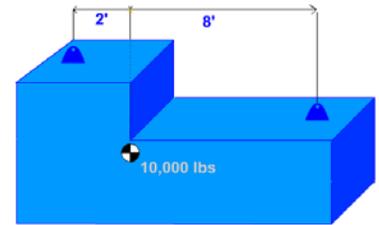


(Unequal) Weight Distribution

In the second example, the weight is greatest in the left attachment point because it's closest to the center of gravity. When one attachment point is closer to the center of gravity than the other attachment point, it carries more weight. It carries 75% of the weight and the opposite end carries 25%.

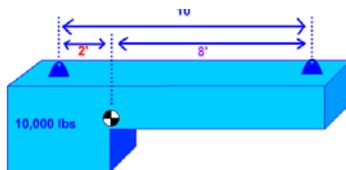
Information Needed to Calculate Weight Distribution

Now, let's move beyond estimating and show how to calculate the weight distribution. In order to calculate weight distribution, you must know the object weight, the location of the center of gravity and the distance of each attachment point from the center of gravity.



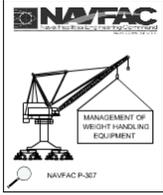
Weight Distribution - Example

If we want to find out how much weight is distributed to the attachment closest to the center of gravity, we divide the 8-foot distance by the overall distance between attachment points, which is 10 feet. Then we multiply this answer by the total weight of the object. Eight divided by 10, times 10,000 equals 8,000 pounds.



NOTES

[Rigging Gear Marking and Record Requirements](#)



[NAVFAC P-307 Section 14](#)

Let's look at the section of NAVFAC P-307 that deals with rigging, Section 14. Section 14 provides administrative and technical requirements for inspection, testing, certification, alteration, repair, operation, and use of rigging gear. These requirements help ensure the rigging gear you use is safe. When followed, these requirements help ensure optimum service life of the gear. These requirements apply to Navy owned gear and to contractor owned gear used with Navy owned cranes.

[The Test and Inspection Program](#)

P-307 requires each activity to establish a program that includes initial visual inspection and load test of all equipment and markings, pre-use inspections before equipment is used, documented periodic inspections of all equipment, and documented periodic load tests of certain equipment.

[Why test and inspection?](#)

Why do we need a test and inspection program? The primary goal is to prevent personnel injury! The test and inspection program is designed to identify sub-standard, defective, damaged, or worn equipment, and remove unsafe equipment from service.

[Covered Equipment](#)

Test and inspection requirements apply to the following equipment used in weight handling operations. Rigging hardware such as shackles, links and rings, swivels, eye bolts, swivel hoist rings, turnbuckles, and hooks. These requirements also apply to slings including chain slings, wire rope slings, metal mesh slings, synthetic web slings, synthetic rope slings and synthetic round slings. These requirements also apply to crane structures without permanently mounted hoists.



[Covered Equipment](#)

Equipment covered includes manually operated hoists as identified in ASME B30.16 and B30.21 which include chain hoists and lever operated hoists.



Equipment covered also includes miscellaneous equipment, including below the hook lifting devices as identified in ASME B30.20, such as spreader beams, plate clamps, magnet lifters, pallet lifters, and tongs.

Equipment Not Covered

Equipment not covered includes ordnance equipment, which falls under NAVSEA OP-5, original equipment manufacturer or OEM installed welded lift lugs, threaded holes and bolt-on pads, and OEM provided rigging gear used for limited lifts such as off-loading, re-loading, initial storage, and shipment.



Equipment Markings

Markings on each piece of equipment are the most apparent way for you, the user, to know the requirements of NAVFAC P-307 have been met. Each piece of equipment must be clearly marked, tagged or engraved with the rated load of the equipment and indication of the re-inspection due date. Markings must be done in a manner that will not affect the strength of the component. Vibra-etch methods and low stress dot faced stamps are generally acceptable ways of marking equipment. Contact the OEM for guidance on where and how to mark.

Special Roundsling Markings

NAVFAC P-307 has additional requirements for alternate yarn roundslings. Alternate yarn roundslings are roundslings made from yarns other than nylon or polyester. The certificate of proof test must include the diameter of the pin used for the proof test. This will be the minimum diameter over which the sling may be used. The sling must be marked with the minimum allowable pin diameter.



Specific use Endless Wire Rope Sling Markings

In specific applications where endless wire rope slings are designed for a particular use, they shall be marked to indicate the pin diameter used to determine the rated load.

Markings on Chain Slings

In accordance with CFR 29 1915.112 and CFR 29 1917.42 chain slings used in ship repair or cargo transfer require quarterly periodic inspections and must be marked to show the month they were inspected.



Markings on Lashing

Lashing must be marked to identify it to the spool or reel from which it came. The rated load must be marked on each piece as well as the re-inspection due date.

Markings on Below-the-Hook Lifting Devices

Any below the hook lifting device weighing more than 100 pounds must have the weight clearly marked on it.

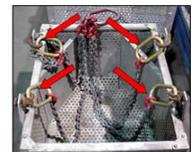


Multiple Part Equipment

Some rigging gear has multiple parts that can disassemble. To help avoid miss matching parts, all individual components of equipment such as shackles and pins must be identified to each other. Matching ID marks are needed on the primary and subordinate parts.

Markings on Multi-leg Sling Assemblies

Multi-leg slings assemblies shall be marked with the rated load of each leg, the rated load of the entire assembly, and the sling angle upon which the rated load is based.



WLL Markings for Multi-part Slings

NAVFAC P-307 requires that multi-part braided slings must have the OEM's marking re-marked at 70% of the OEM's rated load unless destructive tests are conducted on sample slings. The documentation is reviewed by the Navy Crane Center. So, there are many additional markings that may be required for different equipment. Not only do these markings have to be present, they must be legible.

Hard to Read or Missing Markings

Sometimes markings become hard to read due to wear or they may even be removed during a repair process. Replace markings that are hard to read or have been removed. Remember, all rigging equipment must be marked.



Required Records

Equipment markings should link the piece of equipment to its test and inspection records. NAVFAC P-307 requires documentation of tests and inspections. Records are the auditable proof that equipment has been tested and inspected and provide a basis for ongoing evaluation of the equipment. The latest test and inspection record will be retained on file at the activity. Computer generated files are acceptable if they identify the individual components and inspection results.

MASTER HISTORY RECORD CARD		EQUIPMENT TYPE / DWG NO		EQUIPMENT ID					
SPS CAPACITY	MANUF. RECOMMENDED PERIODIC TEST VALUE	MAX. MATERIAL REMOVAL AUTHORIZED	PROOF TEST VALUE						
THIS CARD IS TO BE USED FOR RECORD BASE (ORIGINAL) DIMENSIONS AND INFORMATION FOR SPECIAL PURPOSE EQUIPMENT. REFER TO UAP 2A12.3 FOR DETAILED INSTRUCTIONS. FILL IN APPLICABLE ITEM ONLY. USE REVERSE SIDE TO RECORD HISTORY AS REQUIRED BY UAP 2A12.3.									
ITEM	DESCRIPTION	ORIGINAL VALUE	SIGNATURE / DATE	FIRST REPLACEMENT VALUE	SIGNATURE / DATE	SECOND REPLACEMENT VALUE	SIGNATURE / DATE	THIRD REPLACEMENT VALUE	SIGNATURE / DATE
HOOKS	CAPACITY								
	TRAIL DIMENSION								
	LOWER TOPPER								
FORGED	TYPE								
FITTINGS	SIZE (INCLUDE THREAD LENGTH)								
CHAINS	SIZE (INCLUDE WEIGHT)								
	ARCHIVE LENGTH OVER S LINKS								
	LINK DIAMETER AT BEARING								
SLINGS	TYPE								
	CLASSIFICATION								
	DIMENSIONS (ATTACH CERTIFICATION)								
LOAD INDICATOR	TYPE BREAKING STRENGTH								
REMARKS REQUIRED									

Documented Test and Inspections provide:

- Auditable proof of tests and Inspections
- The basis for ongoing evaluation
- Latest record to be kept on file

Records Must Include...

NAVFAC P-307 requires that the records include identification of individual components, latest test and inspection results, and dates of inspections and tests. There are many ways to identify the equipment to the records.

MASTER HISTORY RECORD CARD		EQUIPMENT TYPE / DWG NO		EQUIPMENT ID	
SPS CAPACITY	MANUF. RECOMMENDED PERIODIC TEST VALUE	MAX. MATERIAL REMOVAL AUTHORIZED	PROOF TEST VALUE		
			CF 127D		
RECORD OF INSPECTION / TESTING		MAINTENANCE REPAIR AND MODIFICATION RECORD			
CYCLE	PURPOSE / DESCRIPTION	S	U	** C/740 VSR/DATE	CYCLE DESCRIPTION ***C740 VSR/DATE
Annual	Load Test Chainhoist	X		J.W. Inspector 1/27/20XX	

Identifying Gear to its Record

A unique identification number may be used to identify the equipment to its record. The ID number can be as simple or complex as you need it to be. A simple method might be to use a letter designator that represents a particular type of gear followed by a serialized number. For example, "S" could represent shackles. If you have 50 shackles they could each be individually identified S1, S2, S3, etc. Mark the equipment ID number on the gear. Write the ID number on the record. Now the gear has identifiable records.



Identifying Gear to its Record

This is an example of how the gear is marked at one Naval Shipyard. This is just one example of how an activity could choose to identify individual components to their records. This example reflects a fairly complex system that may be useful for activities who own multiple groups of equipment that need to be segregated. In this example, the unique identification number is used to identify three different things. The first number "98" identifies which shop, group, or code owns the equipment. Secondly, "P28" identifies the specific piece of gear with a serialized number. This particular number indicates that it was the 28th sling manufactured or certified on a specific day. The number 94-350 identifies the day it was manufactured or certified, 94 being the year 1994, 350 being the Julian date. No matter what method you use, there is important information that should be included in the gears records.



NOTES

[Rigging Gear Marking and Record Regt's Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. The goal of the rigging gear test and inspection program is to prevent personnel injury and:

- A. Be in line with OSHA guidelines
- B. Identify sub-standard equipment
- C. Reduce gear expenditures
- D. Follow OEM guidelines

2. Select the best answer. Rigging gear identification markings applied by the activity usually indicate that the equipment is:

- A. Authorized for use
- B. In an inspection program
- C. New to the activity
- D. Not damaged

3. Select the best answer. Matching ID marks on rigging gear are required for:

- A. Chain slings with permanent attachments
- B. Rope or chain sling bridle assemblies
- C. Components that can be separated
- D. All rigging equipment
- E. End fittings on slings

4. Select the best answer. What type of rigging gear inspection requires documentation?

- A. Monthly
- B. Weekly
- C. Pre-use
- D. Periodic

5. Select the best answer. Rigging gear test and inspection records are required to be kept on file:

- A. For 6 months
- B. For 1 year
- C. Until replaced by a more current record
- D. For 3 years

6. Select the best answer. Rigging gear test and inspection records must include:
Identification of individual components

- A. Latest test inspection results
- B. Dates of tests and inspections
- C. None of the data listed above
- D. All of the data listed in A through C above

7. Select the best answer. Equipment test and inspection requirements in section 14 of the NAVFAC P-307 do not apply to:

- A. Cranes and hoists integral to larger machines
- B. Personnel platforms
- C. Container spreaders
- D. OEM installed integral attachments

8. True or False. Rigging gear that has been inspected by a trained inspector does not require inspection before it is used.

- A. True
- B. False

9. True or False. A shackle must be marked with the rated load, re-inspection due date, and the date of manufacture.

- A. True
- B. False

10. Select all that apply. Markings on lashing must identify:

- A. Rated load
- B. Serial number
- C. The spool or reel
- D. The re-inspection due date
- E. Size

Rigging Gear Inspection

Types of Inspections

There are two types of required inspections, pre-use and periodic. The pre-use inspection is performed prior to use. No documentation is required for pre-use inspections. The periodic inspection is a comprehensive, documented inspection, performed on a schedule.

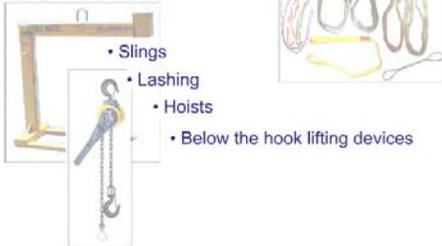
Pre-use Inspection

All equipment must be inspected prior to each use. The pre-use inspection ensures the equipment is not damaged or worn beyond allowable limits. The inspector must verify the rated load of the equipment and ensure the markings are legible. If the inspection due date has passed, the equipment must not be used. Remove any gear from service that fails inspection.

Periodic Inspection

Periodic inspections must be done by a qualified person. If inspection reveals that the equipment has accumulated damage or is worn beyond the allowable limits it must be removed from service. Records must be kept on file for all periodic inspections. Inspection records provide a basis for evaluation, and provide the audit trail proving the equipment is in a test and inspection program. The inspection frequency varies depending on the type of equipment. See table 14-1 of NAVFAC P-307.

Annual Inspection
Equipment Covered



Annual Inspection

Periodic inspections are required every year for slings, lashing, hoists, equalizers, load indicating devices, container spreaders, personnel platforms, cranes integral to larger machine systems, and below the hook lifting devices.

Biennial Inspection

Periodic inspections are required every 2 years for rigging hardware such as beam clamps, tackle blocks, snatch blocks and wire rope blocks. Crane structures without permanent hoists are also included, as are: eye bolts, eye nuts, links and rings, portable A-frames, portable gantries, portable floor cranes, shackles, swivels, swivel hoist rings and turnbuckles.

Equipment covered in the biennial inspection program includes:



Inspection Every 3 Months

In addition to the annual inspection noted previously, OSHA requires a periodic inspection every three months for chain slings used in ship repair and cargo transfer.



