Boom Truck Operator –
Stiff Boom Unlimited Tonnage

Operator Certification Exam

Getting Ready Guide

BC Association for Crane Safety
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Introduction

Who Should Use This Guide

This document is for any new or experienced crane operator preparing to write a crane operator certification exam.

It may have been a while since you wrote an exam. And if you’re like most people, the prospect of writing an exam causes you some anxiety. Use this guide to help you prepare. The better prepared you are, the less stress you will feel, and the better you are likely to perform on the exam.

Please note: This Getting Ready Guide is not a training course. It is provided only to help you prepare for writing this exam.

How to Use This Guide

We want you to succeed. This guide helps you identify how and what to study, where to find study materials, and what to expect on the exam. It also provides example questions in each subject area so you can try a mini-practice exam.

Here’s how we suggest you use this guide:

1. Make sure you’re looking at the right Getting Ready Guide. There are different guides for each crane type, so make sure you’re reading the right one for the exam you intend to write.

2. Skim through the guide from start to finish so you know what’s in it.

3. Read Section 1 – The Exam, so you can picture what the exam looks like, how many questions there are, and the conditions under which you’ll be writing it.

4. Read Section 2 – Exam Topics. It provides information on each topic covered on your exam, the competencies being tested, and the key study areas. If you’re unclear on any topic or competency, read up on it, ask questions, or take some training.

5. Use Section 3 – Practice Questions to get a feel for what the questions will be like on your exam.

6. Mark your practice questions using the Answer Key provided in the Appendix. Review any topics that gave you trouble.

7. You are ready to write the exam!
Section 1 – The Exam

Exam Purpose

What is certification and why do I need it?

The WorkSafeBC regulations state that as of July 1, 2007, all mobile crane, tower crane or boom-truck operators require a valid operator’s certificate (Occupational Health and Safety Regulation [OHSR], Section 14.34.1). Operator certificates for these cranes are issued by the BC Association for Crane Safety (BCACS) upon successful completion of a written exam and practical assessment.

For more information on certification, refer to the BCACS website (http://www.bcacs.ca/index.html).

Where does this exam fit into the whole certification process?

There are four levels of certification for operators in each category of cranes. Each level is described in detail on the CraneSafe website (http://www.fulford.ca/cs_levels.html). The table below summarizes the differences between each level.

Table 1. Crane Operator Certification Levels.

<table>
<thead>
<tr>
<th>Level</th>
<th>Operator Status</th>
<th>Certificate Owner</th>
<th>Supervision Required</th>
<th>Certification Steps Required</th>
<th>Expires</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Journeyperson Operator</td>
<td>Operator</td>
<td>None</td>
<td>Written exam on crane type for which certification is issued Practical Assessment</td>
<td>Re-certification is not required at this time</td>
</tr>
<tr>
<td>B</td>
<td>Trainee/Apprentice Employer</td>
<td>Employer</td>
<td>Indirect at all times. Direct for critical lifts</td>
<td>Written Exam on crane type on which operator is being trained</td>
<td>1 year (renewable)</td>
</tr>
<tr>
<td>C</td>
<td>Probation (direct supervision required)</td>
<td>Employer</td>
<td>Direct at all times</td>
<td>None</td>
<td>6 months</td>
</tr>
<tr>
<td>D</td>
<td>Periodic Use Employer</td>
<td>Employer</td>
<td>Indirect at all times</td>
<td>Written Exam on crane type on which operator is being trained</td>
<td>Re-certification is not required at this time</td>
</tr>
</tbody>
</table>
Am I writing the right exam?

There are seven different crane certification exams. Table 2 shows the type of crane that each exam certifies you to operate.

Make sure you are writing the correct exam for the type of crane(s) you are, or will be operating.

Table 2. Crane Certification Exams

<table>
<thead>
<tr>
<th>Exam Title</th>
<th>Crane Types this Exam Certifies You to Operate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lattice Boom Friction</td>
<td>All crane types except Tower and Self-Erect</td>
</tr>
<tr>
<td>Lattice Boom Hydraulic</td>
<td>Lattice Boom Hydraulic, Hydraulic Unlimited Tonnage, Hydraulic 80 Tonnes and Under, Stiff Boom Unlimited Tonnage, Folding Boom Unlimited Tonnage</td>
</tr>
<tr>
<td>Hydraulic Unlimited Tonnage</td>
<td>Hydraulic Unlimited Tonnage, Hydraulic 80 Tonnes and Under, Stiff Boom Unlimited Tonnage, Folding Boom Unlimited Tonnage</td>
</tr>
<tr>
<td>Hydraulic 80 Tonnes and Under</td>
<td>Hydraulic 80 Tonnes and Under, Stiff Boom Unlimited Tonnage, Folding Boom Unlimited Tonnage</td>
</tr>
<tr>
<td>Stiff Boom Unlimited Tonnage</td>
<td>Stiff Boom Unlimited Tonnage, Folding Boom Unlimited Tonnage</td>
</tr>
<tr>
<td>Folding Boom Unlimited Tonnage</td>
<td>Folding Boom Unlimited Tonnage</td>
</tr>
<tr>
<td>Tower</td>
<td>Tower, Self-Erect</td>
</tr>
</tbody>
</table>

After writing this exam, what happens next?

Once you have passed your exam, you are immediately eligible to register for the practical assessment. Information on practical assessment registration and requirements is available from the CraneSafe Certification website (http://www.fulford.ca/crane_cert.html).

About the Exam

How do I apply to take the exam?

The BC crane operator exams are administered by the Industry Training Authority (ITA) and CraneSafe BC. Refer to the ITA website (http://www.itabc.ca/site3.aspx) for information on applying to write exams, exam schedule and locations, and exam writing instructions.

What if I have to reschedule the exam date?

If you are not able to write the exam on your scheduled date, you must notify the ITA Customer Service Office (778-328-8700) or toll free (within BC) 1-866-660-6011 as soon as possible to reschedule for another day.
Failure to provide at least five days’ notice is considered a no-show, and a reschedule service fee will be charged.

What is a pass/fail?

If you achieve 70% or more on the exam, you are determined to be *competent* in the knowledge skills related to operation of the crane on which you’ve been tested.

If you achieve 69% or less on the exam, you are determined to be *not yet competent* in the knowledge skills related to operation of the crane on which you’ve been tested.

What if I don’t pass the exam?

If you do not pass the exam the first time, you can schedule a re-write after 30 days. If your mark on the first try was between 60 and 70 percent, there is no fee for the re-write. If your mark on the first try is less than 60 percent, or if your mark on the second try is less than 70%, you must attend technical training or demonstrate equivalent upgrading. There is a $100 fee for the third and any subsequent attempts. Please view the ITA’s Examination Policy for further information ([http://www.itabc.ca/AssetFactory.aspx?did=679](http://www.itabc.ca/AssetFactory.aspx?did=679)). For more information on re-writing the exam, refer to the Examinations page of the ITA website ([http://www.itabc.ca/Page30.aspx](http://www.itabc.ca/Page30.aspx)).

Exam Questions

What types of questions are on the exam?

All of the exam questions are multiple choice, and written according to the specifications for all Red Seal exams. Each question on the exam is worth the same as every other question – no question is worth more or less.

► Each question is clearly and simply written, and deals with only one main idea or concept.
► Negative questions are avoided (e.g., “Which of the following is NOT...”).
► Questions are not asked about obscure topics or documentation.
► Multiple choice answers are presented in ascending length (shortest to longest answer), or ascending numerical order (lowest to highest number).

Every question has been reviewed numerous times by industry personnel to ensure it is relevant to today’s work environment. The competencies that are being tested have been defined by industry personnel as necessary in order to operate a crane safely and effectively.

What are the questions testing?

The exam contains a variety of questions that test your abilities on different levels:

► Knowledge and Recall – Your ability to recall and understand definitions, facts, and principles.
Procedure and Application – Your ability to apply your knowledge of procedures and theoretical concepts to new or practical situations.

Critical Thinking – Your ability to judge the relevancy and accuracy of data, to interpret data, solve problems, identify cause-and-effect relationships, and formulate valid conclusions.

Strategies for Success

Are you nervous about writing an exam? Who isn’t? Being well-prepared and rested will help reduce your stress.

The following strategies are offered to help you prepare for writing any exam. They have been condensed from the ITA document, Final Exams: Preparing for Success. The full document is available as a PDF download file from Examinations page on the ITA website (http://www.itabc.ca/Page30.aspx).

