

Department of Labor and Industry Elevator Licensing

License Examination Guide

The information in this guide is provided by the Licensing Unit of the Department of Labor and Industry to ensure that applicants for personal elevator licenses administered by the department understand basic qualifications, knowledge areas, examination criteria and format to enable them to successfully complete requirements to become licensed. Although this document contains a significant amount of detail, it should not be construed by applicants to be inclusive of all information necessary to successfully pass a license examination, and subsequently become licensed by the department. It is the applicant's responsibility to adequately prepare to successfully complete the license examination process.

Note: Master elevator constructor and journeyman elevator constructor examinations will not be based on elevator technology as identified in this guide until January 1, 2014. In the interim, applicants for these license types should focus on the electrical knowledge areas identified in this guide.

The examination question format is based on the previous elevator electrical license examination which has been in effect since July 1, 2005.

This test has been developed to recognize the Statutory change from the existing elevator electrical licenses to an elevator licenses that recognizes the electrical and mechanical work being performed on various forms of elevator related devices.

In addition to elevator and electrical theory, examinations are based on the following codes:

The ASME A17.1- 2004 Safety Code for Elevators and Escalators, with the 2005 supplement and addenda

The ASME A17.3-2002 Safety Code for Existing Elevators and Escalators

The ASME A18.1-2005 Safety Code for Platform Lifts and Stairway Chairlifts

The ASME A90.1-2003 Safety Code for Belt manlifts

The ASME B20.1-2003 Safety Code for Conveyors

The 2011 Field Employee Safety Handbook

The 2014 National Electrical code

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Examination

Purpose

Successfully completing a license examination provides evidence that the applicant possesses the necessary knowledge and expertise to be licensed in a specific profession or for a specific scope of work within a profession.

Licensing examinations are designed to assess the applicant's competence after they have completed their qualifying education, training, and experience. Licensing examinations are designed to assess higher level skills than academic examinations by assessing the applicant's ability to apply the competencies they gained from their education, training, and experience in actual practice.

Licensing examinations are intended to assure the public that the person passing an examination is qualified to practice within the scope of the license without causing harm to the public.

The purpose of this license examination guide is to provide applicants with awareness of knowledge areas covered by specific license examinations, question and examination format, degree of difficulty for specific license examinations, length of examination, and length of time allowed to complete their examination. Applicants are encouraged to review this entire guide to ensure their understanding of the examination process and governing rules.

General

1. Examination instructions are intended to be clear, concise, and complete. No questions may be asked of the examination proctor (test administrator).
2. Examination questions and answer selections have been developed to be clear, concise, and complete. Applicants should understand the question without having to read the answer selections. No questions may be asked of the examination proctor (test administrator).
3. Examination questions relate to knowledge areas within the scope of the applicable license.
4. Examination questions reasonably cover the knowledge areas within the scope of the applicable license.
5. Examination questions relate to knowledge areas that are common. The examination knowledge areas are within the areas of work generally experienced by applicants for, or persons holding, the class of the applicable license.
6. Applicants are allowed to use the reference standards listed below and an electronic calculator during their entire examination. All reference materials and a calculator are provided by the Department. No other materials or electronic devices, including cell phones are allowed in the building. Although reference materials are available for the entire examination, applicants should be adequately prepared and not rely on provided reference materials to answer all questions. The majority of questions are intended to be answered without the applicant needing to refer to reference materials.

A copy of the ASME A17.1-2004 (05 1a), ASME A17.3-2002, ASME A18.1-2005, ASME A90.1-2003, ASME B20.1-2003 Safety Codes and the National Electrical Code is provided in the soft cover format and do not include tabs or other aids. The edition of the listed standards is the edition adopted as part of the state building code at the time the examination is administered. The electronic calculator is of the common desk type that includes addition, subtraction, multiplication, division, square root, and percentage functions. The Laws and Rules Booklet provided for the examination is in the Department's current format and represents the laws and rules in effect at the time the examination is administered.