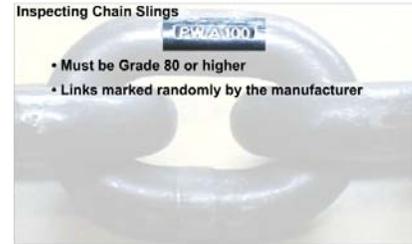
Sling Rejection Criteria - Knots

A knot in any part of a sling is cause for rejection.

Inspecting Chain Slings

Chain slings used for overhead lifting must be fabricated from chain that is grade 80 or 100.

Links are randomly marked by the manufacturer with 8, 80, or 800 for grade 80 chain, and 10, 100, or 1000 for grade 100 chain.



Inspecting Chain Slings

Chain slings are generally very tough and durable and consequently they tend to get a lot of hard use. Carefully inspect each link and end attachment; including master links and coupling links. Nicks and cracks may be removed by grinding. Measure the link or component after grinding. Rejection is required if the defect cannot be removed or if any part of the link diameter is below the required minimum. Look for deformation such as twisted, bent, stretched links, or broken welds.

Chain Link Wear

Remove the sling from service if the thickness is below the value shown in NAVFAC P-307.



[Chain Link Stretch](#)

Chain links stretch when they are overloaded. Worn chain links will also cause the sling length to increase. Measure the length of each sling leg and look for increased chain length that may indicate overloading or link wear.

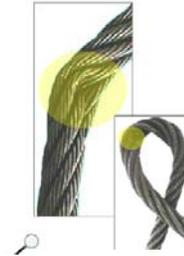


[Inspect Hammer Link](#)

Inspect hammer links carefully. Make sure the keeper pin is not loose or protruding.

[Wire Rope Sling Rejection Criteria](#)

Inspect wire rope slings along the entire length of the sling including splices, end attachments, and fittings. Look for permanent distortion such as kinked, crushed, or bird-caged areas.



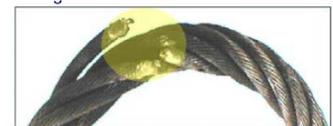
[Wire Rope Sling Rejection Criteria 2](#)

Look for core protrusion in-between the strands of the wire rope. Core protrusion is indicative of structural failure within the wire rope. The core should not be visible in straight runs. However, when a wire rope is bent, you will be able to see the core; this is not core protrusion. Fiber core wire rope slings may sometimes protrude between the strands in the end of an eye, opposite the bearing point; this too is not core protrusion.



[Wire Rope Sling Rejection Criteria 3](#)

Look for signs of heat damage such as discoloration and other more obvious signs as shown here.



Wire Rope Sling Rejection Criteria 4

Look for severe corrosion or pitting of the wires or any condition that would cause loss of wire rope strength



Measure Crown to Crown



Not Flat to Flat

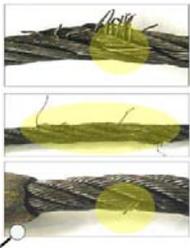


Measuring Wire Rope

When measuring wire rope sling diameter with calipers, make sure you place the caliper on the crowns of the wire strands. Do not place the caliper across the flats or valleys of the strands.

Broken Wires

Do not run your bare hand along the wire rope to detect broken wires! Bend the sling while watching for broken inside wires. Bending will open the area between the two ends and expose a broken wire making it easy to detect. Broken wire rejection criteria is based on a section of the wire determined by its "lay length". Lay length is the linear distance along the wire rope in which a strand makes one complete turn around the rope's center.



Strand Laid Wire Rope Slings

Single part and strand laid wire rope slings must be removed from service if inspection reveals any of the following criteria: ten randomly distributed broken wires in one lay length, five broken wires in one strand in one lay length or two broken wires within one lay length of the end connection.

Braided Wire Rope Sling Rejection Criteria

For braided wire rope slings with less than eight parts, reject slings with 20 randomly distributed broken wires in one rope lay length, or one completely broken strand. For braided wire rope slings with eight parts or more, reject slings with 40 randomly distributed broken wires in one rope lay length or one completely broken strand.



Cable Laid Wire Rope Slings

Cable laid wire rope slings must be removed from service if inspection reveals, 20 randomly distributed broken wires in one rope lay length, or one completely broken strand.



Wire Rope End Fittings

When inspecting slings with end fittings, ensure the fitting is not cracked, deformed or loose. Make sure the wire rope in the fitting is not corroded. Inspect the end attachment for wear that exceeds 10% of the OEM's nominal socket dimension or 5% of the socket pin diameter.

When inspecting slings with splintered sockets, the wire should not have any axial or lateral movement.

Metal Mesh Slings

Inspect the entire length of metal mesh slings including welds, end attachments, and fittings. Remove the sling from service if inspection reveals a broken wire in any part of the mesh, a broken weld or broken brazed joint along the sling edge, reduction in wire diameter of 25% due to abrasion or 15% due to corrosion, lack of flexibility due to distortion of the mesh or any cracks in the end fitting.



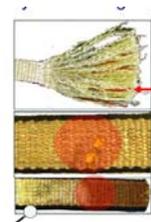
Remove From Service

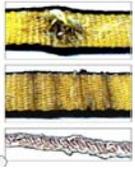
Remove the sling from service if the eye openings in the end fitting are increased by more than 10%, or if there is a reduction of 15% of the original cross sectional area at any point around the hook opening of the end fitting. In addition, remove the sling from service if there is visible distortion of either end fitting out of its plane, any cracks in either end fitting, or knots in any part of the sling.



Synthetic Sling Rejection Criteria

Never use synthetic slings with exposed core warning yarns. Do not rely on core warning yarns to indicate damage, as not all manufacturers use them and damage can reach rejection limits without exposing core yarns.



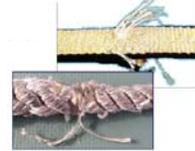


[Synthetic Sling Rejection Criteria - 2](#)

Other damage that would require a synthetic sling to be removed from service includes heat or chemical damage, punctures, cuts, and variations in size, thickness or roundness of the sling.

[Synthetic Sling Rejection Criteria - 3](#)

Look for broken or damaged stitches or splices. The stitching holds the sling together. Check it carefully.



[Synthetic Sling Rejection Criteria - 4](#)

Look for damage caused by prolonged exposure to sunlight, which can result in discoloration, fading or roughness. Look for cracked, distorted, broken, or excessively worn, pitted, or corroded end fittings. Also look for knots or indications the sling has been knotted. If you find evidence that a sling has been knotted, remove it from service.

[Synthetic Rope Sling Removal Criteria](#)

Remove from service if considerable fiber or filament breakage is found along the line where adjacent strands meet. Light fuzzing is acceptable. Look for powder or particles of broken filaments or fibers inside the rope between the strands. Twist or pry the rope open for inspection. Inspect filaments or fibers for weakness, brittleness, or variations in the size or roundness of the strands.



[Synthetic Round Sling Removal Criteria](#)

Remove the sling from service if inspection reveals holes, tears and snags in the cover, broken or worn stitching, embedded particles, exposure of any core yarns, bumps, bulges, or irregularities. A knot in the yarn where the cover is joined is acceptable.



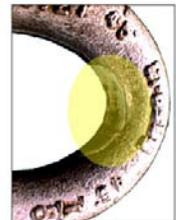


Types of Hardware Damage

When inspecting rigging hardware, look for corrosion or severe pitting that would leave an orange peel effect when cleaned. Slight surface rust is okay. Inspect for wear, cracks, nicks, gouges, deformation, or distortion. Distortion may include elongation, peening, or heat damage.

Areas to Inspect for Hardware Damage

Inspect the whole body of the hardware, but be particularly vigilant when inspecting the bearing surfaces for wear and distortion. Pay particular attention to the bearing surfaces since this is where the load is applied and will often show tell-tale signs of overload or abuse; just as the flattened area indicates on this picture.



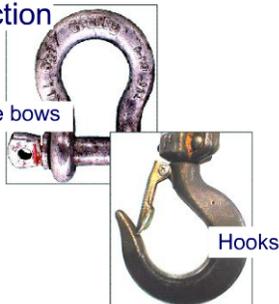
10% Wear Reduction

Remove shackle bows and welded links, from service when wear exceeds 10% of the nominal diameter shown in federal specification RR-C-271. For shackle sizes not shown in federal specification RR-C-271, the OEM's listed nominal dimensions will be used.

Remove hooks from service when wear exceeds 10% of OEM's nominal dimensions.

10% Wear Reduction

Remove from service when wear exceeds 10% of nominal dimensions



5% Wear Reduction

Remove weldless links, shackle pins, and swivels, from service when wear exceeds 5% of the nominal diameter shown in federal specification RR-C-271. For sizes not shown in federal specification RR-C-271, the OEM's listed nominal dimensions shall be used. Remove eyebolts when wear exceeds 5% of the OEM's nominal eye section diameter. Remove turnbuckles when end-fitting wear exceeds 5% of the OEM's nominal dimensions. Remove swivel hoist rings when wear exceeds 5% of the OEM's minimum dimensions.

Area to Inspect for Hardware Damage



Threaded shanks must be inspected carefully before use or load testing. When using gear with threaded shanks such as eyebolts, hoist rings, etc., inspect the shank carefully for bends, twists, or damaged threads.

Inspecting Moving Parts

Some hardware has moving parts such as hoist rings and turnbuckles. Ensure that all moving parts move freely. Hoist ring bases should swivel 360° and the bail should pivot at least 180°.



Tackle Blocks

Tackle blocks shall be removed from service if inspection reveals distortion, cracks in the housing or sheaves, damaged sheaves, binding, abnormal sheave play, or any damage that may cause doubt as to the strength of the unit.

Below-the-Hook Lifting Devices

Below the hook lifting devices and container spreaders shall be inspected in accordance with ASME B30.20 and OEM recommendations. Always read and follow the information provided by the OEM.



Hoists, Cranes, A-Frames, Gantries

Chain hoists and portable hoists shall be inspected in accordance with: ASME B30.16 and OEM recommendations. Lever operated hoists shall be inspected in accordance with ASME B30.21 and OEM recommendations. Other equipment shall be inspected in accordance with applicable ASME B30 criteria and/or OEM recommendations.

Portable Load indicating Devices

Check for visible damage and any other attributes listed by the OEM. Portable load indicating devices shall only be used in the range that ensures the proper design factor. Ensure they are marked or tagged to indicate the reduced maximum rated load, if required.

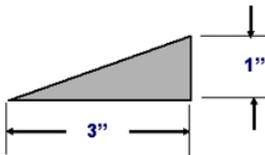


Repairs and Alterations

When minor damage, such as nicks or cracks are found, it may be possible to remove the defect rather than replacing the gear. Repairs must be performed in accordance with OEM or engineering instructions. Alterations must be approved by the activity engineering organization. Re-inspection and load test of the repaired or altered equipment shall be performed prior to returning to service.

Authorized Hardware Repair

Grinding to remove defects is the only method authorized to repair rigging gear. Heat or welding is not permitted to correct defects. And no attempt shall be made to straighten bent or twisted rigging gear. Grinding shall follow the contour of the piece. Blending with a maximum 1 to 3 taper. The component dimensions after grinding must be within the wear limits for the piece being repaired. If the after-grinding dimensions exceed the wear limits specified by the OEM or NAVFAC P-307, the component must be removed from service.



Removal of defects as specified will not require a load test.

Non-Destructive Test

Removal of cracks must be verified by non-destructive testing before the hardware can be returned to service.



Removal of cracks requires non destructive testing before returning equipment to service

NOTES

[Rigging Gear Inspection Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. What is the minimum grade of chain required for chain slings?

- A. Grade 80
- B. Grade 100
- C. Grade 70
- D. Grade 60

2. Select the best answer. What are the two types of rigging gear inspections?

- A. Periodic and Random
- B. Periodic and Pre-Use
- C. Annual and Biannual
- D. Frequent and Annual

3. Select the best answer. Who is required to perform an inspection prior to using rigging gear, and what is this inspection called?

- A. Rigging gear room personnel, Prior to Use Inspection
- B. Gear Room personnel, Pre-Operational Inspection
- C. Gear Room Qualified personnel, Pre-Use Inspection
- D. The User, Pre-Use Inspection
- E. The User, Periodic Inspection

4. True or False. Rigging hardware that is bent can be repaired by straightening it back to its original shape.

- A. True
- B. False

5. True or False. Documented records must be kept for periodic inspections.

- A. True
- B. False

6. True or False. Two broken wires within one lay length of the end connection would remove a wire rope sling from service.

- A. True
- B. False

7. True or False. A knot in a synthetic sling is allowed as long as it does not cause permanent damage to the sling.

- A. True
- B. False

8. True or False. Chain slings used in cargo transfer should be inspected annually.

- A. True
- B. False

9. True or False. Rigging hardware such as eyebolts, hooks, and shackles are required to have a periodic inspection every 2 years.

- A. True
- B. False

10. True or False. A metal mesh sling can remain in service if only one wire is broken in the mesh.

- A. True
- B. False

11. Select the best answer. Distorted rigging hardware must be:

- A. Heat treated and returned to service
- B. Evaluated for repairs
- C. Remarketed for a reduced capacity
- D. Removed from service and destroyed.

Rigging Gear General Use

Section 14 of the P-307

NAVFAC P-307 provides specific rules for using rigging equipment described in section 14. It does not, however, provide specific direction on rigging practices or techniques.



Rigging Manuals

Information on rigging techniques can be found in rigging handbooks, rigging manuals, OEM publications, textbooks, and consensus standards. Let's cover some of the safety precautions that apply to all types of rigging equipment or operations.