Studying

- Study at the same time and same place regularly, so your body and brain know when it’s time to study. Try to pick a time when you can concentrate, and stick to your routine.
- Study for shorter periods of time over a longer timeframe. Avoid “cramming”.
- At the beginning of a study session, prepare a quick list of what you need to cover in order to stay focused and not overlook important topics.
- Organize your study material into chunks, based on the topics and competencies covered on the exam.
- Frequently review material you’ve already covered. Repeated exposure keeps it fresh in your mind and helps get it into your long-term memory.
- Periodically take breaks when you’re studying (e.g., last 10 minutes of each hour) to give you brain time to process the new material.
- Prepare a summary of key information (e.g., one or two pages of formulas, definitions, key concepts). Write it yourself, using your own words, to enhance your understanding of the material.
- Create a study plan that ensures you finish studying several days before the exam. That way, you will feel well-prepared, and can spend the remaining time reviewing areas where you feel least confident.

Minimizing Test Anxiety and Stress

As the exam approaches, a bit of anxiety is useful and natural; it keeps you focused and alert. However, if the anxiety becomes overwhelming and keeps you from performing your best, consider using one of the strategies below to help reduce stress.

- Focus on your breathing. Long, deep breaths will help calm you physically.
- Remind yourself that you are in control. Tell yourself to calm down and regain control of your thoughts and emotions. If you need to, physically leave your studying and come back when you have calmed down.
- Remind yourself of what you have already accomplished, and encourage yourself that you will get through this, too.
- Concentrate on the next task. Instead of feeling overwhelmed by everything, just focus on what you need to do next. Step-by-step, you will make it.
- Get adequate rest, regular exercise, and proper nutrition. Studying when you are physically or mentally fatigued will only make you upset or more anxious, and hinder your ability to learn.
- Consider re-scheduling the exam if you have too much on the go at the moment, or if there has been a significant event in your life that causes stress (e.g., an accident, death of a friend or family member, birth of a child).
- Avoid gossip about the exam, especially fear-mongering (“it’s the hardest thing I’ve ever done”), or bragging (“it was a snap” or “I finished in only one hour”). Concentrate instead on studying the necessary material.
- Don’t try to second guess what will or will not be on the exam. There are multiple versions of the exam, and the exams are continually under revision. It is highly unlikely you will ever write the same exam as someone else you know.
- Get a good sleep the night before the exam. Avoid excessive alcohol or caffeine the night before the exam.
- Avoid stressing yourself out the night before the exam. Avoid others who may make you anxious, and don’t try to learn new material. Focus on what you know.

**Before the Exam**

Make sure you have everything you need to write the exam, including:

- A scientific pocket calculator provided it is not programmable or trade-specific. Use one that is familiar to you, and make sure it has fresh batteries (or bring replacements with you). Note: You will not be permitted to use the calculator on a cell phone.
- Your exam notification letter
- **Government-issued photo identification**, to verify that you are the person who is supposed to be writing the exam
- Payment for the exam (if this has not already been done)
- A watch, so you can pace yourself when writing the exam.

Make a list ahead of time of what you need to take so you don’t forget anything.

Plan to arrive early for the exam, allowing time for unexpected events like traffic delays or difficulty finding parking. Make sure you know how to get to the exam location. If you are late, you will not be allowed to sit for the exam but will have to reschedule for a later date and pay the rescheduling service fee.

Watch what you eat and drink immediately before the exam – you don’t want to have stomach or bladder pains, and you won’t be allowed to leave the room once the exam begins. At the same time, be sure to eat before the exam as food is not allowed in the exam room.

If you find yourself feeling anxious, just remind yourself that you are well-prepared.
During the Exam

Do not speak to others once the exam begins. Try to ignore the other candidates writing their exams as this can be distracting.

Do not attempt to cheat or copy someone else’s answers, or allow anyone to look at your answers. Many different trades exams are written at any given exam session, so it is unlikely that someone close to you will be examining for the same trade. Even if they are, they could very well be writing a different version of the exam, so the questions may not match yours. If you are caught trying to cheat, your exam will be removed and scored as a zero. Your privilege of writing the exam will be forfeited for one year.

You cannot write in the exam book, so if you need to make note of something, use the scrap paper provided. When the exams are distributed, you will be given an HB pencil and scrap paper in addition to the exam book and answer sheet. It is a good idea when the exam begins to write down any significant formulas or other memorized information on the scrap paper, to avoid panicking and being unable to recall the information when answering the questions.

Do not open or begin the exam until instructed to do so. Before diving into the questions, read the directions carefully, and quickly look over the exam to make sure you have the proper exam (for your trade) and that your exam is not missing any pages. Look at how many questions are on the exam, get a sense of the types of questions asked, and the different sections of the test.

Watch your time – determine how much time you have for each question and establish targets to pace yourself.

Take advantage of the entire time allocated for writing the exam. You get no extra points for leaving early, so don’t panic when you see others handing in their exams. Leave only when you’re satisfied you have done your best. Finish the exam – do not leave any questions unanswered, as you’re not penalized for incorrect responses.

Do the easy questions first, and skip over the more difficult questions until later. This helps to calm your nerves, instil confidence, and get you into the exam writing mindset. Don’t panic if you come across a question you didn’t anticipate and for which you are unprepared. Just use your knowledge and common sense and try to reason out a logical answer. Don’t forget, you need 70% to pass, not 100%.

Strategies for Answering Multiple Choice Questions

- Read each question stem carefully so you understand exactly what is being asked.
- Pay particular attention to key words or phrases or qualifying words in the question. For example, if the question contains a word like all, always, none, or never, then the correct answer must be a fact, or an absolute.
- When reading the question and response options, be careful not to make assumptions or jump to conclusions. Stick to the facts contained in the statements.
- Use scrap paper to draw a diagram or jot down a formula if it helps you answer a question.
- Each question is written to stand by itself, so do not assume that any information in one question applies to another question, unless stated otherwise in the exam.
Before answering a question, try to determine the answer without looking at the response options. Once you think you know the answer, look for the one that matches your answer. Doing this helps you avoid being distracted by incorrect response options.

Read all of the responses before you select an answer. Sometimes the distractors (or the wrong answers) contain familiar words to make them appear correct, or are correct statements by themselves, but they do not answer the question asked.

If you are not sure of the answer, identify the ones you know are wrong to narrow your options. If none of the response options seem correct, re-read the question and try to figure out what you may have missed.

If more than one answer seems correct, try to determine the difference between the possible options. Then re-read the question to figure out how the differences are important. The answer you choose should completely address the question — it should not be correct only sometimes, or be correct only if you make significant assumptions.

If you are still unable to answer the question, move on and come back to it later. It’s better to finish the questions you know first, and come back later to the ones you find harder to answer. Sometimes the answer comes to you when you’re working on another question.

Never leave any questions unanswered, even if you have to guess at the answer. You are not penalized for incorrect answers.

Only select one answer for each question. If you circle more than one response, the question is marked wrong, even if one of the answers you select is correct.

Try not to second guess or over-analyze your answers as your first instinct is often correct. However, if you have a good reason to change an answer (e.g., the information provided in another question suggests that your answer may be incorrect), then do so.
Section 2 – Exam Topics

Safety

About the topic
As a crane operator, you must have a clear understanding of safe working practices in order to prevent damage to equipment and materials, and injuries to yourself and others.

Competencies Tested
This exam tests your ability to do the following:

► A1 K – Demonstrate knowledge of safe working practices for crane operators.
► A2 K – Demonstrate knowledge of power line hazards and high voltage equipment.

Key study areas
2. Read the WorkSafeBC Occupational Health and Safety Regulation (OHSR) parts that pertain to cranes (http://www2.worksafebc.com/publications/OHSRegulation/Home.asp)
3. Read or review the Safety section of the Operations Manual for the type of crane you are using or being examined on.

Communications

About the topic
Hand signals and radio communication are used to direct crane operations. The ability to communicate clearly with crane owners, supervisors, dispatchers and crew members is an essential skill for a crane operator.

You must be able to interpret common hand signals, and give and receive clear direction to avoid problems and accidents. Repeat what you’re told in order to ensure you’ve heard correctly, and make sure you understand what is being asked.

Competencies tested
This exam tests your ability to do the following:

► B1 K – Demonstrate knowledge of personnel involved in crane operations.
Key study areas

1. Make sure you know the Crane operator hand signals. They are demonstrated in the following document available from the CraneSafe website: [Core Workplace Competencies](http://www.fulford.ca/bccs_cwc_core_v2.pdf). See Section 2 of the document, Communications.

2. Practice your hand signals with a buddy.

3. Review the standard procedures and signals for voice communications from the American Society of Mechanical Engineers (ASME) Standards.