7. Applicants observed giving or receiving assistance from other applicants or outside parties shall be automatically failed and required to submit a new application, including submission of required fees.

8. Applicants observed copying questions or making notes regarding questions shall be automatically failed and required to submit a new application, including submission of required fees.
9. During their examination, applicants may leave the examination room to use the restroom, but are not permitted to leave the building. Applicants leaving the building prior to completing and turning in their examination shall be automatically failed and required to submit a new application, including submission of required fees.
10. In addition to being monitored by the on-site proctor, the examination room may be electronically monitored.
11. Examination materials, including completed examinations and scoring keys are classified as nonpublic by Minnesota Statutes section 13.34. Applicants will only be provided with access to examination materials during the time they are being examined.

Question Format

1. Examination questions are formatted in a manner that requires the applicant to demonstrate mastery of the knowledge area.
2. Questions that require calculations resulting in an absolute answer may not always include multiple-choice answers.
3. Variables in a question ensure that the appropriate knowledge area(s) or code rule(s) must be applied to arrive at the correct answer.
4. Multiple-choice answer selections for knowledge areas with multiple conditions or requirements are worded in a manner that requires the applicant to demonstrate knowledge of the subject matter and minimize the applicant's opportunity to select a correct answer(s) based on key words.
5. Questions requiring more than one multiple-choice answer selection are clearly identified, including the number of correct answer selections. This is a companion format to the negative-response format identified in 6 below.
6. Questions with a negative-response format such as "which of the following does **not** apply," are only used in limited instances. This is a companion format to the multiple-correct answer format identified in 5 above.
7. Negative response questions and questions requiring more than one multiple-choice answer are limited to: a list of conditions, a list of requirements, or a list of methods.
8. Incorrect multiple-choice answer selections are "plausible."
9. Questions may include extraneous information.
10. Unless stated otherwise in specific questions, all questions and related answers related to electrical theory or code assume a "unity power factor".
11. As many as 5 variations of an examination may be administered on the same examination date.
12. Individual examinations are modified not less than three times each code cycle.
13. Examination questions and suggestions are accepted on an on-going basis from interested parties and become part of an examination question database from which examinations are created.
14. Some questions relate to code violations repeatedly made by license holders. Practical experience must be augmented by quality training to ensure the applicant's complete and accurate understanding of the subject matter.

Degree of Difficulty

1. Each examination question is assigned a degree of difficulty rating from 1 to 5, with 5 being the most difficult. "Degree of difficulty" as used in administration of the department's license examinations has no relationship to academic "grade point average" achievement.
2. Questions rated least difficult (lowest) are those that relate to a single knowledge area, such as definitions or those requiring the application of a single code rule, or do not require complex mathematical calculations.
3. Questions rated most difficult (highest) are those that require the application of multiple code rules or require multiple or complex mathematical calculations.
4. Each examination is assigned a degree of difficulty range that is commensurate with the responsibility or authority of the applicable license.
5. Approximately 50% of specific license examination questions have a degree of difficulty within the overall "degree of difficulty" range for the license type.
6. The examination for those license types that allow the holder of the license to be the "responsible licensed person" for an employer or contractor have an average degree of difficulty range between 2.5 to 3.5. This category includes master elevator constructor, and limited master elevator constructor.
7. The examination for those license types that require the license holder to be provided with general supervision by a person holding a license type identified in 6 above have an average degree of difficulty range between 1.5 to 2.5. These license types include the journeyman elevator constructor and limited journeyman elevator constructor.
8. Examination questions are structured to use words and phrases appropriate to the license, without using non code and theory terms that would unnecessarily increase the degree of difficulty.

Length of Examination

1. The license examinations for the master, limited master, elevator journeyman, and limited elevator journeyman constructors consist of 80 questions.
2. Unless stated otherwise, all examination questions have the same point value. Partial points are not given - either full point credit or zero point credit is awarded for each question.
3. The passing score for all examinations is 70 percent.
4. The time allowed to complete all examinations is 5 ½ hours.