General Safety Rules

Remain alert when performing rigging operations. Hazards are always present. Two common danger areas are between the rigging gear and the load; and between the load and other objects. These areas are sometimes referred to as "the bight". Be sure to keep your hands, feet, and head, out of the bight.

Never Use Homemade Gear

Never use shop made equipment unless it has been approved by engineering and certified for use in weight handling operations.



Selecting Rigging Equipment

Use rigging gear only for the purpose it is designed for. Rigging gear is a tool like a hammer or wrench. We've all heard the phrase... "use the right tool for the job." It's the same for rigging gear. If you don't have the right rigging gear to safely do the job, stop and get it! Never use damaged gear. Never use gear past its inspection due date! Your safety and the safety of the rest of the crane team depend on the gear you use, and how you use it. Take the time to do it right.

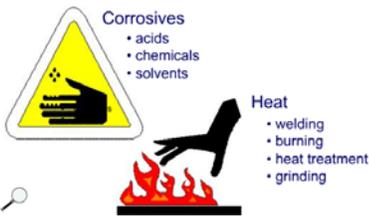
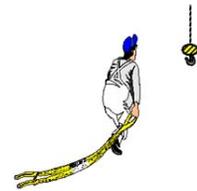


Selecting Rigging Equipment

Keep the following in mind when selecting rigging equipment. Rigging equipment must be selected based on the total force that will be applied to the gear, not just the weight of the load. Remember, in some cases, the force in one leg of a multiple sling leg could exceed the weight of the load. Keep the overhead height restrictions or clearances in mind when selecting sling length. Sling lengths that are too long may cause the hook to reach the limit switch before the load reaches the desired height. You must also think about the hazards the gear may be subjected to so you can choose the appropriate equipment.

Hazards to Rigging Gear

The first major hazard we must talk about is abuse. Here the biggest hazard is you, the user! Don't drag your slings on the ground. Cement or paved surfaces will quickly abrade slings and gear. Contact with the ground can embed grit and abrasives into the sling, which will cause damage. Don't pull slings from under a load while the load is resting on them. Set the load down on blocking to keep from crushing the sling.



Hazards to Rigging Gear

Keep gear away from corrosives, acids, paint thinners, and any other harmful chemicals. Chemicals that may have a corrosive effect on one type of gear may not affect another. For example, acids would quickly destroy a nylon sling but

might not harm another synthetic material. Protect your gear from all heat sources such as welding, burning, grinding, or heat-treating.

Hazards to Rigging Gear

Another common hazard is sharp edges. No matter what type of gear you use, sharp edges will leave their mark if the gear is not protected. Never use slings against sharp edges without adequate protection.



Hazards to Rigging Gear

You must be aware of the danger electricity presents when working around energized components or electrical lines. Watch out for welding leads, light strings, shore power and other common hazards when looking for lay down areas. Wire rope, chain, and metal mesh slings should never be used if they could increase the possibility of electrical shock. Protect yourself and the gear by ensuring all power is secured prior to installing your gear on or around electrical components.



Protective Materials

So how do we protect our gear from being damaged by sharp edges? It's necessary to use protective materials, known as "chafing gear", to protect and prolong the life of our rigging gear and items being lifted. Chafing gear can be any material used for protecting rigging gear or loads. Chafing gear increases friction thereby reducing the tendency for rigging to slip. Wood blocks, canvas, cardboard, rubber, leather and old fire hose are great for protecting critical or machined surfaces and increasing friction. Other items include metal sweeping shoes and split piping. These are just a few examples of chafing gear. Chafing protection material must be of sufficient thickness and strength to prevent sling damage. With high stresses on slings, soft chafing protection material may not maintain the minimum required radius or provide the required protection. (i.e., using cardboard or thin rubber on a heavy, sharp edged object will not provide sufficient protection for the load or rigging gear.)



Using Chafing Gear

Chafing gear can be many types of materials and it may be used many different ways. Wood blocks may be used to keep slings away from sharp edges. Old fire hose can be placed between your gear and sharp edges or a sling can be passed through the hose and used as a protective sleeve. Remove the hose to inspect for damage before and after each use. hose can hide sling damage if left on the sling.



Hoist and Crane References

Portable floor cranes, portable a-frames, portable gantries, and cranes integral to larger machine systems must be operated in accordance with applicable ASME B30 criteria and OEM recommendations. Chain Hoists and portable hoists must be operated in accordance with ASME B30.16 and OEM recommendations. Lever operated hoists must be operated in accordance with ASME B30.21 and OEM recommendations. Other applicable equipment must be operated in accordance with ASME B30 and OEM recommendations.

Using Hoists and Cranes

When using chain hoists and portable floor cranes, ensure hoist capacities meet or exceed the expected load. Load indicating devices may be used to help prevent overload of the hoist and related gear when leveling, rotating, or tilting objects.

Using Hoists to Distribute Sling Loading

When chain hoists are used to equalize a load they should be used in conjunction with load indicating devices to ensure equal loading



Using Hoist and Cranes

Secure hand chain and excess load chain to prevent tangling and inadvertent operation. A bag can be attached to the hoist body to hold excess chain. Do not use excessive force to operate a hoist. Only one person at a time should operate a hoist. And never use extension bars on lever-operated hoists.

Using Hoist and Cranes

Never use the load chain to choke around an object and never “tip load” the hook.



Below-the-Hook Lifting Devices

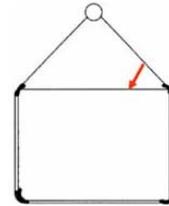
Below the hook lifting devices and container spreaders must be operated in accordance with ASME B30.20 and OEM recommendations. Never use below the hook lifting devices if you do not thoroughly understand the operating characteristics and limitations. Ensure the lifting device has sufficient capacity for the expected load.

NOTES

Sling Use

Wire Rope Sling Use

A common metal sling is the wire rope sling. Wire rope slings have some limitations even though they are generally strong and durable. D-to-d is the term for the ratio between the diameter of the object around which the sling is bent and the diameter of the sling body. The capital D represents the diameter of the object and the small d represents the diameter of the sling. When using wire rope slings always maintain a minimum D-to-d ratio of one to one in the body of the sling. In other words, Never bend a wire rope around a diameter smaller than itself! Bending a wire rope around a diameter smaller than its minimum D-to-d ratio will damage the wires and weaken the sling.



Wire Rope Sling Use

For loads with a non-circular cross section the bend diameter is derived from the minimum bend diameter of the wire rope around the corner of the load. For slings bent around corners, the corners must be rounded to provide the minimum D/d efficiency. Chafing protection is used to protect the load and sling from damage.



Wire Rope Temperature Restriction

Wire rope must also be protected from extreme temperatures, which can seriously affect the wire's strength. Do not use wire rope slings below minus 40 degrees or above 400° Fahrenheit. Fiber core rope wire should not be used above 180° Fahrenheit.

Rope Sling Restrictions

Wire rope clips should not be used to fabricate slings. And wire rope slings should never be knotted.



Chain Sling Use

Chain slings are a good choice when the job demands abrasion and damage resistant slings. However, if used improperly, they too can be damaged. Chain slings should not be used on loads that are damaged easily. Never use knots or bolts to shorten or extend the sling. Use chafing on sharp corners and edges to prevent damage to slings and load. Always check OEM instructions for the chain sling you are using.

Chain Sling Temperature Restrictions

NAVFAC P-307 requires that chain slings should not be used when temperatures are below minus 40° Fahrenheit. When chain slings are used at or above 400° Fahrenheit, follow OEM recommendations.



Metal Mesh Temperature Restrictions

Metal mesh slings are often used in abrasive or high temperature environments that would damage slings. Do not use metal mesh slings when temperatures are below 0° or above 550° Fahrenheit. Do not use elastomer coated slings when temperatures are below 0° or above 200° Fahrenheit. Always follow OEM recommendations.

Types of Synthetic Slings

Synthetic slings should be used only when they can be protected from damage! Natural fiber rope slings are not to be used for overhead lifting.



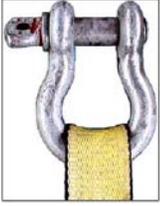
Using Synthetic Slings

Synthetic slings cannot be substituted for other slings specified on rigging sketches. Avoid chemical exposure to synthetic slings and always use chafing gear! Minimize exposure to sunlight and other sources of ultraviolet light. Store all synthetic slings indoors in a cool dry place. *And, always follow OEM recommendations when using synthetic slings.*

Synthetic Web Sling Use

Web slings must be installed flat around the load without kinks or twists. Kinks and twists reduce friction on the load and can cause the sling to roll or slide out of position. These slings are not affected by D-to-d ratio. Eye length in relation to the diameter of the hook is critical. The eyes of webbing slings are stitched and the stitching can be damaged if the eye is spread excessively.





Using Shackles with Web Slings

Shackles used with synthetic web slings must allow the sling to lay relatively flat without excessive curling of the edges. Curling causes uneven loading of the sling. Slight curling, however, is acceptable.

Web Sling Temperature Restrictions

Do not use synthetic web slings at temperatures exceeding 194° Fahrenheit or OEM recommendations whichever is more restrictive.

Minimum D/d Ratio for Synthetic Rope Sling Use

When making single point lifts with eye and eye synthetic rope slings, use two slings or double up a single sling. These slings are hand spliced. If they are allowed to spin, the splice could come undone and drop the load! The minimum D-to-d ratio is 1 to 1. This means a one half-inch diameter synthetic rope sling cannot bent around any object that is smaller than one half-inch.



Synthetic Rope Temperature Restrictions

Do not use nylon or polyester synthetic rope slings at temperatures exceeding 194° Fahrenheit (140° Fahrenheit for polypropylene slings) or OEM recommendations, whichever is more restrictive.

Round Sling Use

For roundslings, NAVFAC P-307 recommends that you use the shackle types listed by the OEM. Alternate yarn synthetic round slings must not be used around items smaller in diameter than the pin used to test the sling. The minimum D-to-d ratio shall be marked on all alternate yarn round slings.





Round Sling Temperature Restrictions

Follow OEM recommendations when using roundslings in extreme temperatures

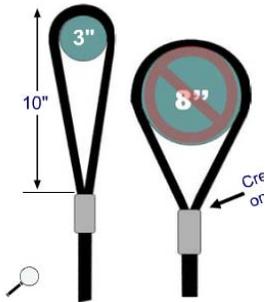
Common Sling Use Rules

Slings must not be used at angles less than 30° from horizontal unless specifically authorized by an engineering work document. Never use a sling that has been knotted. Chafing gear should be used where needed. Rigging gear including slings, shackles, turnbuckles, and eyebolts, must be sized such that two legs can carry the load to allow for variations in sling length and load flex.



Eye Length vs. Hook Diameter

The size of the hook or shackle relative to the size of the sling eye can be critical. If we place a ten-inch long sling eye on a load which is 3 inches in diameter, the eye opens slightly and causes very little added stress to the eye or the splice. However, if we place that sling on a hook with a diameter of 8 inches, this can stress the eye and can cause the swage or stitches to fail. Never place the eye of any sling around an object which has a diameter greater than 1/2 the length of the eye. If the hook diameter is too large, a shackle can be used to connect the slings to the hook, thereby reducing the diameter over which the sling eyes are placed.



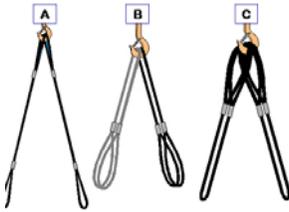
Attaching Gear to Hook

When attaching rigging gear to hooks be sure the safety latch is working properly and closes the throat opening without obstruction. Failure to do so can allow the gear to come off the hook. All gear attached to the hook must seat properly in the bowl. Do not stack slings or allow slings to cross each other in the hook. That can lead to crushing of the slings.



Correct use of Sling on Hooks

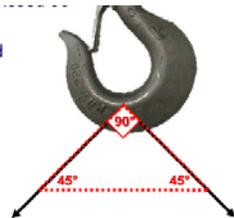
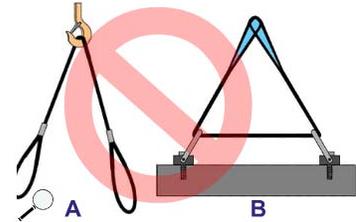
These graphics illustrate correct ways to attach slings to a hook. Graphic “A” shows a vertical application with two sling eyes seated in the bowl of the hook. Graphic “B”



shows two slings doubled over the hook and sling eyes pointing down to attachment points. Graphic “C” shows two slings doubled with sling eyes on the hook and the bight pointing down to attachment points. When wire rope slings are used as in graphics “B” and “C”, and a heavy load is applied, individual wires may become permanently deformed or kinked. If the slings become kinked, they should not be used again in vertical applications.

Incorrect use of Sling on Hooks

These graphics illustrate some incorrect ways of attaching slings to a hook. Incorrect sling applications can be extremely dangerous and can result in loss of load control and personnel injury! Graphic “A” shows a single sling with the “bight” riding the hook and the eyes attached to two separate attachment points. Slings applied in this manner could slip on the hook causing the load to shift. Graphic “B” shows a sling through two attachment points. Installing a sling through more than one attachment point will create excess stress on the sling, the attachment points, and the gear.

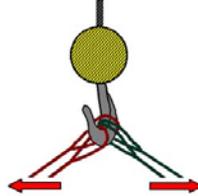


Attaching Legs to Hooks

Included angle is the angle measured between two slings sharing a common attachment point. To prevent tip loading when lifting with two slings, the included angle created by slings attached to the hook must not exceed 90°. If the horizontal angle of the slings is less than 45°, the included angle will exceed 90°. In this case, you must use a shackle or other collection device to connect the slings to the hook.

Inside and Outside Slings

When rigging four slings to a hook, separate the slings into two pairs, inside and outside so they do not pull in the plane of the hook. Attach the inside slings to one end of the object and the outside slings to the other end, being careful that they are not crossed.