### ASME Standards – Section 5-5.3: Signals

#### 5-3.3.5 Standard Voice Signals

Prior to beginning lifting operations using voice signals, the signals shall be discussed and agreed upon by the person directing lifting operations, the crane operator, and the appointed signal person.

(a) Telephones, radios, or equivalent, if used, shall be tested before lifting operations begin. If the system is battery powered, extra batteries should be available at the job site.

(b) Prior to commencing a lift, the operator and signal person shall contact and identify each other.

(c) All direction given to the crane operator by the signal person shall be given from the operator’s direction perspective (e.g., swing right).

(d) Each series of voice signals shall contain three elements stated in the following order:

1. function and direction
2. distance and/or speed
3. function stop.

   NOTE: These are some examples of signals.

   (a) swing right 50 feet, 25 feet, 15 feet, 10 feet, 5 feet, 2 feet, swing stop
   (b) load down 100 feet, 50 feet, 40 feet, 30 feet, ...2 feet, load stop
   (c) load up slow, slow, slow, load stop.

(e) For lifting operations using voice signals, the person directing lifting operations shall consider the complexity of the lift, the capabilities of the particular crane, the experience and skill of the operator and signal person, and the ability to communicate the necessary signals before permitting multiple simultaneous crane function signals.

Cranes

**About the topic**

The questions in this subject area are written to assess your general knowledge of cranes, the crane industry, and regulatory requirements for crane operators.
Competencies tested

This exam tests your ability to do the following:

- C1 K – Demonstrate knowledge of types of cranes and classifications.
- C2 K – Demonstrate knowledge of terminology related to craning and craning concepts.
- C3 K – Demonstrate knowledge of hoisting terminology, functions and systems.
- C4 K – Demonstrate knowledge of regulatory requirements pertaining to cranes.
- C5 K – Demonstrate knowledge of crane components and attachments for boom trucks.
- C6 K – Demonstrate knowledge of engines and ancillary systems.
- C7 K – Demonstrate knowledge of power transfer for boom trucks.

Key study areas

1. Make sure you are knowledgeable about the different types of cranes listed in Table 2. You should know their capabilities and what they’re used for.
2. Review the Glossary of Common Crane Terms in Appendix D and make sure you know each of the terms it describes.
3. Review the operation manual(s) for the type of crane on which you are becoming certified. Crane operation manuals are a good source of information, and must be read and understood before operating any crane.
4. Read the WorkSafeBC Occupational Health and Safety Regulation (OHSR) parts that pertain to cranes (http://www2.worksafebc.com/publications/OHSRegulation/Home.asp)
5. Additional resources for information on this subject:
   - Canadian Standards Association (CSA) Safety code on Mobile Cranes: http://www.shopcsa.ca/onlinestore/GetCatalogItemDetails.asp?mat=2007625. Costs about $60, but your employer should have a copy.
   - ASME (American Society of Mechanical Engineers) Standards - B30.5 - 2004 Mobile and Locomotive Cranes: http://catalog.asme.org/Codes/PDF/B305_2004_Mobile_Locomotive.cfm. Costs about $80, but your employer should have a copy.
   - Crane manufacturer’s websites.

Rigging and Lifting Theory

About the topic

It is important to test your knowledge in this area because if improper rigging is used to lift the load, the rigging may fail and cause a serious accident. In March 2008, a tower
A crane in New York City fell over causing a multi-million dollar accident and 7 deaths. The accident was determined to be caused by the use of a $50 sling that had previous damage and should not have been used.

As a crane operator, you may not do the rigging, but if a load on the ground is within your line of sight, you are responsible for the rigging. If you see a problem, it’s up to you to stop further work, or get out and check it.

Competencies tested

This exam tests your ability to do the following:

- D1 K – Demonstrate knowledge of lifting theory and forces.
- D2 K – Demonstrate knowledge of slings (all types), rigging hardware, materials, inspection and capacity cards.
- D3 K – Demonstrate knowledge of wire rope hoist line construction and inspection.

Key study areas

1. Review the rigging manuals and books listed under Load Charts, or take a rigging course.
2. Review the CraneSafe rigging practice questions and exercises for the type of crane on which you are becoming certified (http://www.fulford.ca/cs_pex.html).
3. Make sure you know and understand the terms listed in Appendix D, Glossary of Common Crane Terms, and Appendix E, Glossary of Rigging Terms.
4. Review rigging manufacturer’s websites (the following are two examples):
5. Additional References:
   - Refer to the online store of the Crane Institute of America. http://www.craneinstitute.com/shop/cgi-bin/commerce.cgi?listcategories

Hoisting Fundamentals

About the topic

Correct use of load charts is one of the fundamental competencies of a crane operator. You must thoroughly understand how to read and use load charts in order to pass the ITA exam and the CraneSafe practical assessment.

Proper use of load charts is a critical safety issue. If you do not read a load chart properly and over-extend the capabilities of your crane, accidents happen that cause damage and injury.
Competencies tested

This exam tests your ability to do the following:

- **E1 K** – Demonstrate knowledge of determining load weights using fundamental math functions and calculations.
- **E2 K** – Demonstrate knowledge of determining the capacity of a crane using load charts.

Key study areas

1. Try the Practice Questions in the next section of this document. Also try the practice questions for the practical assessment on the CraneSafe site (http://www.fulford.ca/CS_LCR_LFC_AM5299A.pdf). If you are unable to correctly answer these, or you are not able to calculate crane capacity by looking at the manufacturer’s load chart and subtracting deductions from the rated or gross capacity, you should get training in this area before writing the exam. A list of qualified trainers is available from the BCACS website (http://www.bcacs.ca/).

2. The crane manufacturer’s load charts give good information, but they’re intended for use by experienced crane operators. The following books provide the background information you need to become proficient in this area:

Transportation and Delivery

About the topic

Commercial vehicles and the transportation of loads are regulated by the Ministry of Transportation and ICBC. You must know and follow the rules of the road because failure to do so creates safety hazards and results in fines.

Competencies tested

This exam tests your ability to do the following:

- **F1 K** – Demonstrate knowledge of BC Ministry of Transportation – Commercial Transport rules and regulations.
- **F2 K** – Demonstrate knowledge to prepare a boom truck and associated loads for highway/road travel.
Key study areas

1. Refer to the ICBC reference and study guide called, “Driving Commercial Vehicles”, chapter 5: Skills for Driving Trucks and Trailers. It is available online at: http://www.icbc.com/licensing/lic_utility_resman_commercial.asp

Site Planning and Positioning

About the topic

Before a crane is sent to a jobsite to lift an object, careful planning and preparation is required. Several factors must be considered, including:

- Evaluation of the site where the crane is to be set up to ensure ground conditions are suitable
- Checking for hazards such as power lines and underground services
- Personnel and rigging requirements
- The weight of the load and where it is to be placed. For example, the distance from the crane to the load placement location determines the size of crane required.

Competencies tested

This exam tests your ability to do the following:

- G1 K – Demonstrate knowledge of accurate site assessment tools.
- G2 K – Demonstrate knowledge to locate and safely position a crane.

Key study areas

1. Read the WorkSafeBC Occupational Health and Safety Regulation (OHSR) parts that pertain to cranes (http://www2.worksafebc.com/publications/OHSRegulation/Home.asp)

2. The following books provide the background information you need to become proficient in this area:
Crane Operations

About the topic

Crane operators are responsible to conduct a pre-operational inspection of the crane before every shift, and make sure the crane is set up properly. The majority of crane accidents are caused by improper set up, so it’s critical to ensure that every crane operator is competent in this area.

Crane set up and pre-operational inspection is an important aspect of both the ITA exam and the CraneSafe practical assessment.

Correct use of load charts to calculate load capacity and knowledge of proper rigging are fundamental to crane operations. For more information, refer to Load Charts and Rigging.

Competencies tested

This exam tests your ability to do the following:

► H1 K – Demonstrate knowledge of pre-operational requirements in crane operations.
► H2 K – Demonstrate knowledge of crane operations.
► H3 K – Demonstrate knowledge of lifting plans and rigging for cranes.
► H4 K – Demonstrate knowledge of folding boom (unlimited tonnage) load charts and load calculations.
► H5 K – Demonstrate knowledge of stiff boom (unlimited tonnage) load charts and load calculations.

Key study areas

1. Review the manufacturer’s manual for the crane type on which you’re writing the exam. It will give proper instructions for crane set up and inspection.

2. Use the IPT Crane and Rigging Training Manual to read about the subject and do the practice questions. It can be purchased from: http://www.iptbooks.com/index.php?option=com_content&view=category&layout=blog&id=42&Itemid=71. This book can be purchased as a handbook or training manual. Only the training manual contains the sample questions and answer key.