Examination Results

1. Examination results are mailed to applicants within two weeks of the examination. Examination results are not provided to applicants by telephone or e-mail.
2. Examination result letters mailed to applicants who passed their examinations will contain directions on how to obtain their license.
3. Examination result letters mailed to applicants who failed their examinations will contain directions on how to make subsequent application.

Examination Review or Appeal

1. Examinations with scores within five (5) percentage points of passing are rechecked to ensure accuracy.
2. Written or oral reviews of individual examinations are not available to applicants. Applicants may provide written comment to the Department's licensing unit on specific examination questions.
3. Applicants who fail any examination are prohibited from retaking the same or greater class of license examination for a period of not less than 30 days. "Greater class of license" is one that includes greater authority or scope of work. The rank by authority or scope of work for licenses administered by the Department are:

Master Elevator Constructor, Journeyman Elevator Constructor.
Limited Master Elevator Constructor, Limited Journeyman Elevator Constructor.

Applicants may take a lower class of license without waiting the 30 days; however, they must submit an application and meet the qualifications for the lower class of license to be approved to take the examination for the lower class of license.

Sample Questions

The sample questions are intended to identify the various question formats that are used in the examinations. The knowledge areas used in the sample questions may not be applicable to all classes of examination.

1. Which **three** of the following conditions apply where Type NM cables are permitted to enter a panelboard through a nonflexible raceway without the cables being secured to the panelboard? Select all **three** that apply.
 - A. The raceway shall be exposed.
 - B. Because the cables are not secured to the enclosure with a fitting, they shall be strapped within 8 inches, measured along the cable sheath, of the outer end of the raceway.
 - C. Ampacity adjustment factors do not apply unless the raceway is longer than 24 inches.
 - D. The number of cables installed in the raceway is not limited where the raceway length is not more than 24 inches.
 - E. The raceway shall be at least 18 inches, but not more than 120 inches long.

Answer: A, C, E NEC 312.5(C)

Question demonstrates "multiple correct answer" multiple-choice question format.

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2. Which of the five statements listed below **does not** correctly state code requirements pertaining to the installation of receptacle outlets installed to serve counter top surfaces in the kitchen of a dwelling unit located in a multifamily dwelling?
- A. A receptacle outlet shall be installed at each wall counter space that is 12" or wider.
 - B. The required receptacle outlets shall be supplied by not less than two small-appliance branch circuits.
 - C. If located above, the receptacle outlets shall not be located more than 20" above the counter top.
 - D. Only receptacle outlets installed within 6" of the outside edge of the sink(s) shall be required to be provided with ground-fault circuit-interrupter protection for personnel.
 - E. Receptacle outlets shall be installed so that no point along the wall line is more than 24" measured horizontally from a receptacle outlet.

Answer D NEC 210.52

Question demonstrates "negative-response" multiple-choice question format.

3. A feeder supplies three 460-volt, three-phase, 1740 RPM, Design B, alternating-current motors. The motors have the following nameplate ratings: 25 horsepower, 28.4 amperes; 15 horsepower, 18.2 amperes; and 10 horsepower, 11.3 amperes. Assuming all the motors are operating under continuous duty, what minimum size XHHW-2 feeder circuit conductors are required to supply the motor load? The conductor terminations are rated at 75°C.

Answer 4 AWG NEC 430.6, 430.24, 430.250, 310.16

Question demonstrates "absolute answer" and "extraneous information" question format.

4. When a single equipment grounding conductor is run with multiple branch circuits in the same raceway or cable, how shall it be sized?
- A. The equipment grounding conductor shall be sized for the average rating of all the overcurrent devices protecting the conductors in the raceway or cable.
 - B. The equipment grounding conductor shall be sized for the sum of all the overcurrent devices protecting the conductors in the raceway or cable.
 - C. The equipment grounding conductor shall not be smaller than 10 AWG.
 - D. The equipment grounding conductor shall not be smaller than 12 AWG
 - E. The equipment grounding conductor shall be sized for the largest overcurrent device protecting conductors in the raceway or cable.