3 Types of Hitches

Slings are used in three types of hitches: the vertical hitch, the choker hitch and the basket hitch. The rated load for the same sling with each hitch will be different.

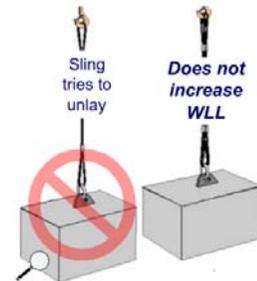
WLL of Vertical Hitches

The rated load for a vertical hitch is 100% of the sling's capacity. Sling angle stress is encountered any time the vertical angle exceeds 5° and must be taken into account.



Use 2 Legs for Vertical Hitches

To prevent unlaying of the wire rope, do not use a single sling leg wire rope sling in a vertical hitch. Use two legs for single point lifts. The second leg prevents the sling from spinning. It is important to note that the configuration shown here does not increase the rated load because slings are rarely the exact same length. The shorter of the two will carry the load.



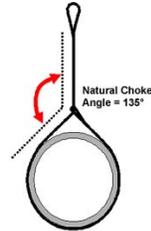
Choker Hitches



Using a shackle to set a choker hitch will prolong the life of the sling. Whenever a shackle is used to set a choker hitch set the eye of the sling on the pin of the shackle. This will prevent the “running” part of sling from rotating the pin of the shackle as it passes over it. Never set the choker so the running part of the sling passes against the shackle pin.

WLL of Choker Hitches

Whenever a choker hitch is used the sling’s rated load is reduced. The natural choke angle is 135°, if a choker hitch is allowed to tighten itself as the load is lifted. When choke angles are less than 120° the rated load must be reduced further.



Wire and Synthetic Sling Choker Hitch Rated Loads

This chart shows the efficiency of the sling’s capacity when choking with a wire rope or synthetic rope sling. Refer to Table 14-4 in NAVFAC P-307 for choker efficiencies for other slings. This does not apply to braided multi-part wire rope slings. Contact the Wire Rope Technical Board for recommended efficiency factors for braided multi-part slings.

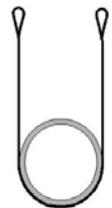
TABLE 14-4
Rated Loads For Slings In A Choker Hitch

Choke Angle in Degrees (See Figure 14-1)	Percentage of Vertical Rated Load		
	Chain	Wire Rope, Synthetic Rope	Synthetic Web and Round
121-135	80	75	80
90-120	see Note 1	65	65
80-90	see Note 1	55	55
30-59	see Note 1	48	46
0-29	see Note 1	38	36

Notes:

WLL of Basket Hitch

Basket hitches are the strongest of the three hitches. Slings in a basket hitch can carry 200% of the sling’s single rated load when the sling angle is less than 5° from vertical, and the required D-to-d ratio is maintained. Wire rope requires a D-to-d ratio of greater than 40 to 1. Synthetic rope requires a D-to-d ratio of at least 8 to 1.



NOTES

[Sling Use Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. When you select rigging for a four leg lift, how many legs can you count on to carry the load?

- A. 3
- B. 1
- C. 4
- D. 2

2. Select the best answer. The minimum D/d ratio that can be in the body of a synthetic rope sling is:

- A. 2:1
- B. 4:1
- C. 3:1
- D. 1:1

3. True or False. D/d ratio does not affect wire rope slings.

- A. True
- B. False

4. True or False. D/d ratio does not affect synthetic web slings.

- A. True
- B. False

5. True or False. It is acceptable to bend a 1 inch wire rope sling around a $\frac{3}{4}$ inch shackle.

- A. True
- B. False

6. True or False. It is okay to tie a knot in or install a bolt into a chain sling leg to shorten the sling.

- A. True
- B. False

7. Select the best answer. There are three slings hanging from a hook. Each sling has a rated load of 2,000 lbs. What is the heaviest load that could be lifted using these slings if they were all attached to a single point?

- A. 6,000 lbs
- B. 2,000 lbs
- C. 4,000 lbs

8. Select the best answer. The minimum D/d ratio allowed for wire rope slings is:

- A. 2:1
- B. 4:1
- C. 1:1
- D. 3:1

9. Select the best answer. With the proper D/d ratio a sling in a basket hitch can lift _____ of the rated load of the sling.

- A. 75%
- B. 200%
- C. 100%
- D. 150%

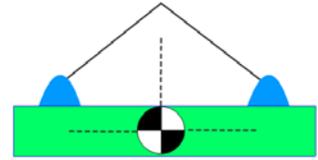
10. Select the best answer. A vertical hitch is good for _____ of the slings rated load.

- A. 75%
- B. 100%
- C. 150%
- D. 50%

Sling Angle Stress

What is sling angle stress?

What is sling angle stress? It is the added force created in the rigging when the slings are not perfectly plumb, vertical, and parallel.



Sling Angle Stress Illustration

It may be beneficial to use an illustration that we can relate to. Though this is not exactly sling angle stress, it illustrates the concept very well.



Sling Angle Stress 90 Degrees

Here's Ace. He is holding a fifty-pound weight in each hand. His arms are vertical, similar to a 90° horizontal sling angle. The amount of stress in Ace's arms is equal to the amount of weight he's holding, fifty pounds. See what happened as Ace moved his arms increasingly further away from his body.



Sling Angle Stress 45 Degrees

When Ace has his arms at a 45° angle the stress in his arms increases even more. The stress increase is 42% of the weight he's holding. It feels like he's holding 71 pounds in each arm



Sling Angle Stress 30 Degrees

At a 30° angle, the amount of stress in Ace's arms increases further. The stress increase at 30° is 100% of the weight he's holding. Now Ace feels like he's holding 100 pounds in each arm even though the weight is still actually 50 pounds. This same effect, called sling angle stress, occurs in rigging gear because the legs of a lift are almost always at angles. This additional stress must be considered when selecting rigging gear.

Choosing Your Gear

The two-leg rule is followed when choosing gear capacities for a lift. Rigging gear must have a capacity greater than the applied load. The load applied to the rigging gear includes the weight carried by the attachment points multiplied by the sling angle stress factor.



What does it affect?

Nearly every lift creates a triangle. All of the components that make up the sides of a lift triangle are affected by sling angle stress including the attachment points on the load, the crane hook, the rigging gear and the load itself. Sling angle stress can cause the load to flex and sag. Excessive sling angle stress can cause a choker hitch or basket hitch to crush a fragile item. Remember, sling angle stress does not change the weight of the load being lifted; only the load on the rigging.

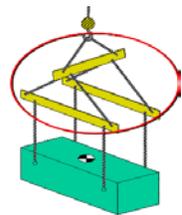


Minimizing Sling Angle Stress

Sling angle stress can be minimized by using spreaders or other below the hook lifting devices. Lifting beams or strong-backs can help ensure each sling is carrying its share of the load and that the load remains level. Sling angles may still affect the rigging gear between the hook and spreaders, even if the slings between the spreader and the load are vertical.

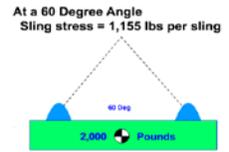
Sling Angle Stress Summarized

When referring to the effects of sling angle, we refer to horizontal sling angle. In other words, we are measuring the angle created between the sling and a horizontal line through the attachment points. Sling angle stress is proportional to the degree of the angle from horizontal. The more vertical the angle - the less added force. The more horizontal the angle - the greater the added force. Let's look at this principle on a load.



Effects of Sling Angle Stress

At a 60° angle the load on the rigging has increased to 1,155 pounds. Keep in mind each leg has 1,155 pounds of stress even though only one leg is shown. 60° is the preferred angle!



At a 45° angle the load has increased to 1,414 pounds in each sling. That's nearly a 42% increase!

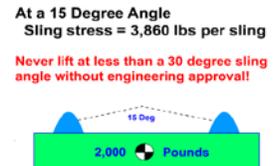


At a 30° angle the stress has increased to 2,000 pounds Each sling now has a load equal to the weight of the object! That is a 100% increase!



Never lift with less than a 30° angle without engineering approval!

At a 15° angle the load has increased to 3,860 pounds. That's a 286% increase in each sling



Why must we account for it?

Not accounting for sling angle stress can lead to overloaded rigging gear and even catastrophic failure.

Selecting Minimum Rated Capacity

Remember, two legs must have the capacity to lift the weight of the object, plus the added force from sling angle stress. After we calculate the sling angle stress, we can determine the minimum requirements for our rigging gear.

Determining Minimum Rated Capacity

There are several ways to determine sling angle stress. We will use the angle factor chart, as it is readily available and easy to use

Using an Angle Factor Chart

To use an angle factor chart, you first need to determine the sling angle. Sling angle can be determined mathematically or measured. Once you have determined the sling angle, find the corresponding angle factor, and multiply that number by the weight carried in each leg. When you look at the angle factor column, you will notice a dramatic increase for angles less than 30°. That's why we do not use sling angles less than 30° unless authorized by an engineering document.

Horizontal Angle	Angle Factor
90	1.000
85	1.004
80	1.015
75	1.035
70	1.064
65	1.104
60	1.155
55	1.221
50	1.305
45	1.414
40	1.555
35	1.742
30	2.000
25	2.364
20	2.924
15	3.861
10	5.747
5	11.490

Angle Factor Chart Example

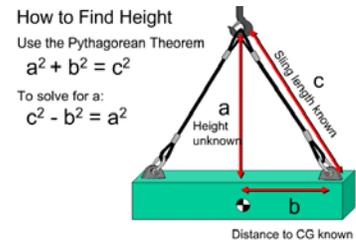
This shape represents the lift we are about to make. Let's say that the angle created by the slings we use is 45°. The angle factor for a 45° angle is 1.414. We must multiply the angle factor, 1.414 by the weight carried in the leg. How much weight will the leg carry? That's right, 5,000 pounds. 1.414 times 5,000 equals 7,070 pounds. This is the total stress in each leg! This number represents the minimum gear capacity that can be used for the lift.

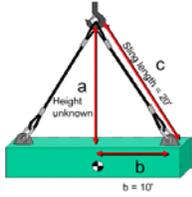
What is angle factor?

Remember the lift triangle? Now the whole triangle idea really comes into play. The sling angle factor is a ratio of the side of the lift triangle, which in this case is the sling, and the height of the triangle. To find it, divide the sling length by the height of the lift triangle. The height is the distance between the bearing area of the hook and an imaginary line running horizontally from the bearing area of the attachment point. If you cannot measure the height, it can be found mathematically.

How to find Height

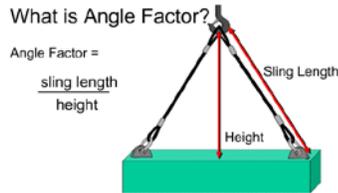
The Pythagorean theorem states that the length of a side of a right triangle squared, equals the length of the base squared plus the height squared. A squared, plus B squared, equals C squared. Here the height of the lift triangle is A, the horizontal base is B and length of the sling is C. Only A, the height, is unknown. To find the unknown height, A, use this variation: C squared minus B squared equals A squared.





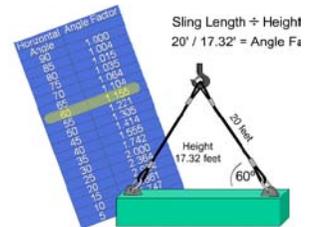
Finding Height

Use C squared minus B squared equals A squared to solve for height. The sling, C, is twenty-feet long. Multiplying the sling length times itself gives us C squared. In this case, that is twenty times twenty or four hundred. We measure the horizontal distance from the bearing area of the attachment to the top of the load directly above center of gravity. This dimension, B, is ten feet. We multiply this number by itself. Ten times 10 equals 100. Subtract 100, Which is B squared, from 400, which is C squared. Therefore A squared equals 300. Now we use the square root function on our calculator to calculate the square root of 300. The height equals the square root of 300, which is 17.32 feet.



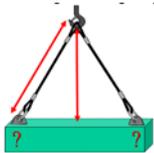
Finding Angle Factor

Remember the angle factor equals sling length divided by height. We just found the height of the lift triangle. Now, here's how to find the angle factor: The sling is 20 feet long and we found the height to be 17.32 feet. 20 divided by 17.32 equals 1.155. This is our angle factor. Finally, we will multiply the angle factor by the amount of weight at the attachment point.



Solving Sling Angle Stress Mathematically

Now we can use everything we've covered thus far to solve for sling angle stress.



Here's the formula: Sling length divided by height, times the weight distributed to each leg. Remember, weight distribution is determined by the distance from the center of gravity to the attachment points. This works for all lifts with level attachment points.

60 Degree Sling Angle

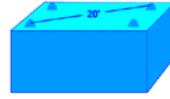
60° is the preferred sling angle. At 60°, the load in the slings increases 16%.



by

Selecting Appropriate Sling Lengths for a 60 Degree Sling Angle

To ensure your slings will have at least a 60° sling angle simply measure the distance between attachment points. Measure diagonally when there are more than two attachment points because it's the longest distance. Then select a sling that is as long or longer than the distance measured. If you use this method to select your slings, you will never have a sling angle less than 60°.



Selecting Minimum Rated Capacities for a 60 Degree Sling Angle

Now we can easily determine the stress in the rigging before we attach the gear. Let's say the weight of the object is 5,000 pounds. How much weight would each attachment point carry? Each would carry 2,500 pounds. What is the angle factor for a 60° sling angle? The angle factor is 1.155. Multiply the angle factor, 1.155, times the weight distributed to the attachment point, 2,500 pounds. 2,888 pounds is the stress in the rigging gear and attachment points. It is also the minimum capacity for all rigging for this lift.