3. Additional reading:


Maintenance and Service

About the topic

A regular schedule of maintenance is required to keep your crane operating efficiently. Mechanics and operators responsible for equipment and must be familiar with the maintenance schedule specified by the manufacturer. All service and repairs must be recorded in the crane logbook.

Competencies tested

This exam tests your ability to do the following:

- I2 K – Demonstrate knowledge of inspecting engines, monitoring devices and hydraulic systems.
- I3 K – Demonstrate knowledge of servicing and maintenance procedures.

Key study areas

1. Review the log book in the crane on which you are being trained, and note how incidents, maintenance and inspections are recorded.
2. Review the pre-shift inspection procedures for the Operators manual of the crane on which you are being trained.
3. Review the following publications:
   - Crane-specific information: Manufacturer’s manuals.
Section 3 – Practice Questions

Introduction

The following practice questions are actual exam questions used from previous versions of crane certification exams. None of them are in use anymore, but they represent the style of question you will encounter on the actual exam.

When you have finished studying and are ready to write the exam, try these practice questions. Depending on the exam you’re writing, the question topics will vary, but these will give you a good feel for how the questions are worded and structured. Try timing yourself when you do these questions. You should be able to answer them all in under an hour. The answer key is provided in Appendix F. Appendix A contains commonly used equations, and Appendix B illustrates the basic functions of a calculator.

Practice Questions

1. According to Occupational Health and Safety Regulations, what is the absolute minimum distance that must be maintained between a crane and a power line energized with 750v to 75 kv (75,000 volts)?
   a. 3 meters (10 feet)
   b. 4.5 meters (15 feet)
   c. 6 meters (20 feet)
   d. 9 meters (30 feet)

2. What does the hand signal indicate in the figure below?
   a. Boom up
   b. Hoist up
   c. Load up
   d. Hold the swing
3. What is the radio protocol between a mobile piece of equipment and a tower crane sharing the same workplace?
   a. Mobile operator to go on to the survey channel
   b. A separate radio with a mobile to tower crane frequency
   c. Mobile rigger maintains radio contact with tower crane rigger
   d. Mobile operator switches to tower crane frequency once on site

4. What does Part 3 of the WorkSafeBC Occupational Health and Safety regulation cover, if as an operator you are presented with a load to lift that you have concerns about?
   a. Wire rope rejection criteria
   b. Right to refuse unsafe work
   c. Storage of rigging equipment
   d. Weight distribution criteria of lifting devices

5. Using the Pythagorean Theorem, what is the unknown side of the triangle in the figure below?
   a. 9.5 feet
   b. 9.8 feet
   c. 10.3 feet
   d. 12.6 feet

![Diagram of a right triangle with sides labeled 5', 9', and unknown side 'c'.]
6. What is the load in tons on each sling for a load rigged as in the figure below?

<table>
<thead>
<tr>
<th>Load Weight</th>
<th>Sling Length</th>
<th>Hook Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 Tons</td>
<td>30 Feet</td>
<td>14 Feet</td>
</tr>
</tbody>
</table>

a. 33.420 Tons  
b. 36.318 Tons  
c. 38.571 Tons  
d. 42.650 Tons

7. What is the minimum size of chain slings required to lift a load weighing 12,000 pounds?

The chain slings are in a double basket hitch configuration at a 60 degree angle. Refer to Appendix C – Practice Question Figures.

a. 1/4 inch  
b. 3/8 inch  
c. 1/2 inch  
d. 5/8 inch
8. What is the minimum size of wire rope slings required to lift a load weighing 10,000 pounds?

The 2-Leg Bridle Hitch is choked at a 45 degree angle. Refer to Appendix C – Practice Question Figures.

- a. 9/16 inch
- b. 5/8 inch
- c. 3/4 inch
- d. 7/8 inch

9. Which of the following is NOT an acceptable method for determining the weight of a load?

- a. Load indicator
- b. Bill of lading
- c. Test lifting the load
- d. Calculating the load weight

10. What is the equivalent of 10,030 pounds in kilograms?

- a. 3,057 kg
- b. 3,238 kg
- c. 4,554 kg
- d. 7,650 kg

11. Refer to the figure below. What is the weight of the steel plate in pounds?

Steel = 490 pounds per cubic foot

- a. 1,673 lbs
- b. 1,899 lbs
- c. 2,112 lbs
- d. 2,207 lbs
12. Refer to the figure below. When calculating the weight of the heavy wall pipe, what is the volume in cubic metres?
   a. 6.525
   b. 7.643
   c. 8.390
   d. 9.819

13. Refer to the figure below. What is the weight of the open top steel tank in pounds?

   Steel = 490 pounds per cubic foot
   a. 7,270
   b. 7,745
   c. 8,206
   d. 9,112

14. When must a pre-operational inspection of a crane be done?
   a. Weekly
   b. At the end of the shift
   c. At the start of the day
   d. At the start of each shift
Refer to the folding boom load chart in Appendix C – Practice Question Figures to answer questions 15-18.

15. What is the net capacity of the crane at a 7.32 metre radius?

Weight of spreader bar – 75 kilograms
Weight of rigging – 20 kilograms

a. 8,105 kilograms  
b. 9,515 kilograms  
c. 10,735 kilograms  
d. 10,830 kilograms

16. What is the maximum radius the gross load can be placed at a height of 5.49 metres?

Weight of load – 6,200 kilograms
Weight of rigging – 75 kilograms

a. 8.23 metres  
b. 9.14 metres  
c. 10.05 metres  
d. 10.97 metres

17. What is the net capacity at a 21 foot radius? The weight of the rigging is 400 pounds.

a. 7,800 pounds  
b. 10,430 pounds  
c. 17,680 pounds  
d. 23,475 pounds

18. What is the maximum radius the gross load can be placed at a height of 15 feet?

Weight of load – 12,800 pounds
Weight of rigging – 350 pounds

a. 30 feet  
b. 33 feet  
c. 34.5 feet  
d. 36 feet
Refer to the stiff boom load chart in Appendix C – Practice Question Figures to answer questions 19-22.

19. What is the net capacity of the crane based on the configuration below?

<table>
<thead>
<tr>
<th>Outriggers and stabilizers extended</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 feet of main boom extended</td>
</tr>
<tr>
<td>Lifting with the downhaul weight</td>
</tr>
<tr>
<td>Fixed length jib stowed</td>
</tr>
<tr>
<td>Radius – 30 feet</td>
</tr>
</tbody>
</table>

a. 4,990 pounds  
b. 5,070 pounds  
c. 5,220 pounds  
d. 5,250 pounds

20. What is the net capacity of the crane based on the configuration below?

<table>
<thead>
<tr>
<th>Outriggers and stabilizers extended</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 feet of boom extended</td>
</tr>
<tr>
<td>Lifting with the one sheave block</td>
</tr>
<tr>
<td>Extendable jib stowed</td>
</tr>
<tr>
<td>Radius – 38 feet</td>
</tr>
</tbody>
</table>

a. 3,455 pounds  
b. 3,555 pounds  
c. 4,055 pounds  
d. 4,155 pounds

21. What is the net capacity of the crane based on the configuration below?

<table>
<thead>
<tr>
<th>Outriggers and stabilizers extended</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 feet of main boom extended</td>
</tr>
<tr>
<td>Lifting from the 40 foot jib</td>
</tr>
<tr>
<td>Lifting with the downhaul weight</td>
</tr>
<tr>
<td>Main boom angle – 68 degrees</td>
</tr>
</tbody>
</table>

a. 1,390 pounds  
b. 1,490 pounds  
c. 1,620 pounds  
d. 1,720 pounds
22. What is the lowest boom angle allowed when placing the gross load based on the configuration below?