Answer E NEC 250.122(C)

Question demonstrates "common" multiple-choice question format.

Formulas and Sample Calculations

The following information includes brief explanation and example of basic electrical formulas and calculations and is **not** intended to be inclusive of all formulas and calculations applicants need to be familiar with to successfully perform electrical work or receive a passing score on any license examination administered by the Department. Examples of more complex code calculations can be found in Annex D of the National Electrical Code as well as in other resources. Knowledge gained through practical experience is generally not adequate to enable an applicant to pass an electrical licensing examination. It is the responsibility of an applicant to adequately prepare themselves, either through formal training or informal, self-help training.

Units of Measurement

The measurement system of preference for the National Electrical Code (Code) is now metric units in accordance with the modernized metric system known as the International System of Units (SI). The SI units appear first, followed by the inch-pound units in parentheses. This same system also applies to the Tables in Chapter 9 and the Annexes.

Compliance with the numbers shown in either the SI system or the inch-pound system constitutes compliance with the Code. Because most applicants are more familiar with the inch-pound units, all questions and answers in department license examinations use the inch-pound unit system. Answers for “absolute answer” format questions may be provided in either SI units or in inch-pound units.

Percentages, Ratios and Equations

Electrical codes often give exact specifications based on exact criteria, then require that these specifications be adjusted if the circumstances differ from the criteria which the exact specifications were based on. In many cases, the original specified value is to be adjusted by a percentage. An example would be the ampacity adjustment factors for conductors. In other cases, the Code gives the applicable percentage to be used in design calculations. Examples of this would be applying demand factors, adjusting for continuous load or selecting overcurrent protection for motors or transformers. A percentage is defined as a ratio of a whole number to 100. The number value, including any decimal of this ratio, is multiplied by 100 and assigned the % sign.

Sample Percentage Questions:

What is 70% of 140?

The percentage amount is divided by 100 to obtain the decimal equivalent. ($70 \div 100 = .70$)
140 is multiplied by .70 ($140 \times .70 = 98$)

Answer: 70% of 140 = 98

What is the result of increasing 120 by 25%?

The percentage amount is divided by 100 ($25 \div 100 = .25$)
120 is multiplied by .25 ($120 \times .25 = 30$)
30 is then added to the original value of 120 ($30 + 120 = 150$)

Answer: 120 x 1.25 = 150

A ratio is defined as a fixed comparison or proportion between two similar values, such as primary vs. secondary or input vs. output.

Sample Ratio Question:

A single phase transformer has a nameplate voltage rating of 480/120. What is the ratio of the primary voltage to the secondary voltage?

The primary voltage is divided by the secondary voltage ($480 \div 120 = 4$)

Answer: The ratio of the primary voltage to the secondary voltage is 4 : 1

Formulas used in code and theory calculations are in the form of equations. An equation is a statement of equality of two quantities of variables, such as $A \times B = C$. While it is important to remember the definition of an equation, it is more important to know how to transpose an equation that is not expressed as being equal to the variable that is unknown. As an example, Ohm's law and Watt's law contain three variables that can be transposed into 10 other equations. Equations (formulas) can be transposed by one or more of the following operations performed equally on each side of the equal sign (=): addition, subtraction, multiplication, or division.

Two things to remember: 1) a variable divided by itself equals 1; and 2) multiplying a variable by 1 does not change the variable and is not shown in the final equation.

Sample Problems:

If $A \times B = C$. Solve for A.

To transpose this formula we divide both sides of the equation by B

$$(A \times B) \div B = C \div B$$

$$B \div B = 1$$

$$A \times 1 = C \div B$$

Answer: $A = C \div B$

Ohm's Law ($E = I \times R$)

Ohm's law expresses the relationship of three variables, E, I, and R. The electromotive force in volts is represented by the letter E, the current in amperes is represented by the letter I, and the resistance in ohms is represented by the letter R.