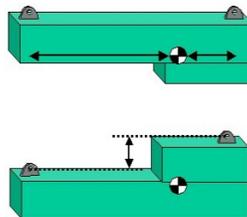
Selecting Minimum Rated Capacities for a 30 Degree Sling Angle

Using the same weight, let's look at the minimum rated capacities for a 30° sling angle. The angle factor for 30° is 2. At a 30° sling angle, the rigging and attachment point stress will double. Two times 2,500 pounds equals 5,000 pounds of stress. The minimum capacity sling and rigging gear required is five thousand pounds.



Not Level nor Equal Distance from CG

Where the center of balance is not equally distant between attachment points or when attachment points are on different levels, sling angle stress will not be equal between legs and extra calculations will be required. Contact your supervisor and consult the activity engineers for guidance when there is a question about sling angle stress for these types of lifts.



NOTES

Rigging Hardware

Using Rigging Hardware

Use the same size and type of shackle on each leg in multiple leg applications. Different types, sizes, or brands of shackles may vary significantly in physical size. This in turn will affect the overall length of the leg and the tension created in each leg. When installing the pin into the bail, be sure the pin is fully seated into the bail.



Side Loading Shackles

It may be sometimes necessary to apply a side load to a shackle. When side loading a screw pin or bolt type shackle reduce the rated load by 50% or as specified by the OEM.

Eyebolt Types

There are two types of eyebolts you may find at your work site, shouldered eyebolts and non-shouldered eyebolts. Non-shouldered eyebolts are sometimes referred to as plain pattern or regular nut eyebolts. All eyebolts must be used in accordance with OEM instructions.

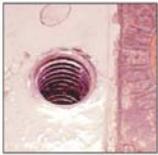
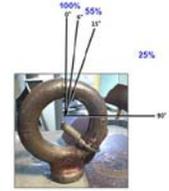


Non-shouldered Eyebolts

Non-shouldered eyebolts may be used in vertical applications only. Angled pulls greater than five degrees, even in the plane of the eye are not permitted.

Shouldered Eyebolts

Shouldered or machinery eyebolts may be loaded at an angle as long as it is loaded in the plane of the eye. When loading a shouldered eyebolt at an angle the capacity of the eyebolt is reduced.



Using Eyebolts, Swivel Hoist & Lifting Rings

When checking the engaging hole in the item you are going to lift: Make sure the threads are not damaged. And the hole is free of debris.

Minimum Thread Engagement

The minimum thread engagement depends on the material into which you are installing the piece of rigging equipment. When installing eyebolts into steel the minimum required thread engagement is one and one half times the diameter. When installing eyebolts into aluminum, the minimum thread engagement is two times the diameter. For other materials contact your activity's engineering organization or the OEM.

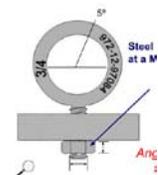


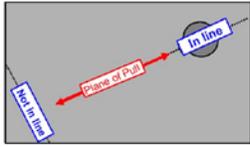
Installing Shouldered Eyebolts

Shouldered eyebolts must be installed with the shoulder seated flush against the mounting surface.

Eyebolts

When eyebolts are used with backing nuts, the backing nut must be at least SAE grade 5 and fully engaged with at least 1 full thread exposed.



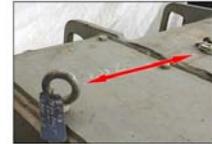


Align Eye with the Plane of the Pull

To use eyebolts with an angular load, the loading must be in line with the plane of the eye. This may not always happen when installing eyebolts. Look at this shape and imagine two slings connected to each eyebolt shown from the top. You can see that the top eyebolt would be in line with the plane if two slings were attached. The bottom eyebolt ended up out of plane when tightened against the seating surface.

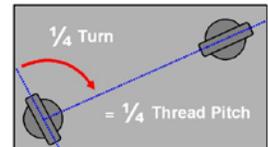
Shims May be Used to Align Eye

To remedy this, shims may be used to align the eye with the plane of the pull. When using shims, use the minimum thickness that will orient the eye the plane of the pull. The total thickness of shims must never exceed one thread pitch. The thread pitch represents one full revolution or rotation of the shank. If there are 16 threads per inch, then the thread pitch is 1/16th inch.



Determining Shim Thickness

In order to determine shim thickness we must determine how much rotation is required. How far would this eyebolt have to rotate in order to line up in the plane of pull? It must rotate 1/4 of a turn. How much shim would that require? One quarter of the thread pitch would orient the eyebolt in line to the plane of pull. For the eyebolt noted previously with a thread pitch of 1/16th inch, total shim thickness would be 1/64th inch.



Incorrect Use of Shims to Align Eye

This is an example of shims being used incorrectly. Do you see the problem with this eyebolt installation? The total shim thickness is more than the thread pitch.



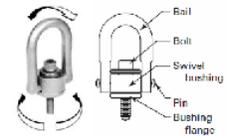
Side Pulls

Side pulls on eyebolts are very dangerous and may cause the eyebolt to fail. Side pulls result from loading out of the plane of the eye. Never install a sling through two separate eyebolts. The result will be side pulls on both eyebolts and damage to the sling

Swivel Hoist Ring Requirements

Swivel hoist rings can be one of your best pieces of rigging gear when used properly. They can be used at any angle up to 90 degrees with no reduction in rated load. Here are some swivel hoist ring general use requirements:

- The minimum thread engagement shall be 1 1/2 times the diameter of the bolt or threaded shank for steel.
- Ensure the bushing flange is fully seated against the load's surface.
- Spacers and washers shall not be used between the flange and load.
- Use a torque wrench to tighten to the manufacturer prescribed value. Guessing does not work!
- The swivel hoist ring must be free to rotate and pivot without interference during load handling activities.
- The load or attachment applied to the swivel hoist ring shall be narrower than the inside width of the bail and centered to prevent side loading.
- Never use more than one attachment in a swivel hoist ring. Using more than one attachment (i.e., a hook, shackle, or sling) will cause the bail to spread and possibly fail, resulting in a dropped load



Use correct thread size and fully seat body.



Use a torque wrench. Don't 'hand tighten'.

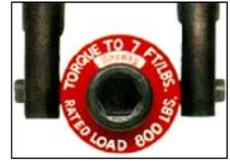
Swivel Hoist Rings



Angular pulls do not reduce rated load of a swivel hoist ring. When using swivel hoist rings, they must be installed with the shoulder flush with the mounting surface. They must be tightened with a calibrated torque wrench in accordance with OEM requirements. Check the OEM instructions prior to installing any shims. Most manufacturers do not allow the use of shims with swivel hoist rings.

Swivel Hoist Rings

Swivel hoist rings must be used in accordance with OEM specifications. They must be tightened to the OEM specified torque. The torque value is usually marked on the hoist ring itself. Before using backing nuts on hoist rings, check the OEM specification to see if it is allowed.



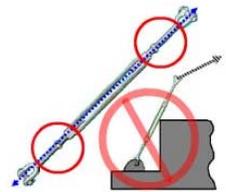
Selection and Use of Turnbuckles

Turnbuckles are commonly used for tensioning lines and securing loads but may be used for crane rigging if they meet the test, inspection and certification requirements of NAVFAC P-307.



Selection and Use of Turnbuckles

Turnbuckles are used only for in-line pulls. Jam nuts, when used, must be tightened in accordance with OEM instructions to prevent rotation. If the possibility of rotation still exists, the turnbuckle must be secured by safety wire or other suitable means in addition to jam nuts.



Never (Threaded Attachments)

Remember to use extreme caution when using a threaded item such as an eyebolt or a hoist ring as a single attachment point! Never rotate or spin an object being lifted with a single threaded attachment point. The lifting attachment may unthread and the object may fall.



Eye-nuts

Eye-nuts must be used in accordance with OEM instructions. They must have full thread engagement. This means the shank or stud they are attached to must be long enough to allow complete engagement of the eye-nut. Eye-nuts must be used for vertical applications only.

NOTES

[Rigging Hardware Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. True or False. Pulls outside the plane of the eye are allowed on eyebolts as long as the rated load has been decreased.

- A. True
- B. False

2. Select the correct answer. The minimum depth of thread engagement for a 3/4 inch eyebolt into a steel object is:

- A. 1 1/8"
- B. 1"
- C. 1 1/2"
- D. 1/2"

3. True or False. An angular pull of 45° is allowed on non-shoulder type eyebolts.

- A. True
- B. False

4. True or False. The rated load of shouldered eyebolts must be reduced at angular pulls.

- A. True
- B. False

5. True or False. When installing shouldered eyebolts, the shoulder must seat firmly against the load.

- A. True
- B. False

6. True or False. The rated load of swivel hoist rings must be reduced when they are used for angular pulls.

- A. True
- B. False

7. Select the correct answer. When a side-load is placed on a shackle, what is the shackle rated load reduced by?

- A. 50%
- B. 75%
- C. 80%
- D. 25%

8. Select the correct answer. What are the two types of eyebolts?

- A. shouldered and non-shouldered
- B. shouldered and swivel
- C. swivel and non-swivel
- D. swivel and non-shouldered

9. Select the correct answer. What can be used to align the eye of a shouldered eyebolt?

- A. torque wrench
- B. lock-washers
- C. shims
- D. lock-wire

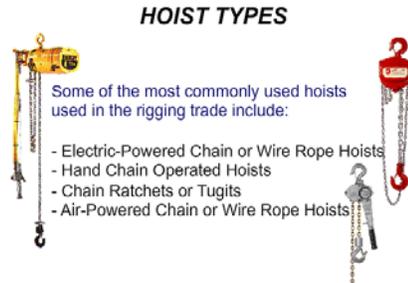
10. Select the correct answer. What must be used to tighten a swivel hoist ring to the manufacturers' requirements?

- A. hex wrench
- B. pliers
- C. Allen wrench
- D. torque wrench

Hoists

Hoist Use

Chain hoists are used in many different applications to assist in performing rigging operations. They work on the principal of mechanical advantage, so in reality very little effort is expended. They are normally used to lift, lower, and drift loads.



Hoist Use

There are a variety of hoist types used in the rigging trade. Some common hoist types include: electric-powered chain or wire rope hoists, hand chain operated chain hoists, chain ratchets or tugits, and air-powered chain or wire rope hoists.



Marking and Inspection

Hoists shall be marked with the name of the manufacturer, the model or serial number, the rated load, and the re-inspection due date. Prior to use hoists must be visually and operationally inspected for damage and proper operation. Inspections required include a daily pre-use (or frequent) inspection that is required to be performed by the user, and a documented periodic inspection (required annually for hoists). Pre-use inspections are not required to be documented. Operation, maintenance, and inspection of hoists shall be in accordance with applicable ASME B30 and OEM requirements.

Visual Inspection

When inspecting hoists, personnel shall perform a visual inspection, checking for evidence of loose, missing, or damaged bolts, nuts, rivets, retaining pins, guards, covers, guides, sheaves, sprockets, hooks, latches, chain, wire rope, and stops. Load chain or wire rope shall be checked for damage and proper reeving.





Operational Inspection

Hoist functions, including hoisting and lowering, the braking system, and hook latch operation shall be operationally tested to inspect for proper operation and unusual sounds. Lifting and lowering functions shall be tested under no-load conditions. Testing through the complete lift length or entire length of load chain or rope is not required. Electric and Air-Powered hoist inspection shall also include a visual inspection of air lines, valves, and other parts for leakage, and an operational inspection of upper limit devices. When checking upper limit devices care shall be exercised. The load block shall be inched into its limit device or run in at the slowest possible speed.

Note: If a deficiency or problem is discovered during the visual or operational inspection personnel shall discontinue operation and remove the hoist from service or use.

Safe Operation and Use

Here are some general requirements when working with hoists and cranes. Only one person may operate a hoist at one time, unless multiple pull chains are on the chain hoist. If it takes more than one person to pull the chain or ratchet, the hoist is possibly being overloaded. Do not use extension bars on lever operated hoists. Chain hoists should be operated slowly, hand-over-hand, one link at a time if necessary for slow controlled movement. Use chain hoists in rigging configurations when lifting loads in potential binding situations. This provides more control than a crane.



Safe Operation and Use

Properly seat the shackle, sling, or other device in the bowl of the hook, not on the tip.

- Ensure the upper and lower hooks are secured with safety latches or mousing prior to handling a load.
- Do not allow the attachment to rest on the safety latch. The safety latch will not support the load.

Keep loads as low as possible when drifting or moving the load.

Safe Operation and Use

Install and use hoists in a manner which will not cause binding against area obstacles or components during use. A hoist may be hung from a wire rope sling without a shackle only if the hook has a diameter equal to or greater than the diameter of the wire rope. (The hook bowl cross section measurement is the hook diameter)

When a load is approaching the rated capacity of the hoist check the hoist brake action by lifting the load just clear of its supports, stop operation, and continue operation only after verifying that the brake system is operating properly (the load does not lower).

Safe Operation and Use

Electric or Pneumatic-Powered hoists should be inched slowly into engagement with a load, but unnecessary inching and quick reversals of direction should be avoided. It is best to stop the motor completely when changing from lifting to lowering, or vice versa.



Improper Operation

Do not run the load chain or wire rope over sharp objects. If the load chain or wire rope does come into contact with other components, ensure adequate chafing material is placed between the chain or wire rope and the component to prevent damage. On wire rope hoists, do not lower the load below the point where less than two wraps of rope remain on each anchorage of the hoist drum, unless a lower limit device is provided, in which case no less than one wrap may remain on each anchorage of the hoist drum. Do not use the limit switch to stop movement of the hoist during load movement. Do not drag loads with hoists. Dragging the load may cause damage to the load, the surface (i.e., the deck, or floor), and/or other components.

Improper Operation

Never use the load chain to choke around an object or component. In addition, never "tip load" the hook.