<table>
<thead>
<tr>
<th>Outriggers and stabilizers extended</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 feet of main boom extended</td>
</tr>
<tr>
<td>Lifting from the 23 foot fixed length jib</td>
</tr>
<tr>
<td>Lifting with the downhaul weight</td>
</tr>
<tr>
<td>Weight of load – 1,800 pounds</td>
</tr>
<tr>
<td>Weight of rigging – 75 pounds</td>
</tr>
</tbody>
</table>

- a. 55 degrees
- b. 60 degrees
- c. 65 degrees
- d. 70 degrees
Appendix A – Commonly Used Equations

1. Converting pounds to kilograms:
   Round off answer to the nearest whole number.
   One pound = .454 kilogram
   Example:  7,800 pounds x .454 = 3,541 kilograms

2. Converting kilograms to pounds:
   Round off answer to the nearest whole number.
   One kilogram = 2.205 pounds
   Example:  3,960 kilograms x 2.205 = 8,732 pounds

3. To determine the load on each sling when using a two-leg bridle, the formula is:
   \[
   \text{load x sling length} \\
   2 \times \text{hook to load height}
   \]

4. To determine the weight of a cubed object, the formula is:
   \[ \text{length x width x thickness x unit weight} \]

5. To determine the weight of a heavy wall pipe, calculate as if the object is solid, and then subtract the volume of the “hole”.
   \[
   \frac{3.14 \times \text{diameter} \times \text{diameter} \times \text{length} \times \text{unit weight}}{4} - \frac{3.14 \times \text{diameter} \times \text{diameter} \times \text{length} \times \text{unit weight}}{4}
   \]

6. To determine the weight of a tank with an open top, the formulas are:
   Formula for bottom: \( \frac{3.14 \times \text{diameter} \times \text{diameter} \times \text{thickness} \times \text{unit weight}}{4} \)
   Formula for pipe: \( 3.14 \times \text{diameter} \times \text{length} \times \text{thickness} \times \text{unit weight} \)
7. To determine the weight of a cylinder, the formula is:

\[ 3.14 \times \text{diameter} \times \text{diameter} \times \text{length} \times \text{unit weight} \div 4 \]
Appendix B – Calculator Help Guide

This help guide contains basic information on how to use a calculator similar to the ones shown below:

![Sharp EL-520W](image1)

![Sharp EL-520X](image2)

<table>
<thead>
<tr>
<th>Keys</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ON/C</strong></td>
<td>Turns the calculator on.</td>
</tr>
<tr>
<td>2nd F + ON/C</td>
<td>Turns the calculator off.</td>
</tr>
<tr>
<td>2nd F</td>
<td>Accesses the secondary function above a key.</td>
</tr>
<tr>
<td>← / →</td>
<td>Moves the cursor left or right.</td>
</tr>
<tr>
<td>↑ / ↓</td>
<td>Moves the cursor up or down.</td>
</tr>
<tr>
<td>DEL</td>
<td>Deletes a number or function.</td>
</tr>
</tbody>
</table>
Calculates fractions.
For example, press the following keys to calculate $\frac{1}{3} + 1\frac{4}{6}$:

$$
1 \ a^{\frac{b}{c}} \ 3 \ +
$$

$$
1 \ a^{\frac{b}{c}} \ 4 \ a^{\frac{b}{c}} \ 6 \ =
$$

(Answer = 2)

Calculates percentages.
For example, press the following keys to find 24% of 120:

$$
1 \ 2 \ 0 \ \times \ 2 \ 4 \ \text{2nd F} \ 1
$$

(Answer = 28.8)

Squares a number.
For example, press the following keys to square the number 4:

$$
4 \ \sqrt{\ }
$$

(Answer = 16)

Finds the square root of a number.
For example, press the following keys to find the square root of 9:

$$
\text{2nd F} \ \sqrt{\ } \ \sqrt{\ } \ 9 \ =
$$

(Answer = 3)
## Appendix C – Practice Question Figures

### Chain Slings

<table>
<thead>
<tr>
<th>Chain Size (Inches)</th>
<th>Working Load Limit in pounds</th>
<th>2-Leg Bridle Hitch &amp; Single Basket Hitch With Legs Inclined</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single Vertical Hitch</td>
<td>Single Choker Hitch</td>
</tr>
<tr>
<td>¼</td>
<td>2,800</td>
<td>2,100</td>
</tr>
<tr>
<td>⅛</td>
<td>5,680</td>
<td>4,260</td>
</tr>
<tr>
<td>⅛</td>
<td>9,800</td>
<td>7,200</td>
</tr>
<tr>
<td>⅜</td>
<td>14,480</td>
<td>10,860</td>
</tr>
<tr>
<td>¾</td>
<td>22,640</td>
<td>16,980</td>
</tr>
<tr>
<td>⅞</td>
<td>27,360</td>
<td>20,520</td>
</tr>
<tr>
<td>1</td>
<td>38,160</td>
<td>28,620</td>
</tr>
<tr>
<td>1¼</td>
<td>57,840</td>
<td>43,380</td>
</tr>
</tbody>
</table>

When using a 2-leg bridle in a choker hitch configuration, multiply the above values by .75.

When using a double basket hitch configuration, multiply the above values by 2.

---

Note: For training and assessment use only.
### Nylon Web Slings

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,100</td>
<td>825</td>
<td>2,200</td>
<td>1,905</td>
</tr>
<tr>
<td>2</td>
<td>2,200</td>
<td>1,650</td>
<td>4,400</td>
<td>3,810</td>
</tr>
<tr>
<td>3</td>
<td>3,300</td>
<td>2,475</td>
<td>6,600</td>
<td>5,715</td>
</tr>
<tr>
<td>4</td>
<td>4,400</td>
<td>3,300</td>
<td>8,800</td>
<td>7,620</td>
</tr>
<tr>
<td>5</td>
<td>5,500</td>
<td>4,125</td>
<td>11,000</td>
<td>9,525</td>
</tr>
<tr>
<td>6</td>
<td>6,600</td>
<td>4,950</td>
<td>13,200</td>
<td>11,430</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Angle</th>
<th>60°</th>
<th>45°</th>
<th>30°</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,905</td>
<td>1,555</td>
<td>1,100</td>
<td></td>
</tr>
<tr>
<td>3,810</td>
<td>3,110</td>
<td>2,200</td>
<td></td>
</tr>
<tr>
<td>5,715</td>
<td>4,665</td>
<td>3,300</td>
<td></td>
</tr>
<tr>
<td>7,620</td>
<td>6,220</td>
<td>4,400</td>
<td></td>
</tr>
<tr>
<td>9,525</td>
<td>7,775</td>
<td>5,500</td>
<td></td>
</tr>
<tr>
<td>11,430</td>
<td>9,330</td>
<td>6,600</td>
<td></td>
</tr>
</tbody>
</table>

When using a 2-leg bridle in a choker hitch configuration, multiply the above values by 0.75.

When using a double basket hitch configuration, multiply the above values by 2.

Note: Capacities are for flat eye, twisted eye and triangle fittings. For training and assessment use only.
Wire Rope Slings

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60°</td>
</tr>
<tr>
<td>¼</td>
<td>1,150</td>
<td>860</td>
<td>2,300</td>
<td>1,100</td>
</tr>
<tr>
<td>½</td>
<td>3,000</td>
<td>2,500</td>
<td>4,400</td>
<td>3,000</td>
</tr>
<tr>
<td>¾</td>
<td>6,000</td>
<td>4,900</td>
<td>8,150</td>
<td>6,000</td>
</tr>
<tr>
<td>1</td>
<td>9,900</td>
<td>8,050</td>
<td>12,300</td>
<td>9,900</td>
</tr>
<tr>
<td>1¼</td>
<td>13,750</td>
<td>10,300</td>
<td>20,400</td>
<td>17,700</td>
</tr>
<tr>
<td>1½</td>
<td>17,950</td>
<td>13,450</td>
<td>27,500</td>
<td>23,800</td>
</tr>
<tr>
<td>1⅛</td>
<td>22,750</td>
<td>17,000</td>
<td>35,900</td>
<td>31,100</td>
</tr>
<tr>
<td>1⅜</td>
<td>28,200</td>
<td>21,200</td>
<td>45,500</td>
<td>39,400</td>
</tr>
<tr>
<td>1⅝</td>
<td>34,800</td>
<td>26,100</td>
<td>56,400</td>
<td>48,800</td>
</tr>
<tr>
<td>1⅞</td>
<td>41,300</td>
<td>31,000</td>
<td>69,600</td>
<td>60,300</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>71,500</td>
</tr>
</tbody>
</table>

When using a 2-leg bridle in a choker hitch configuration, multiply the above values by .75.

When using a double basket hitch configuration, multiply the above values by 2.