In certain alternating current circuits, the term impedance is used rather than resistance. Impedance is a combination of resistance and reactance and is represented by the letter Z.

Sample Question:

In a series circuit, the voltage dropped across a 30 Ω resistor is 75 volts. What is the current of the circuit?

$$\text{If } E = I \times R, \text{ then } I = E \div R$$

$$I = 75 \div 30$$

Answer: $I = 2.5$ amperes

Watt's Law ($P = E \times I$)

Watt's law expresses the relationship of three variables, P, E, and I. The power of an electrical circuit in watts is represented by the letter P, the electromotive force in volts is represented by the letter E, and the current in amperes is represented by the letter I.

Watts is the term for the true power being used in an electrical circuit. True power is only produced when the voltage and current sine waves are both either positive or negative, referred to as a unity power factor. The product of $E \times I$ must be a positive number for watts to be produced. A positive number times a negative number results in a negative number. As an example: $+ \times + = +$, $- \times - = +$, $- \times + = -$.

Sample Question:

An electric baseboard heater is rated 1500 watts at 240 volts. What is the current drawn by the heater?

If $P = E \times I$, then $I = P \div E$

$I = 1500 \div 240$ **Answer: $I = 6.25$ amperes**

Resistance in Series and Parallel Circuits

For the purposes of this discussion of resistance, direct current circuits and alternating circuits that do not contain inductive or capacitive loads (unity power factor) are used.

In a series circuit, the current is the same at any point in the circuit, the total resistance is the sum of the individual resistors, and the applied voltage is equal to the sum of the voltage dropped across all the resistors.

Sample Question:

A series circuit, consists of three resistors valued at 20 Ω , 40 Ω , and 60 Ω respectively. If the current of the circuit is 2 amperes, what is the source voltage?

If $E = I \times R$

$R_{\text{total}} = R_1 + R_2 + R_3$

$R_{\text{total}} = 20 + 40 + 60$ then $R_{\text{total}} = 120 \Omega$

$E = 2 \times 120$ **Answer: $E = 240$ volts**

A parallel circuit is a circuit with more than one path for current flow. The total flow in the circuit is equal to the sum of the currents in all the branches. The voltage drop across any branch of the parallel circuit is equal to the voltage applied to the parallel branch.

There are three methods of determining the total resistance in a parallel circuit.

When resistors of equal value are connected in parallel, the total resistance is equal to the value of the resistance of the resistor divided by the number of resistors.

Sample Question:

What is the total resistance of three 15 Ω resistors connected in parallel?

$R_{\text{total}} = R \div N$ or $R_{\text{total}} = 15 \div 3$

Answer: $R_T = 5\Omega$

The product over sum method can be used for two different resistance values. In a circuit with more than two resistors or branches, the product over sum method can be used sequentially until only one pair of resistors is left.

$$R_T = (R_1 \times R_2) \div (R_1 + R_2)$$

Sample Question:

What is the total resistance of a 20 Ω and a 30 Ω resistor connected in parallel?

$$R_T = (R_1 \times R_2) \div (R_1 + R_2), R_T = (20 \times 30) \div (20 + 30), R_T = 600 \div 50$$

Answer: $R_T = 12 \Omega$

The third method is the reciprocal method. The total resistance of a parallel circuit is equal to the reciprocal of the sum of the reciprocals of the resistor values.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Sample Problem:

What is the total resistance of a 2 Ω, 4 Ω and 8 Ω resistor connected in parallel?

$$\frac{1}{R_T} = \frac{1}{2} + \frac{1}{4} + \frac{1}{8}$$

$$\frac{1}{R_T} = .5 + .25 + .125$$

$$\frac{1}{R_T} = .875 \quad \text{or} \quad R_T = \frac{1}{.875} \quad \text{or} \quad \text{Answer: } R_T = 1.143 \Omega$$