* Never choke a load with the load chain



* Never tip load a hook

Chain Position and Scaffolding

Do not use a hoist or chain ratchet that has twisted, kinked, or otherwise damaged chain links. Do not use scaffolding as a point of attachment for lifting devices, unless authorized by the cognizant technical code or engineering. Do not operate the hoist if the rope or chain is not seated properly on the drum, sheaves, or sprockets.

Attachment and Two-Blocking

Do not hang a hoist or chain ratchet directly into a padeye without a shackle unless authorized by the cognizant code or engineering. The sharp edges of a padeye may cause damage to the hook of the hoist. Do not two-block the hoist. Two-blocking occurs when the hook makes contact with the sheave or body of the hoist. Leave a minimum of 6 links on chain falls or a minimum of 1 link exposed below the chain stopper on ratchets (the link that the stop ring is attached to) to avoid two-blocking the hoist.



Securing Hoists

Always secure the hand chain or hoist when not in use. This prevents inadvertent operation of the hoist if a load remains attached or suspended. A chain bag can be attached to the hoist body to hold excess load chain. One or two half-hitches may be used to secure the hand chain around the load chain. Locks may also be used to prevent operation.

NOTES

[Hoists Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the correct answer. What markings are required on hoists?
 - A. The rated load and re-inspection due date
 - B. The name of the manufacturer, model number, rated load, and re-inspection due date
 - C. The serial number and re-inspection due date
 - D. The name of the manufacturer, model number, and capacity

2. Select all that apply. What are the two types of inspections performed on hoists and rigging equipment?
 - A. Operation Inspection
 - B. Pre-Use Inspection
 - C. Test Inspection
 - D. Periodic Inspection

3. Select the best answer. When securing a chain hoist _____ may be used by securing the hand chain around the load chain.
 - A. Rope
 - B. Half-hitches
 - C. Bends
 - D. Knots

4. True or False. Two people may operate a hoist at the same time if the pull chain is too hard for one person to pull.
 - A. True
 - B. False

5. True or False. A hoist can be hung from a wire rope sling without a shackle installed if the diameter of the hook is equal to or greater than the diameter of the sling.
 - A. True
 - B. False

6. Select the best answer. When lifting a load that is near the rated capacity of the hoist the hoist brake should be checked by:

- A. Lifting the load approximately 4 feet and checking to make sure it does not lower.
- B. Watching the load for lowering as the load is being raised.
- C. Lifting the load just clear of its supports, stopping movement, and then checking to ensure the load is not lowering.
- D. Lifting the load as high as possible and checking for lowering.

7. Select the best answer. Why should hoists not be used in tie down applications?

- A. Because they do not have adequate capacity
- B. Because the manufacturer does not allow it
- C. Because they may be subjected to shock loading
- D. Because the load brakes may fail

8. True or False. Hoist hooks must have latches or be moused during lifting operations.

- A. True
- B. False

9. Select all that apply. Prior to use load chains should be inspected for:

- A. Adequate capacity
- B. Proper reeving
- C. Proper size
- D. Damage

Crane Communications

Radio and Hand Signals

Standard hand signals provide a universal language, understood by everyone involved with weight handling consequently, they are the most common method used in crane operations. When presented properly, standard hand signals help prevent miscommunication and play a very important part in safe crane operations. Radio communications are well suited for blind and complex lifts. As a general rule, direct voice should only be used when the operator and rigger are working in close proximity and ambient noise is not a factor.

Hand Signals

Hand signals are most widely used method of communication between signalers and crane operators. Hand signals like those found in the American Society of Mechanical Engineers, A.S.M.E. B30 standards must be posted in the crane in clear view of the operator. Your activity may approve local signals in addition to these standard signals.



Signalers

Signalers must remain in clear view of the crane operator. If the crane operator can't see you, another method of communication must be used. Only one signaler communicates with the crane operator at a time.

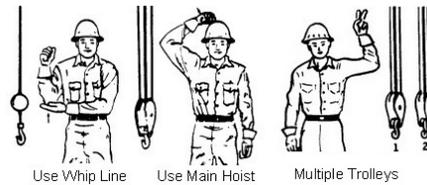
Radio

Radios can be used to direct crane lifts while keeping crane team members informed of the lift status. When using radios: Use a dedicated or isolated channel and limit background noise. The operator's reception of signals shall be by a hands-free system. Voice directions given to the operator shall be given from the operator's directional perspective. Each voice signal shall contain the following elements, given in the following order: the function (such as hoist, boom, etc.), and direction; the distance and/or speed; then the function stop command.



Hook and Trolley Signals

These signals indicate which hook or trolley to use and are used in conjunction with operating signals.



Auxiliary Hook

When calling for the whip line or auxiliary hoist:

- the elbow is tapped with the opposite hand and
- followed with the appropriate hook movement signal



Main Hoist

When calling for the main hoist, the signaler:

- taps a fist on his or her hard hat and
- follows the appropriate hook movement signal



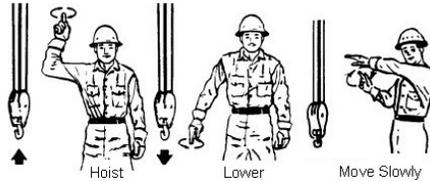
Multiple Trolley

When working with a multiple trolley crane, these signals indicate which trolley to use. They are always followed by movement signals.



Hoist Signals

Hoist and lower signals are the same for all cranes. The distinct circular motion helps the operator see the signal clearly from greater distances and helps distinguish them from other signals.



Hoist Up

The hoist signal is given with:

- the forearm vertical, the index finger pointing up, and
- the hand moving in small horizontal circles



Hoist Lower

The lower signal is given with:

- the arm extended downward,
- the index finger pointed down and
- the hand moving in small horizontal circles



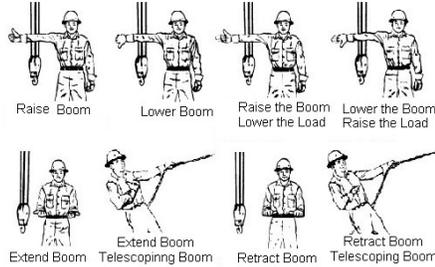
Hoist up Slowly

A hand held motionless in front of any signal indicates to move slowly. In this clip the rigger is signaling to hoist slowly.



Boom Signals

Boom signals direct the operator to raise and lower or to extend and retract the boom. Combination boom and hoist signals allow the load to remain at the same height while booming up or down.



Boom Raise (Boom Up)

The signal to raise the boom, or boom up, is given with:

- an extended arm,
- fingers closed and thumb pointing upward



Lower Boom (Boom Down)

The signal to lower the boom, or boom down, is given with:

- an extended arm,
- fingers closed and thumb pointing downward



Raise the Boom – Lower the Load

The signal to raise the boom and lower the load is given with an:

- extended arm,
- thumb pointing upward and
- fingers flexing in and out



Lower the Boom – Raise the Load

The signal to lower the boom and raise the load is given with an:

- extended arm,
- thumb pointing downward and
- fingers flexing in and out



Boom Extend

The signal to extend the boom is made with:

- both fists in front of the body and
- thumbs pointing outward away from each other



Boom Extend One Handed

The one handed extend signal is made with:

- one fist in front of the chest and
- the thumb pointing inward with a tapping motion



Boom Retract

The signal to retract the boom is made with:

- both fists in front of the body and
- thumbs pointing toward each other



Boom Retract One Handed

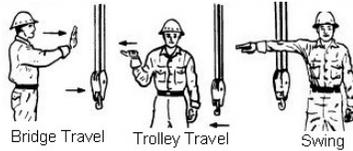
The one handed retract signal is made with:

- one fist in front of the chest, and the
- thumb pointing outward, with a tapping motion



Directional Signals

Directional signals are used to guide horizontal crane movements such as bridge, trolley and swing.



Travel Direction

The signal for crane or bridge travel is made with:

- an extended arm,
- hand open with palm facing outward, and
- the hand moving horizontally in the desired direction of travel



Trolley Direction

The signal for trolley travel is made with:

- a palm up and fingers closed and
- the thumb moving in the desired direction of travel



Rotate (Swing) Direction

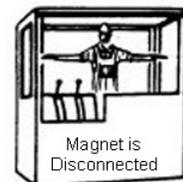
The signal for swing or rotate is:

- an extended arm
- the index pointed in the desired direction of rotation



Magnet Signals

Magnet signals are used to communicate the current status of the magnet - whether it is on or off.



Magnet Disconnected

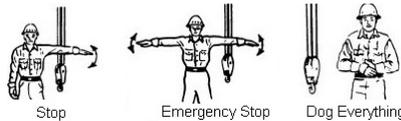
The magnet disconnect signal is used to let the person on the ground know that the electricity has been secured and it is safe to disconnect the magnet from the crane. The magnet disconnected signal is given with:

- both extend arms
- palms up and fingers open



Stop Signals

Stop and emergency stop signals can be given by anyone. When these signals are given, the operator must stop operations as quickly and as safely as possible. The dog everything signal is used when all operations must be secured.



Stop

The stop signal is:

- an extended arm,
- palm down
- moving back and forth horizontally



Emergency Stop

The signal for an emergency stop is:

- both arms extended
- with palms down
- moving them back and forth horizontally



Dog Everything

The signal to dog everything is:

- clasped hands in front of the body



[Review and Summary](#)

In order for communications to be effective, they must be clear, concise, continuous, and understood by the crane team. Hand signals are the primary means of communication between signalers and operators. Radios are preferred for complex and blind lifts. Voice communication should only be used in close proximity and where ambient noise is not a problem.

NOTES

[Crane Communications Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. A universal language understood by everyone involved with weight handling is:

- A. Hand signals
- B. Signal flags
- C. Direct voice commands
- D. Spoken word

2. Select the best answer. Direct voice should only be used when:

- A. The rigger has not learned hand signals.
- B. The operator and the rigger are working in close proximity and ambient noise is high
- C. No other form of communication is available and ambient noise is high
- D. The operator and rigger are working in close proximity and ambient noise is low.

3. Select the best answer. In the crane cab, the crane operator must have a clear view of the...

- A. Crane lift history
- B. Crane maintenance records
- C. ASME Hand Signal Chart
- D. EOM

4. Select the best answer. Any additional hand signals must be

- A. Approved by the ASME
- B. Approved by NOSH
- C. Approved by the activity
- D. Approved by OSHA

5. Select the best answer. Another form of communications, other than hand signals, must be used if:

- A. The signaler is not in clear view of the crane operator
- B. The signaler is in clear view of the rigger in charge
- C. Activities designates alternative methods
- D. Ambient noise is greater than the lack of visibility

6. Select the best answer. For multiple crane lifts, _____ will communicate with the crane operators.

- A. No signalers unless directed by the rigger in charge
- B. One signaler at a time
- C. One signaler for each crane involved
- D. Up to three signalers

7. Select the best answer. This signal indicates:

- A. Auxiliary hoist
- B. Travel
- C. Main hoist
- D. Raise hoist



8. Select the best answer. When the signalers fingers are flexing in and out, this signal indicates:

- A. Stop activities
- B. Raise the load – lower the boom
- C. Lower the hoist
- D. Lower the boom



9. Select the best answer. This signal indicates to:

- A. Stop
- B. Raise the load
- C. Forward
- D. Extend the boom



10. Select the best answer. This signal indicates to:

- A. Retract the boom
- B. Separate the load
- C. Lower the load
- D. Move closer



11. Select the best answer. This signal indicates:

- A. Travel back
- B. Swing
- C. Stop
- D. Emergency stop



12. Select the best answer. This signal indicates:

- A. Emergency Stop
- B. Magnet Disconnect
- C. Stop
- D. Swing



13. Select the best answer. This signal indicates:

- A. Lower load
- B. Dog everything
- C. Emergency stop
- D. Retract boom



14. Select the best answer. This signal indicates:

- A. Emergency Stop
- B. Magnet disconnected



Complex and Non-Complex Lifts

Non-Complex Lifts

Non-complex lifts are ordinary in nature, do not require direct supervisory oversight, and are made at the discretion of the rigger in charge.



Complex Lifts

Complex lifts have a moderate to high level of risk. Activities are required to identify complex lifts and prepare detailed written procedures for their execution. Procedures may be in the form of standard instructions or detailed procedures specific to a lift.

Complex Lift Categories

This is a list of complex lifts.

- Hazardous materials
- Large and complex geometric shapes
- Lifts of personnel
- Lifts exceeding 80% of the capacity of the crane's hoist (Lifts exceeding 50% of the hoist capacity for barge-mounted mobile cranes)
- Lifts of submerged or partially submerged objects
- Multiple crane or multiple hook lifts
- Lifts of unusually expensive or one-of-a-kind equipment or components
- Lifts of constrained or potentially constrained loads (binding condition)
- Other lifts involving non-routine operations, difficult operations, sensitive equipment, or unusual safety risks

Identification, Procedures, and Oversight

Activities shall identify complex lifts and prepare procedures (including rigging sketches where required) for conducting these lifts. Procedures may be standard written instructions or detailed procedures specific to a lift. A supervisor or working leader must review on-site conditions and conduct a pre-job briefing for all complex lifts. A rigger supervisor, operator supervisor, or working leader shall personally supervise the following lifts:

- Lifts exceeding 80% of the certified capacity of the crane's hoist used for the lift
- Multiple hook lifts when the weight of the object being lifted exceeds 80% of the certified capacity of any hoist used for the lift
- Lifts of ordinance involving the use of tilt fixtures.

If the lifts are repetitive in nature, the supervisor or working leader must be present during the first complex lift evolution with each rigging crew. Subsequent identical lifts by the same crew may be done under the guidance of the rigger-in-charge

Complex Lift Exceptions

Exceptions to the complex lift requirements include lifts over 80% of capacity made with jib cranes, pillar jib cranes, fixed overhead hoists, and monorail cranes. These cranes are usually smaller capacity cranes used primarily to service only one workstation, machine or area.