Note: For training and assessment use only.
Eye Bolts

<table>
<thead>
<tr>
<th>Stock Diameter (Inches)</th>
<th>Working Load Limit in pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical</td>
</tr>
<tr>
<td>1/4</td>
<td>500</td>
</tr>
<tr>
<td>5/32</td>
<td>800</td>
</tr>
<tr>
<td>3/16</td>
<td>1,200</td>
</tr>
<tr>
<td>7/32</td>
<td>2,200</td>
</tr>
<tr>
<td>1/2</td>
<td>3,500</td>
</tr>
<tr>
<td>5/16</td>
<td>5,200</td>
</tr>
<tr>
<td>7/8</td>
<td>7,200</td>
</tr>
<tr>
<td>1</td>
<td>10,000</td>
</tr>
<tr>
<td>1 1/4</td>
<td>15,200</td>
</tr>
<tr>
<td>1 1/2</td>
<td>21,400</td>
</tr>
</tbody>
</table>

**SHOULDER BOLTS**

Correct for Shoulder Eye and Ring Bolts
Providing loads are reduced to account for angular loading

- Nut must be properly torqued.
- Ensure that bolt is tightened into place.
- Ensure that tapped hole is deep enough.
- Pack with washers to ensure that shoulder is firmly in contact with surface.

Incorrect
- Shoulder must be in full contact with surface.

**SHOULDERLESS BOLTS**

Correct
- Shoulderless eye and ring bolts are designed for vertical loads only.

Incorrect
- If shoulderless eye and ring bolts are pulled at an angle as shown they will either bend or break

Results In

Note: For training and assessment use only.
Folding Boom Load Chart

Load charts are for training purposes only.
Stiff Boom Load Charts

Load charts are for training purposes only.
Stiff Boom Load Charts (cont’d)

Load charts are for training purposes only.

BC Association for Crane Safety (BCACS)
www.bcacs.ca

Getting Ready Guide – Stiff Boom Unlimited Tonnage
Version 9 – November 27, 2011
Appendix D – Glossary of Common Crane Terms

Many terms are used by crane operators which refer to crane function, assembly, operation and maintenance. The following glossary provides a list and brief definition of fundamental terms used in the crane industry.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulator</td>
<td>A container in which fluid is stored under pressure as a source of hydraulic energy</td>
</tr>
<tr>
<td>Annually</td>
<td>Once a year</td>
</tr>
<tr>
<td>Anti-Two Block System</td>
<td>A system of electromechanical devices used to prevent the crane operator from two blocking the crane. See Two Block</td>
</tr>
</tbody>
</table>
| Audio/Visual Warning System | 1. Alarm device that signals the operator of low engine oil pressure, high engine coolant temperature and high hydraulic oil and transmission oil temperature.  
2. Device utilizing buzzer and/or lights as a signal of approaching two block and/or overload condition. See Rated Capacity Indicator. |
<p>| Auxiliary Lifting Sheave    | A unit which connects to the boom head and is used for reeving winch rope for a second hoist line. Also know as an Auxiliary Boom Head or Rooster Sheave. |
| Backward Stability          | Resistance to overturning of the crane in rearward direction.               |
| Bail                        | A frame equipped with sheaves and connected to the gantry. The bail is used in conjunction with the boom hoist drum and bridle to alter the crane’s boom angle. |
| Base Section                | The lower most section of a lattice boom or luffing jib.                    |
| Basic Boom                  | Lattice boom attachment made up of only the base and top sections of the boom. |
| Basic Jib                   | Jib attachment made up of only the base and top section of the jib.         |
| Boom Angle                  | The angle above or below horizontal of the longitudinal axis of the boom.    |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boom Angle Indicator</td>
<td>An accessory which measures the angle of the boom relative to horizontal.</td>
</tr>
<tr>
<td>Boom Chord</td>
<td>A main corner structural member of a boom.</td>
</tr>
<tr>
<td>Boom Foot</td>
<td>Base of boom where it attaches to the upper revolving frame.</td>
</tr>
<tr>
<td>Boom Hoist</td>
<td>Rope drum and its drive, or other mechanism, for controlling the angle of a lattice boom crane.</td>
</tr>
<tr>
<td>Boom Length</td>
<td>The distance along a straight line through the centreline of the boom foot pin to the centreline of the boom head sheave shaft, measured along the longitudinal axis of the boom.</td>
</tr>
<tr>
<td>Boom Section</td>
<td>Individual lattice structures which are pinned together to form the boom attachment. Crane lattice booms are usually in two basic sections, tip and base. Such booms may be lengthened by insertion of one or more additional extension sections.</td>
</tr>
<tr>
<td>Bridle</td>
<td>A frame equipped with sheaves and connected to the boom by stationary ropes called pendants. The bridle is used in conjunction with the boom hoist drum and bail to alter the crane's boom angle.</td>
</tr>
<tr>
<td>Cantilever</td>
<td>Any unsupported boom or jib section that projects beyond the supporting point.</td>
</tr>
<tr>
<td>Capacity Chart</td>
<td>A chart for the crane which gives rated lifting capacities for the crane under different load conditions and setups. Capacity charts are found on the crane or in the Crane Rating Manual.</td>
</tr>
<tr>
<td>Carbody</td>
<td>The crawler carrier upon which the revolving upper frame is mounted.</td>
</tr>
<tr>
<td>Carrier</td>
<td>The portion of the crane located below the turntable bearing.</td>
</tr>
<tr>
<td>Cavitation</td>
<td>A condition where air is induced into a cavity, line, or chamber normally filled with oil. This condition can cause damage to pumps, cylinders, valves, etc.</td>
</tr>
<tr>
<td>Check Valve</td>
<td>A valve which permits flow in one direction only.</td>
</tr>
<tr>
<td>Chord</td>
<td>A main corner structural member of a lattice boom section.</td>
</tr>
<tr>
<td>Clamshell Bucket</td>
<td>A device consisting of two or more similar scoops hinged together and used for digging and moving material.</td>
</tr>
</tbody>
</table>
Closing Line
The rope reeved from hoist drum to control closing of clamshell bucket.

Clutch
A friction, electromagnetic, hydraulic, or pneumatic device for engagement or disengagement of power.

Concrete Bucket
Bucket for handling wet concrete, usually handled on lifting crane for hoisting to dumping location.

Counterweight
Weight used to supplement the weight of the crane in providing stability for lifting loads.

Cracking Pressure
The pressure at which a pressure actuated valve begins to open to allow flow.

Cylinder
A device which converts fluid power into mechanical force and motion. It usually consists of a moveable element such as a piston and a piston rod, which operates within a cylindrical bore.

Derricking
Operation of changing boom angle in a vertical plane. See Boom Hoist.

Dragline
Machines with dragline attachments are generally used to excavate material from below the grade on which the machine is placed. A dragline bucket is loaded by the drag rope pulling it toward the machine, it is lifted and carried by the hoist rope reeved over the boom point sheave, and is balanced by the dump rope interconnecting the drag and hoist ropes.

Drum Rotation Indicator
A device that is used to indicate winch drum motion and can also be used to monitor speed.

Extension (Boom or Jib)
Sections of the boom or jib which come in various lengths and are used to increase the overall length of the basic boom or jib.

Filter
A device which functions to remove insoluble contaminants from a fluid by a porous media.

Force
Any cause which tends to produce or modify motion. In hydraulics, total force is expressed by the product of pressure (P) and the area of the surface (A) on which the pressure acts (Force = P X A).