Volt-Amperes (VA) and Kilo-Volt-Amperes (KVA)

For single phase loads, the volt-amperes are simply the product of multiplying the voltage times the current. In most cases the Code uses the term volt-amperes in lieu of watts. "Watts" generally is the volt-amperes multiplied by the power factor of the circuit because it takes into account that current and voltage may not always be in-phase or in unity. A power factor for other than resistive loads is normally less than unity or 100% and will result in less usable power or energy. The volt-ampere load of an alternating current circuit is also called "apparent power," as it appears the circuit is producing power equal to the volts times the amperes.

Since this number can be quite large, the term KVA is sometimes used. One KVA is equal to 1000 volt-amperes.

$$\text{Single Phase} \quad KVA = \frac{E \times I}{1000}$$

For three phase circuits, the volt-amperes are multiplied by 1.732 (square root of 3).

$$\text{Three Phase} \quad KVA = \frac{E \times I \times 1.732}{1000}$$

Sample questions are included in the discussion of transformer ratings.

Voltage Drop Calculations

While the Code does not mandate a specific allowable amount of voltage drop on feeders and branch circuits, it does recommend that the total voltage drop not exceed five percent for reasonable efficiency of operation. In addition, the recommendation states that the feeders and branch circuit should have a maximum of three percent. If the feeder circuit had two percent, the branch circuit could have three percent or if the branch circuit had two percent, the feeder could have three percent. The voltage drop calculation is an application of Ohm's law. The voltage drop is equal to the current times the resistance of the circuit. Determining the resistance of the circuit is the problematic part of the equation. The size, material, and length of the circuit conductors determine the total resistance. Each set of parallel conductors must be considered as one conductor when calculating voltage drop. The voltage drop calculations presented here result in an approximate voltage drop for alternating current circuits. Skin-effect, power factor, and harmonics are factors not taken into consideration in these examples. The formulas described below should not be relied on for the design of large feeders or feeders for inductive or harmonic loads.

There are two formulas that can be used to calculate single-phase volt drop:

The first formula is: $VD 1\phi = (2 \times K \times I \times L) \div CM$

Where K is a constant of the ohms per mil foot, I is the circuit current in amperes, L is the length of the circuit in one direction and CM is the circular mil area of the conductors from NEC Chapter 9, Table 8. The "ohms per mil foot" is defined as the resistance of a conductor, one foot long and one circular mil of area. A mil is .001 of an inch.

The second formula is: $VD 1\phi = (2 \times R \times I \times L) \div 1000$

Where R is equal to the ohms per 1000 feet of conductor from NEC Chapter 9, Table 8, I is the circuit current in amperes and L is the length of the circuit in one direction.

The voltage drop of a three phase circuit is slightly less than that of a single phase circuit as only one of the three conductors is at maximum current at any given time.

If you are using either $VD 1\phi = (2 \times K \times I \times L) \div CM$ or $VD 1\phi = (2 \times R \times I \times L) \div 1000$, these formulas are modified as follows for three phase applications:

$VD 3\phi = (1.732 \times K \times I \times L) \div CM$ or $VD 3\phi = (1.732 \times R \times I \times L) \div 1000$

Sample Problems:

What is the voltage drop on a 240 volt, single phase circuit, that is 150 feet from the panelboard, has a current of 28 amperes, and No.8 THWN copper conductors?

Use K = 12.8

$VD 1\phi = (2 \times K \times I \times L) \div CM$, $VD 1\phi = (2 \times 12.8 \times 28 \times 150) \div 16510$

$VD 1\phi = 107520 \div 16510$ **Answer: $VD 1\phi = 6.5$ Volts**

Percentage of Voltage Drop

What is the percentage of voltage drop on a 480 volt, three phase, feeder circuit, that is 280 feet from the service equipment to the panelboard, has a current of 135 amperes, and 250 kcmil XHHW-2 aluminum conductors?