Lifts of test weights during maintenance or load test are excluded from the complex lift requirements. Ordnance lifts covered by NAVSEA OP 5 in lieu of the NAVFAC P-307 are also excluded. Lifts of ordnance as described in NAVFAC P-307 subparagraphs 10.4.1(d) through (i) shall be treated as complex lifts.



Lift Requirements for Hazardous Materials

Lifting hazardous materials with a crane is a complex lift. Materials such as oxygen, acetylene, propane or gasoline in bottles, cans or tanks that are properly secured in racks designed for lifting by a crane are excluded.

Lift Requirements for Complex Geometric Shapes

Complex lifts also include large and complex shapes. For example, objects with large sail area that may be affected by winds, objects with attachment points at different levels requiring different length slings, and odd shaped objects where the center of gravity is difficult to determine.



Lift Requirements for Personnel Lifts

Use cranes for lifting personnel only when no safer method is available. Cranes, rigging gear and personnel platforms shall conform to OSHA requirements, Title 29 Code of Federal Regulations, Part 1926.1431 and ASME B30.23 for the personnel platform. A body harness and shock absorbing lanyard shall be worn and attached to a structural member within the personnel platform capable of supporting the impact from a fall. The total weight of the loaded personnel platform and rigging shall not exceed 50% of the rated capacity of the hoist. A trial lift with at least the anticipated weight of all personnel and equipment to be lifted shall be performed immediately before placing personnel in the platform. A proof test of 125% of the rated capacity of the platform must be held for 5 minutes. This may be done in conjunction with the trial lift. Tag lines shall be used unless their use creates an unsafe condition. Before personnel exit or enter a hoisted platform that is not to be landed, the platform shall be secured to the structure where the work is to be performed. During the lift, occupants shall keep all parts of the body inside the platform and shall not sit or stand on, or work from, the top or intermediate rail or toe board, or use any other means/device to raise their work height.



Lift Requirements for Lifts Over 80% Capacity

Lifts exceeding 80% of the capacity of the hoist are considered complex lifts. Use a larger capacity hoist if possible to avoid exceeding 80% of capacity.



Lift Requirements for Multiple Crane Lifts

Lifts with two or more cranes are complex lifts. These lifts require special planning, coordination and skill. The weight carried by each crane must be calculated carefully. One signal person must be assigned to direct and control the entire operation.

Review and Summary

There are two types of lifts, complex and non-complex. Complex lifts have a moderate to high level of risk involved. All complex lifts require preplanning, written procedures and supervisory oversight. Complex lift exceptions include: lifts by certain smaller cranes used primarily to service only one work area, cranes designed for simultaneous lifting, load tests, and ordnance lifts covered by NAVSEA OP-5.

NOTES

[Complex and Non-Complex Lifts Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. Which of the following identify the two basic categories of crane lifts?

- A. Usual and Unusual
- B. Critical and Non-Critical
- C. Complex and Non-Complex
- D. Common and Non-Common
- E. None of these

2. Select the best answer. Detailed written procedures are required for:

- A. Non-complex lifts
- B. All lifts
- C. Some lifts
- D. Complex lifts

3. Select the best answer. Personnel lifts are...

- A. Always considered complex lifts
- B. Considered complex only under special conditions
- C. Not considered complex if personal protective gear is worn
- D. Not considered complex if personnel lifting devices are used

4. Select the best answer. For all complex lifts, a supervisor or working leader must review on-site conditions and...

- A. Inspect all rigging gear
- B. Select rigging gear
- C. Conduct a pre-job briefing
- D. Define the crane operating envelope

5. Select the best answer. Lifts of test weights during maintenance or load test are...

- A. Routine lifts because they are not complex shapes
- B. Excluded from the complex lift requirements
- C. Included in the complex lift requirements
- D. Evaluated according to the complex lift requirements

6. Select the best answer. Personnel in the man-lift platform or basket must...

- A. Wear aircraft reflective tape on their hard hat
- B. Stand with knees bent to absorb motion shock
- C. Wear a safety belt with a shock-absorbing lanyard
- D. Wear a body harness with a shock-absorbing lanyard

7. Select the best answer. Materials such as oxygen, acetylene, propane or gasoline in bottles, cans or tanks, properly secured in racks designed for lifting by a crane are considered:

- A. Non-complex lifts
- B. Hazardous lifts
- C. Explosive lifts
- D. Complex lifts

8. Select the best answer. A crane with a capacity of 100,000 pounds is performing a lift of 90,000 pounds. This is a(n)...

- A. Hazardous lift
- B. Non-complex lift
- C. Overload lift
- D. Complex lift

9. Select the best answer. A crane with a capacity of 100,000 pounds is performing a lift of 40,000 pounds. This is a(n)...

- A. Hazardous lift
- B. Non-complex lift
- C. Complex lift
- D. Overload lift

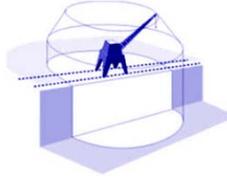
10. Select the best answer. For personnel lifts, the total load must not exceed...

- A. 50% of the hook capacity
- B. The gross capacity if designated as a complex lift
- C. The load chart capacity
- D. 80% of the hook capacity

Crane and Rigging Gear Accidents

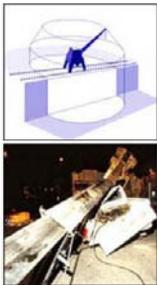
Crane Envelope

In order to define a crane accident, you must first understand the crane operating envelope. The operating envelope includes the crane, the operator, the riggers, and the crane walkers, other personnel, the rigging gear between the hook and the load, the load itself, the supporting structures, such as the rails or the ground, and the lift procedure.



Rigging Gear Envelope

The rigging gear operating envelope contains the rigging gear and miscellaneous equipment covered by NAVFAC P-307 section 14, the user of the gear, the load itself, other personnel involved in the operation, the structure supporting the gear, the load rigging path, and the rigging procedure.



Crane Accident

A crane accident occurs when any of the elements in the operating envelope fail to perform correctly during operations, including operations during maintenance or testing, resulting in the following: personnel injury or death, material or equipment damage, dropped load, derailment, two-blocking, overload or collision. No matter how insignificant a collision, i.e., the crane block contacting the deck, or the load, or crane contacting another object, it is still considered a crane accident.

Rigging Gear Accident

Rigging gear accidents occur when any of the elements in the operating envelope fails to perform correctly during weight handling operations resulting in the following: personnel injury or death, material or equipment damage, dropped load, two blocking, or overload.





[Accident Examples](#)

Some common examples of accidents are: dropped loads, injuries from a shifting load, failure of rigging gear resulting in a dropped load, overloads, and improperly secured loads falling from pallets.



[Accident Exception](#)

Component failure such as motor burnout, gear tooth breakage, bearing failure, etc. is not considered an accident just because damage to equipment occurred, unless the component failure causes other damage such as a dropped boom or dropped load.



[Accident Causes](#)

In most cases, crane accidents result from personnel error and can be avoided. Most crane accidents are due inattention to the task, poor judgment, team members having too much confidence in their abilities, or operating the crane, or rigging too fast.

[Operator Responsibilities](#)

The operator can play a significant role in eliminating human error and accidents. Drugs and alcohol can affect a person's capability to think, reason, or react in normal situations and can certainly lead to serious accidents. Operators must always consult their physicians regarding effects of prescription drugs before operating equipment, and recognize that medications often affect people differently. An operator is responsible for evaluating his or her physical and emotional fitness.

[Accident Actions](#)

Upon having an accident or having seen evidence of damage, the crane team, riggers, equipment users, etc., shall stop all operations and notify immediate supervisor(s). If there is impending danger to the equipment or personnel, place the crane and/or load in a safe position prior to notifying supervision. Ensure the accident scene is secured and undisturbed so as to facilitate the investigation. The supervisor shall review the situation and take any further emergency action. The supervisor shall notify management personnel as well as the activity safety office.

Reporting

Activities shall notify the Navy Crane Center (Code 06, *formerly code 07*) by fax, phone, or e-mail as soon as practical but not later than 24 hours after an accident involving a fatality, in-patient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane, load or adjacent property. For all other accidents the Navy Crane Center must be notified no later than three working days after the accident. For each suspected accident, activities shall promptly perform a comprehensive investigation, prepare a Crane and Rigging Gear Accident Report and forward a copy to the Navy Crane Center within 30 days of the accident.

Near Misses

Near Misses and other unplanned occurrences that do not fall under the crane and rigging gear accident definitions shall also be reported per NAVFAC P-307 Section 12. A Near Miss is a situation where an accident was avoided by mere chance or where intervention prevented an ongoing sequence of events that would have resulted in an accident.

NOTES

[Crane and Rigging Gear Accidents Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select all that apply. The crane operating envelope includes the crane, the operator, the riggers, the crane walkers, and...

- A. Any supporting structures
- B. Rigging gear between the hook and the load
- C. The area where the load will be landed
- D. The load

2. Select all that apply. The rigging gear envelope contains the rigging gear and miscellaneous equipment covered by NAVFAC P-307 section 14, the load itself and...

- A. The user of the gear or equipment
- B. The gear or equipments supporting structure
- C. Load rigging path
- D.

3. Select the best answer. During maintenance the rigging gear between the crane hook and the load fails and results in equipment damage. This is reported as a(n)...

- A. Rigging gear deficiency
- B. Crane accident
- C. Rigger error
- D. Operator error

4. Select the best answer. During crane operations the load shifts. The operator reacts quickly and saves the load but causes the crane to derail. This is reported as a(n)...

- A. Crane walkers error
- B. Load configuration error
- C. Operator error
- D. Crane accident

5. Select the best answer. When rigging gear covered by NAVFAC P-307 fails while suspended from a structure and drops the load it is a...

- A. Crane accident
- B. Rigging error
- C. Rigging gear accident
- D. Load configuration error

6. Select the best answer. If component failure occurs, such as motor burnout, and does not result in damage, the component failure is considered:

- A. A crane accident
- B. A non-accident
- C. Crane maintenance's responsibility
- D. A rigging accident

7. Select the best answer. To whom or to what are the majority of crane accidents attributed?

- A. Equipment failure
- B. Crane operators
- C. Weather conditions
- D. Riggers or signalmen
- E. Personnel error

8. Select all that apply. Over-confidence and poor judgment among team members can contribute to crane and rigging gear accidents. Select additional factors that can contribute to accidents:

- A. The crane operating envelope
- B. Engineering lift specifications
- C. Inattention to the task
- D. Operating the crane too fast

9. Select the best answer. If you have an accident with a crane or you find damage and suspect an accident has happened, your first step is to:

- A. Call emergency services if anyone is injured
- B. Secure the crane and power as required
- C. Notify your supervisor immediately
- D. Stop operations as soon as safely possible

Safe Crane Operations

Operator Responsibilities

The key factor of Category 3 Crane Safety is you, the operator. It is your operation skill and your good rigging practices that ensures not only your safety, but the safety of those around you. The crane operator is responsible for:

- The pre-use check of the crane
- The proper operation of the crane in accordance with good work practices
- The safety of the crane and personnel in the area; and
- Reporting any deficiencies or accidents

Safety is only attained by learning and applying good work practices. Never compromise safety by taking shortcuts.

Before Operating the Crane

As an operator, you must first consider your physical and mental condition before working with any weight handling equipment. Your body and mind must be fit for the job you are to perform. You must perform a self-assessment; that is, determine whether you are:

- Physically fit to operate the machine
- Mentally fit to operate the machine; and
- Emotionally fit to operate the machine

Consult a physician regarding adverse effects if you are currently taking medication.

Operator Self Assessment

The purpose of the self-assessment is to determine if you are physically, mentally, and emotionally fit to operate the crane. Ask yourself these questions to assess your condition:

- Do I feel well?
 - Can I handle the physical tasks of operating?
 - Do I have a clear head - am I thinking and remembering properly?
 - Am I alert?
-
- Is my attitude good today?
 - Am I calm, cool, and collected?

Do not operate the crane if you cannot honestly answer "Yes" to these questions. No matter how many times you've performed an operation, you must always be in control of all your faculties. Never take a chance when operating a crane. If you feel you cannot operate the machine safely, inform your supervisor.

Assess the Work Area

You must assess your work area for safety hazards. Here are some things you should look for:

- Ensure the crane path is clear. Identify obstacles and hazards. Look for objects which may interfere with the crane or load path.
- Identify other cranes and railway stops. The railway stops may not be listed on warning tags. Don't allow your crane to collide with them and never assume the other crane operator sees you.
- Look for other personnel. Warn them you will be working with the crane.
- Be aware of vehicles. Pay attention to vehicles which may enter your area.
- Look for machinery. Machinery, such as forklifts, may get in the way when you are operating the crane. Forklifts often have high boom carriages that can collide with your crane or hang up on the crane controller

Additional Hazards

Here are some additional hazards to check for:

- Tripping hazards - Objects in your path that could trip you when you're traveling the crane.
- Footing hazards - Check your footing. Look for wet, slippery, or damaged flooring. You must always have good footing when operating category 3 cranes.
- Identify hazardous areas where you could be in the "bight" - Never work yourself into a corner where you could be hurt if some component of the crane or rigging fails.
- Clear Escape Routes - Always have an escape route

[Before Working with a Crane](#)

Before you do any production work with a category 3 crane there are important activities that you must do; especially if the crane is new to you or one that you have operated only a few times. You need to become familiar with the crane. Each crane is unique and has its own characteristics. Some cranes may travel faster or slower than you are used to. The stopping distance is likely different from one crane to another. The crane may have just one operating speed; or, it may have variable operating speeds. Proportional control buttons change the operating speed in relation to how far they are depressed. Take the time to get to know the equipment and its operating characteristics. If you operated a crane with proportional controls the way you operated a crane with just one operating speed you could be in for a big surprise. Fully depressing the button of a proportional control puts it in top speed immediately.