Frame
Structure on which either upper or carrier machinery is attached.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Free-Fall</strong></td>
<td>Lowering of the hook and or load without using power. The motion is caused by gravity and must be controlled by a brake.</td>
</tr>
<tr>
<td><strong>Friction</strong></td>
<td>The property which tends to resist the relative motion of one surface in contact with another surface. It always exerts a &quot;Drag&quot; in the direction opposite of the motion, thus consumes power.</td>
</tr>
<tr>
<td><strong>Function Limiter</strong></td>
<td>Devices incorporated into the anti—two block system or rated capacity indicator system which will disable the crane function of winch up, telescope out and or boom down (as applicable) as two block or overload situations approach.</td>
</tr>
<tr>
<td><strong>Gradeability</strong></td>
<td>The slope which a machine can climb expressed as a percentage (45° equals 100% slope).</td>
</tr>
<tr>
<td><strong>Ground Pressure</strong></td>
<td>Weight of machine divided by the area of the surface directly supporting the machine.</td>
</tr>
<tr>
<td><strong>Hoist</strong></td>
<td>Function of lifting and lowering the loads.</td>
</tr>
<tr>
<td><strong>Hoist Drum</strong></td>
<td>A rotating cylindrical spool with side flanges used to wrap the winch rope during the raising and lowering of the load with the winch.</td>
</tr>
<tr>
<td><strong>Hoist Rope</strong></td>
<td>The wire rope used to reeve the winch and the attachments for lifting loads.</td>
</tr>
<tr>
<td><strong>Hook Block</strong></td>
<td>Block with hook attached used in lifting service. It may have a single sheave for two or three part line, or multiple sheaves for four or more parts of line.</td>
</tr>
<tr>
<td><strong>House Assembly</strong></td>
<td>The housing which covers the machinery mounted on the upper revolving frame.</td>
</tr>
<tr>
<td><strong>Hydraulic Reservoir</strong></td>
<td>The storage tank for hydraulic fluid.</td>
</tr>
<tr>
<td><strong>Idler Roller</strong></td>
<td>Rollers of track mechanism which are not power driven but are used to maintain proper tension on the track.</td>
</tr>
<tr>
<td><strong>Jib</strong></td>
<td>A pendant supported extension attached to the boom or fly head to provide added boom length for handling specified loads. The jib may be in line with the boom or offset.</td>
</tr>
<tr>
<td><strong>Lattice Boom</strong></td>
<td>Lattice structure consisting of multiple sections, pinned together to a specific length and their support system.</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
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<td>-----------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lattice Boom</td>
<td>Boom of open construction with angle or tubular lacing between main corner members (chords) in the form of a truss.</td>
</tr>
<tr>
<td>Lifting Capacity</td>
<td>The rated load for any given load radius and boom angle under specified operating conditions and machine configurations.</td>
</tr>
<tr>
<td>Line Pull</td>
<td>The rope pull generated off a rope drum or lagging at a specified pitch diameter.</td>
</tr>
<tr>
<td>Line Speed</td>
<td>The feet per minute that a load can be raised or lowered.</td>
</tr>
<tr>
<td>Live Mast</td>
<td>Frame hinged at or near the boom foot and extending above the cab for use in connection with supporting a boom. Head of mast is usually supported and raised or lowered by the boom hoist ropes.</td>
</tr>
<tr>
<td>Load Indicator</td>
<td>A device for measuring and displaying the net load being lifted.</td>
</tr>
<tr>
<td>Load Line</td>
<td>Another term for &quot;Hoist Rope&quot;. In lifting crane service it refers to the main hoist. The secondary hoist is referred to as a &quot;Whip Line&quot;.</td>
</tr>
<tr>
<td>Load Moment Indicator</td>
<td>See Rated Load Indicator.</td>
</tr>
<tr>
<td>Load Moment Limiter (LML)</td>
<td>A device which aids the operator by automatically sensing the overturning moment on the crane, i.e. load X radius. It compares this lifting condition to the crane's rated capacity, provides an audible visual signal when the loading conditions approach the rated capacity, and when the rated capacity is reached and/or exceeded, it limits crane functions that would result in an overload condition.</td>
</tr>
<tr>
<td>Load radius</td>
<td>The horizontal distance from the centreline of rotation of the upper to the centre of gravity of the suspended load.</td>
</tr>
<tr>
<td>Luffing Jib</td>
<td>A crane attachment adaptable to a crane boom. The luffing jib can be raised or lowered from the operator’s cab while the main boom is stationary. The luffing jib allows the crane to be set up close to a high building or structure and place an object on the roof of a building while maintaining close proximity to the building.</td>
</tr>
<tr>
<td>Mat</td>
<td>Support, usually of timber or wire construction, for supporting pontoons or tracks on soft surfaces to add stability and or distribute machine loads (reduce ground pressure).</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>Midpoint Suspension</td>
<td>Wire rope pendants used to support the centre portion of a long lattice boom when it is being raised from a horizontal position.</td>
</tr>
<tr>
<td>Motor (Hydraulic)</td>
<td>A rotary motion device which changes hydraulic energy into mechanical energy.</td>
</tr>
<tr>
<td>Offset Fly</td>
<td>A hydraulic crane fly section that is capable of being pinned at different angles.</td>
</tr>
<tr>
<td>Oil Cooler</td>
<td>A heat exchanger used to remove heat from the hydraulic or transmission fluid.</td>
</tr>
<tr>
<td>Operational Aid</td>
<td>An accessory that provides information to facilitate operation of a crane or that takes control of particular crane functions without action of the operator when a limiting condition is sensed.</td>
</tr>
<tr>
<td>Operator's Cab (Upper Cab)</td>
<td>A housing which covers the operator's station.</td>
</tr>
<tr>
<td>Outrigger</td>
<td>An extendable supporting device used to level the crane and increase stability.</td>
</tr>
<tr>
<td>Outrigger Beam</td>
<td>The part of the outrigger which extends horizontally and acts as the support for the outrigger jack.</td>
</tr>
<tr>
<td>Outrigger Jack</td>
<td>The hydraulic cylinder on the outrigger beam which extends vertically to raise and lower the crane for leveling.</td>
</tr>
<tr>
<td>Pawl (dog)</td>
<td>A pivoting locking lever which will permit movement in only one direction. Movement in the opposite direction can be achieved only by manually releasing the mechanism.</td>
</tr>
<tr>
<td>Pendant</td>
<td>A supporting rope, which maintains a constant distance between its points of attachment.</td>
</tr>
<tr>
<td>Periodic</td>
<td>Time intervals usually determined by crane manufacturer when crane inspections are required.</td>
</tr>
<tr>
<td>Pick and Carry</td>
<td>The crane operation of lifting a load and traveling with it suspended.</td>
</tr>
<tr>
<td>Pilot Pressure</td>
<td>Hydraulic pressure used to actuate or control hydraulic components.</td>
</tr>
<tr>
<td>Pinion</td>
<td>The small gear in a gear train which drives the other gears.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>-------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pitch Diameter</td>
<td>Root diameter of drum, lagging, or sheave, plus the diameter of the rope.</td>
</tr>
<tr>
<td>Planetary</td>
<td>A set of gears used to either speed up or slow down the input or the output to gain speed or power whichever is applicable.</td>
</tr>
<tr>
<td>Pontoon</td>
<td>The support which attaches to the outrigger jack to increase the supporting area.</td>
</tr>
<tr>
<td>Power Take-Off (PTO)</td>
<td>Device used for the transfer or transmission of engine power to the operating functions of the crane.</td>
</tr>
<tr>
<td>Pressure</td>
<td>Force per unit of area usually expressed in pounds per square inch (psi) or Kilopascals (kPa)</td>
</tr>
<tr>
<td>Pump (Hydraulic)</td>
<td>A device which converts mechanical force and motion into hydraulic fluid flow.</td>
</tr>
<tr>
<td>Radius</td>
<td>The horizontal distance from the centerline of rotation of the crane, with no load, to the centre of gravity of the hook or suspended load.</td>
</tr>
<tr>
<td>Rated Capacity Indicator (Rated Load Indicator)</td>
<td>A device that automatically monitors radius, load weight, and load rating and warns the crane operator of an overload condition.</td>
</tr>
<tr>
<td>Rated Capacity Limiter (RCL)</td>
<td>A device that automatically monitors radius, load weight, and load rating and prevents movements of the crane that would result in an overload condition.</td>
</tr>
<tr>
<td>Reieving</td>
<td>Passing of ropes over pulleys and or sheaves.</td>
</tr>
<tr>
<td>Relief Valve</td>
<td>A pressure operated valve which by—passes pump delivery to the reservoir, limiting system pressure to a predetermined maximum value.</td>
</tr>
<tr>
<td>Reservoir</td>
<td>A container for storage of fluid in a fluid power system.</td>
</tr>
<tr>
<td>Shall</td>
<td>The word shall is to be understood as mandatory.</td>
</tr>
<tr>
<td>Side Frame</td>
<td>Supporting structure of the track mechanism. Side frames are attached to the crawler carbody and may be extendable.</td>
</tr>
<tr>
<td>Sprocket</td>
<td>The driving element of the track mechanism. Receiving power through the drive mechanism, the sprocket meshes with the track to travel the crawler.</td>
</tr>
<tr>
<td>Swing (Slew)</td>
<td>The rotation of the upper portion of the crane.</td>
</tr>
</tbody>
</table>
Swing Brake  A brake which is used to resist the rotation of the upper during normal, stationary crane operations.

Swing Lock  A mechanical lock that engages the upper with the lower of the crane. The swing lock is used during a pick & carry operation (moving loads on site).

Swing Motor  Hydraulic device which uses a planetary to rotate the upper on the carrier.

Tailswing  The distance from the centerline of rotation of the upper frame to the extreme rear swing arc of the counterweight.

Third Drum  A third hoist drum, in addition to two main hoist drums, often used in pile driving.

Tip Section  The outermost section of a boom. This section contains the sheave/sheaves for reeving hoist lines.

Torque  Turning or twisting force usually measured in foot-pounds (ft-lb) or Newton meters (Nm).

Track Roller  Rollers of track mechanism which are not power driven, but are used to support the tread member and guide the track along the ground.

Tubular Jib  Multiple section lattice extensions supported by pendants and attached to the main boom head.