[Multiple Operations](#)

Performing multiple operations is not recommended. Trying to do more than one operation at a time can make handling the crane and load more difficult. The best practice is to perform only one function at a time when operating a category 3 crane. Multiple operations at one time can create hazards and lead to accidents. For example, raising the load while traveling. A load that is being raised while the crane is traveling can cause the wire rope to cross on the drum and can severely damage the wire rope. Performing multiple operations at one time can also distract you. They make it harder to concentrate on the load and any obstacles or hazards in the area. It is a lot easier on the operator to perform just one function at a time, especially if the crane is new to you.

[Operating the Controls](#)

Category 3 crane operation is a big responsibility. Your safety, and the safety of those around you, depends on your skill and good work practice. Always give your full attention to the crane and the load when operating cranes. Set the load down if someone wants to talk to you, or inform them that you'll talk to them later. Never leave the controls when a load is suspended. This does not include slings and other gear used to rig the load and does not include a load attached to the crane with slack in the rigging gear. See NAVFAC P-307 paragraph 10.7 for additional exceptions and requirements. Only use your hands to actuate controller buttons. Never use clamping devices. Do not "jog" controls unnecessarily. Jogging the controller can cause the load to swing and can cause damage to the crane.

Chain Hoist Operation

Avoid sudden acceleration and deceleration of suspended loads. Rapid acceleration and deceleration causes shock loading and can greatly increase the stresses in the rigging equipment and load attachment points. Operation of chain hoists should be performed in a smooth, hand-over-hand motion. This will ensure control of the load during movement. Operating the hoist at excessive speeds should not be done with a load on the hook. During initial hoisting of a near capacity load, when it is just clear of its supports, verify that the hoist brake system is operating properly by stopping operation. Continue only after verifying proper operation. Do not use the limit switch or chain stops on hoists to stop hoist movement during operation! If the limit switch or chain stops were to fail, the hoist will two-block (make contact with the structure of the hoist) and may result in failure of the load chain and cause the load to fall.



Know the Total Weight

One of the first things you must know in order to use a crane safely is the total weight of the lift. Remember:

- The weight of the load must be verified when it is estimated to exceed 50% of the crane's capacity.
- Don't forget the rigging gear weight must be added to the weight of the load being handled to prevent overloading the crane.
- If you exceed 80% of the hook's rated capacity of the crane for bridge, wall, or gantry cranes you must meet the requirements for a complex lift. Jib cranes, pillar jib cranes, monorail cranes, and fixed overhead hoists are excluded from this requirement

Assess the Lift

When preparing to work with a category 3 crane there are assessments that you must make before you begin operations.

- You must assess the lift in order to use the proper rigging gear.
- You must determine what type of lift it is; whether it is complex or non-complex. Complex lifts require written procedures and supervisor oversight.
- You should avoid blind lifts. Blind lifts are lifts that are conducted when the operator cannot see the load or when the operator cannot see the person(s) assisting them

Establish Communication

It is imperative that you establish good communication with all personnel assisting you. Good communication is the key to everyone's safety. You should:

- Always brief those assisting you. Let them know exactly what is planned to be done with the crane and load.
- Let them know exactly what you need them to do.
- Make sure they understand, and convey back to you, what is expected of them.
- Discuss the hazards and establish escape routes.
- Always inform them before you operate any function of the crane to be sure they are not caught in the bight.
- Use proper hand signals when necessary.

Every day use of these topics in preparing for your lifts can be referred to as Operational Risk Management (ORM). ORM can be an integral tool used for anticipating hazards, minimizing risks associated with a job, and reducing the potential for accidents

Before Lifting the Load

When you are ready to make the lift, take one last moment to make these final checks:

- Make sure the hook is centered over the object's center of gravity.
- Make sure the rigging is still in its proper place.
- Make sure the rigging is not hung up on protruding components.
- Make sure the chafing gear is still in place

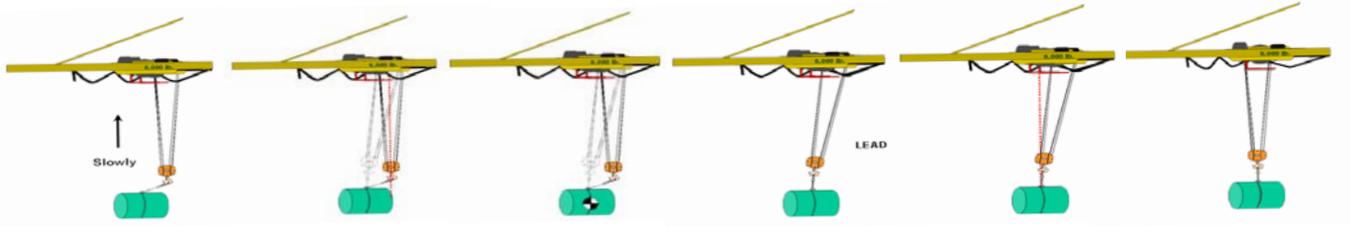


Prior to Lifting

Moveable components should be secured to prevent motion that may affect load stability. Examples include drawers of a safe, the tail stock and carriage of a lathe, or a door of a cabinet. Evaluate the structural integrity of the load prior to lifting. Consider the strength of any area on the load where the rigging bears against it. When attachment points are not specified choose load bearing points that are clearly strong enough to support the load. If doubt exists, contact engineering for an evaluation.

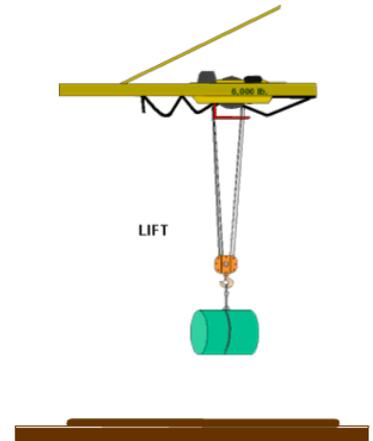
Procedure for Lifting Loads

Here is the first step necessary prior to the actual lifting of an object. Remove the slack by hoisting up slowly. Watch for a lead as the hook moves to the center of gravity, and then move the hook over the center of gravity



Procedure for Lifting Loads (2)

Lift the load just off of the ground or work surface and stop. This allows you to test the brakes and ensure the rigging gear is in place. If there is any shift in the load or problems, set the load down and repair the problem



While Lifting Loads

While lifting loads you should watch the load being lifted, the crane, wire, and the drum. When you drive a car you continuously scan the speedometer and mirrors while you are driving. You need to make a similar practice when you are making crane lifts.

Load Control

Control load movement at all times. Do not move the load with excessive speeds. When a load is moved, ensure that personnel or any portion of their bodies are not in potential pinch points. Example: When installing a valve, ensure shop personnel do not insert their fingers into the bolt holes to line the valve up or under the valve. Personnel have had finger tips or even fingers cut off doing this. Use a marline spike or other tool to help line the flanges up. When the stability of the load becomes uncertain, stop, land the load and modify the rigging configuration. When loads are to be moved in areas with tight clearances, take measurements and use a positive means of load control to ensure that binding or damage to the load or area will not occur.

Load Control (2)

When landing loads you must ensure the landing area and supporting structure provide adequate support for the weight of the load. Land loads on dunnage for protection if the load has to be placed on decks or floors that may potentially be damaged. When the orientation of a load must be changed, such as turning it on its side, use holdbacks, physical barriers or other methods to prevent loss of control of the load. Before the rigging gear is disconnected, ensure that the load is stable and adequately supported.

Never...

When you are operating category 3 cranes, never...

- allow side-pulls or end-pulls to be placed on the crane hoist. In other words, never lift a load when there is a "lead" in the wire or chain in any direction. The crane's structure is designed for vertical lifting. Serious damage can occur to hoisting equipment, especially the wire rope, from side and end pulls.
- operate if there are twists in the load chain. The picture at right shows a chain hoist that has twisted chain leading to the block. The chain shown on the right side of the picture is straight. If a load is placed on the hoist and the load is raised, the twisted chain can jump off of the gears or damage the gear teeth, resulting in hoist damage, failure, or a dropped load.
- operate if the wires appear crossed between hook block and drum or on the drum itself.
- allow the hook to set down on the ground or load (This is a crane accident!). Letting the hook set down releases tension in the wires and can cause spooling problems. It may even cause the crane wire tail to slip out of the drum and result in a dropped load.
- allow the hook block to contact the upper limit switch any other time except when performing the crane pre-use checks

Never (2)

In addition, when you are operating category 3 cranes, never...

- allow riders on the hook or the load.
- carry loads over personnel.
- allow the crane to be a ground for welding.
- lift a load when the hook block is not centered over the object's center of gravity. The load will swing and can crush you, another worker, or cause damage to the load or other equipment.
- travel the crane when any part of the crane, the hook, or the load can strike anything. If there is no load on the hook, raise the hook high enough to clear and travel over personnel. If there is a load on the hook ask the person(s) to move or warn them and carefully travel the load around them

General Rules for Traveling

Here are some general rules pertaining to traveling the crane:

- Avoiding abrupt starts and stops will help you maintain control of the load and prevent it from excessive swinging. These actions put dangerous impact loads on the machine and its components.
- Always start traveling slow and then evenly accelerate to a safe speed.
- Always decelerate evenly to a smooth, controlled stop to prevent the load from swinging.
- When you travel without a load, always travel with the hook higher than the nearest obstacle that it could strike and travel with the hook just below the limit switch. This decreases the pendulum action (swinging) that is created when the hook reacts to the crane's movement.
- When you travel with a load, only hoist high enough to clear any obstacles that the load could collide with

Securing the Crane

Here are the procedures to follow any time you secure a crane:

1. Remove all rigging gear from the hook. Rigging gear left on the hook can pose a threat to other cranes, machines, or personnel that could run into it and cause an accident. It is a good practice to remove the gear any time it is not in use to eliminate hazards to or from other operations in the area. It doesn't need to be removed when taking a break.
2. Position the hook block about 1 foot below the upper limit switch. Raise it higher if needed to allow clearance for people, forklifts, other machinery, etc.
3. Position the crane out of the way. Be sure it isn't blocking someone else's work area when you leave. Swing jibs out of the work area.
4. Place the controller out of the way. Make sure it can't get hung up in vehicle traffic and personnel can't run into it.
5. Secure the power

NOTES

[Safe Crane Operations Module Exam Questions & Answers](#)

Online exam questions may appear in a different order than those shown below.

1. Select the best answer. The purpose of the operator self assessment is to ensure that:

- A. You are in the proper condition to operate a crane
- B. You understand the lift
- C. You are qualified to operate the crane
- D. None of the above

2. Select all that apply. Select all of the items that you should discuss with those who may assist you.

- A. Hazards
- B. Break time
- C. Escape routes
- D. What is expected of them
- E. The load weight

3. Select the best answer. Before you operate a crane that is new to you, you should first:

- A. Test the controls and functions
- B. Be assured that the crane is certified
- C. Test the upper limit switch
- D. Lift a light load
- E. Make sure you are familiar with how it operates

4. Select the best answer. Select the action you would perform in step 1 of the Procedures for Lifting Loads.

- A. Hoist at one speed until the load lifts
- B. Hoist slowly and remove the slack
- C. Hoist slowly until the load lifts

5. Select the best answer. Select the action you would perform in step 2 of the Procedures for Lifting Loads.

- A. Lift the load until completely suspended and stop
- B. Lift the load to the desired height and stop
- C. Lift the load until the load clears all obstacles and stop

6. Correct order. Put the steps for securing a crane into chronological order by writing the correct number next to the steps.

_____ Secure Power

_____ Position the crane out of the way

_____ Remove the rigging gear

_____ Place the controller out of the way

_____ Position the hook block just below the upper limit switch

7. Select all that apply. Select all of the items from the list that you will never apply when following the safety rules for safe crane operation.

- A. Hoist into the upper limit switch with a load
- B. Carry a load over personnel
- C. Warn personnel before moving a crane
- D. Allow side-pulls or end-pulls
- E. Start travel slowly

8. True or False. Category 3 Operators are responsible to ensure all functions of the crane operate correctly before working with the crane.

- A. True
- B. False

9. True or False. Category 3 Operators are responsible to report problems they encounter with the crane.

- A. True
- B. False

10. True or False. Abrupt starts and stops can cause the load to swing.

- A. True
- B. False

11. True or False. The higher an empty hook is when you travel, the less it will swing.

- A. True
- B. False

12. True or False. It is okay to travel the crane when the hook could strike someone, as long as they have been warned.

- A. True
- B. False



Category 3 Crane Safety Course Evaluation

Student Name: _____

Command/Activity/Organization: _____

Instructor: _____ Date: _____

Directions: To assist in evaluating the effectiveness of this course, we would like your reaction to this class. Do not rate questions you consider not applicable.

Please rate the following items:	Excellent	Very Good	Good	Fair	Poor
Content of the course met your needs and expectations.					
Content was well organized.					
Materials/handouts were useful.					
Exercises/skill practices were helpful.					
Training aids (slides, videos, etc) were used effectively.					
Instructor presented the material in a manner, which was easy to understand.					
Instructor was knowledgeable and comfortable with the material.					
Instructor handled questions effectively.					
Instructor covered all topics completely.					
Probability that you will use ideas from the course in your work.					
Your opinion of the course.					
Your overall opinion of the training facilities.					

What were the key strengths of the training? How could the training be improved? Other comments?

List other training topics in which you are interested: _____

Note: If you would like a staff member to follow up and discuss this training, please provide your phone number _____