Turntable Bearing  A large bearing which attaches the upper to the carrier allowing the upper to rotate on the carrier.

Two Block  The situation when the crane's hook block or hook ball contacts the attachment's head machinery.

Two Block Warning System  A system of electromechanical devices used to warn the crane operator of impending two block condition, also known as an Anti-two block system.

Upper  The portion of the crane located above the turntable bearing.

Upper Revolving Frame  The main structure of the upper section of the crane which serves as mounts for other components of the upper.

Valve  A device for controlling flow rate, flow direction, or pressure of a fluid.
| **Viscosity** | The resistance to flow. High viscosity indicates a high resistance; low viscosity, a low resistance. |
| **Whip Line** | Secondary hoist line. |
| **Winch** | Function of lifting and lowering loads. |
| **Winch Drum** | A rotating cylindrical spool with side flanges used to contain the winch rope during the raising and lowering of the load with the winch. |
| **Winch Rope** | The wire rope used to reeve the block and the attachments for lifting loads. |
Appendix E – Glossary of Rigging Terms

The following glossary provides a list and brief definition of rigging terms used in the crane industry.

**Angle of loading**
Inclination of a leg or branch of a sling measured from the horizontal or vertical plane; provided that an angle of loading of five degrees or less from the vertical may be considered a vertical angle of loading.

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

**Bridle hitch**
Sling composed of multiple legs with the top ends gathered in a fitting that goes over the lifting hook. The bridle can be wire rope, chain or synthetic slings.

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

**Designated**
Selected or assigned by the employer or the employer’s representative as being qualified to perform specific duties.

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

**Link**
A single ring of a chain.

**Master coupling link**
Alloy steel welded coupling link used as an intermediate link to join alloy steel chain to master links.

**Master link or gathering ring**
Forged or welded steel link used to support all members (legs) of an alloy steel chain sling or wire rope sling.

**Mechanical coupling link**
Non-welded, mechanically closed steel link used to attach master links, hooks, etc., to alloy steel chain.

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

**Rated capacity or working load limit**
Maximum working load permitted by the provisions of a section.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach</td>
<td>The effective length of an alloy steel chain sling measured from the top bearing surface of the upper terminal component to the bottom bearing surface of the lower terminal component.</td>
</tr>
<tr>
<td>Sling</td>
<td>An assembly which connects the load to the material handling equipment.</td>
</tr>
<tr>
<td>Sling manufacturer</td>
<td>Person or organization that assembles sling components into their final form for sale to users.</td>
</tr>
<tr>
<td>Strand laid endless sling-mechanical joint</td>
<td>Wire rope sling made endless from one length of rope with the ends joined by one or more metallic fittings.</td>
</tr>
<tr>
<td>Strand laid grommet-hand tucked</td>
<td>Endless wire rope sling made from one length of strand wrapped six times around a core formed by hand tucking the ends of the strand inside the six wraps.</td>
</tr>
<tr>
<td>Vertical hitch</td>
<td>Method of supporting a load by a single, vertical part or leg of the sling.</td>
</tr>
</tbody>
</table>
Appendix F – Practice Question Answer Key

1. According to Occupational Health and Safety Regulations, what is the absolute minimum distance that must be maintained between a crane and a power line energized with 750v to 75 kv (75,000 volts)? Answer: A

2. What does the hand signal indicate in the figure below? Answer: A

3. What is the radio protocol between a mobile piece of equipment and a tower crane sharing the same workplace? Answer: B

4. What does Part 3 of the WorkSafeBC Occupational Health and Safety regulation cover, if as an operator you are presented with a load to lift that you have concerns about? Answer: B

5. Using the Pythagorean Theorem, what is the unknown side of the triangle in the figure below? Answer: C

   \[ A = 5 \text{ feet}, \ B = 9 \text{ feet}. \text{ Formula: } A^2 + B^2 = C^2. \]

6. What is the load in tons on each sling for a load rigged as in the figure below? Answer: C

   \[ \text{Formula: } \text{Load on Each Sling Leg} = \frac{\text{Load}(W) \times \text{Sling Length}(L)}{2 \times \text{Hook to Load Height}} \]

7. What is the minimum size of chain slings required to lift a load weighing 12,000 pounds? Answer: B

8. What is the minimum size of wire rope slings required to lift a load weighing 10,000 pounds? Answer: C

9. Which of the following is NOT an acceptable method for determining the weight of a load? Answer: C

10. What is the equivalent of 10,030 pounds in kilograms? Answer: C

11. Refer to the figure below. What is the weight of the steel plate in pounds? (Steel = 490 pounds per cubic foot) Answer: B

   \[ \text{Formula: } \text{length} \times \text{width} \times \text{thickness} \times \text{unit weight}. \text{ Unit weight is 490 pounds} \]

12. Refer to the figure below. What is the volume of the heavy wall pipe in cubic metres? Answer: A

   To determine the volume of the heavy wall pipe, calculate as if the object were a solid shape and then subtract the volume of the “hole”.

   \[ \text{Formula: } 3.14 \times \text{diameter} \times \text{diameter} \times \text{length} \div 4 \text{ minus } 3.14 \times \text{diameter} \times \text{diameter} \times \text{length} \div 4 \]
13. Refer to the figure below. What is the weight of the open top steel tank in pounds? (Steel = 490 pounds per cubic foot) Answer: B

Two calculations must be made to answer this question. The weight of the “pipe” must be added to the weight of the tank bottom.

Formula for bottom: \[3.14 \times \text{diameter} \times \text{diameter} \times \text{thickness} \times \text{unit weight}\] Divided by 4

Formula for pipe: \[3.14 \times \text{diameter} \times \text{length} \times \text{thickness} \times \text{unit weight}\]

14. When must a pre-operational inspection of a crane be done? Answer: D

15. What is the net capacity of the crane at a 7.32 metre radius? Answer: A (8,105 kilograms)

The gross capacity at a 7.32 metre radius is 8,200 kilograms. The weight of the spreader bar and the rigging must be deducted from the gross capacity to determine the net capacity. 8,200 minus 95 = 8,105 kilograms

16. What is the maximum radius the gross load can be placed at a height of 5.49 metres? Answer: C (10.05 metres)

Gross load: 6,200 plus 75 = 6,275 kilograms. The gross capacity at a 10.05 metre radius and a height of 5.49 metres is 6,520 kilograms. The gross capacity is greater than the gross load of 6,275 kilograms.

17. What is the net capacity at a 21 foot radius? The weight of the rigging is 400 pounds. Answer: C (17,680 pounds)

The gross capacity at a 21 foot radius is 18,080 pounds. The weight of the rigging must be deducted from the gross capacity to determine the net capacity. 18,080 minus 400 = 17,680 pounds

18. What is the maximum radius the gross load can be placed at a height of 15 feet? Answer: B (33 feet)

Gross load: 12,800 plus 350 = 13,150 pounds. The gross capacity at a 33 foot radius and a height of 15 feet is 14,375 pounds. The gross capacity is greater than the gross load of 13,150 pounds.
19. What is the net capacity of the crane based on the configuration below? Answer: B

**Deductions from gross capacity**
- Downhaul weight: 180 pounds
- Fixed length jib stowed: 150 pounds
- Total deductions: 330 pounds

The gross capacity at a 30 foot radius is 5,400 pounds.
5,400 minus 330 = 5,070 pounds
The net capacity is 5,070 pounds.

20. What is the net capacity of the crane based on the configuration below? Answer: A

**Deductions from gross capacity**
- One sheave block: 375 pounds
- Extendable jib stowed: 270 pounds
- Total deductions: 645 pounds

There is no capacity for a 38 foot radius so we must use the next longer radius to determine gross capacity.
- The gross capacity at a 40 foot radius is 4,100 pounds.
- 4,100 minus 645 = 3,455 pounds
- The net capacity is 3,455 pounds.

21. What is the net capacity of the crane based on the configuration below? Answer: C

**Deductions from gross capacity**
- Downhaul weight: 180 pounds

There is no capacity listed for a 68 degree boom angle so we must use the next lower boom angle to determine gross capacity.
- The gross capacity at a 65 degree boom angle is 1,800 pounds.
- 1,800 minus 180 = 1,620 pounds
- The net capacity is 1,620 pounds.

22. What is the lowest boom angle allowed when placing the gross load based on the configuration below? Answer: C

**Gross load to be lifted**
- Downhaul weight: 180 pounds
- Load: 1,800 pounds
- Rigging: 75 pounds
- Gross load: 2,055 pounds

The gross capacity at a 65 degree boom angle is 2,400 pounds which is greater than the gross load of 2,055 pounds.