Use K = 21.1

$$VD\ 3\emptyset = (1.732 \times K \times I \times L) \div CM, VD\ 3\emptyset = (1.732 \times 21.1 \times 135 \times 280) \div 250,000$$

$$VD\ 3\emptyset = (1,381,409 \div 250,000), VD\ 3\emptyset = 5.53\ \text{volts}$$

$$\text{Percent of VD} = VD \div EL-L \times 100, \text{Percent of VD} = 5.53 \div 480 \times 100$$

$$\text{Percent of VD} = .01152 \times 100,$$

Answer: Percent of VD = 1.15%

What is the voltage drop on a 208-volt, three-phase branch circuit, that is 205 feet from the panelboard, has a current of 33 amperes, and the conductors have a resistance of .510 Ω per 1000 feet?

$$VD\ 3\emptyset = (1.732 \times R \times I \times L) \div 1000, VD\ 3\emptyset = (1.732 \times .510 \times 33 \times 205) \div 1000$$

$$VD\ 3\emptyset = 5976 \div 1000 \quad \text{Answer: VD } 3\emptyset = 5.98\ \text{volts}$$

Transformer Ratings

Transformers are commonly rated in KVA. The term KVA is a measure of apparent power in units of 1000 volt-amperes. The term KVA is not to be confused with KW (kilo-watts). KW is a measure of true power units of 1000 watts. Even though there are some losses associated with transformers, for general calculations the KVA of the primary is considered equal to the KVA of the secondary. The nameplate of the transformer generally includes the KVA rating, primary and secondary voltages or combinations, the manufacturer's name, temperature rise, percent of impedance and if it is single or three phase.

$$\text{Single Phase KVA} = \frac{E \times I}{1000}$$

$$\text{Three Phase KVA} = \frac{E \times I \times 1.732}{1000}$$

Sample Problems:

A 25 KVA, single phase transformer is rated 480-120/240 volts. What is the full load, primary current rating?

$$\text{If } 1\emptyset\ \text{KVA} = (E \times I) \div 1000, \text{ then } I = (KVA \times 1000) \div E$$

$$I = (25 \times 1000) \div 480, I = 25000 \div 480 \quad \text{Answer: I} = 52\ \text{amperes}$$

For three phase loads the KVA rating is equal the voltage times the current times 1.732.

A three phase, 750 KVA transformer is rated at 4160-208/120 volts. What is the full load, secondary current rating?

$$\text{If } 3\emptyset\ \text{KVA} = E \times I \times 1.732 \div 1000, \text{ then } I = (KVA \times 1000) \div (E \times 1.732)$$

$$I = (750 \times 1000) \div (208 \times 1.732), \text{ then } I = 750000 \div 360.26$$

Answer: I = 2081 amperes

Transformer Short-Circuit Fault Current Calculations

The available short-circuit fault current value must be known to properly select equipment ratings. Although there are a number of factors that will effect the available short-circuit fault current at any point on an electrical system, most calculations begin with determining the maximum available short-circuit fault current at the load terminals of a transformer under a bolted short circuit condition without any short-circuit or overcurrent protection and assuming an infinite primary source. Only transformer short-circuit fault current calculations are demonstrated by the following examples. The formula for maximum available fault current for a transformer is: short-circuit current = transformer secondary full-load current x the multiplier, or $I_{s.c.} = \text{transformer } f.l.a. \times \text{multiplier}$. The transformer multiplier is equal to 100 divided by the transformer impedance expressed as a percentage. The transformer impedance is generally marked on the nameplate of the transformer and is identified by the letter "Z".

Sample Problems:

What is the maximum available short-circuit fault current for a transformer with the following secondary nameplate rating: 75 kva, 120/240 volt, single phase, 2.5% Z?

The transformer full-load ampere rating is $75000 \div 240 = 312.5$. The multiplier is $100 \div 2.5\% = 40$. The maximum available short-circuit fault current is 312.5 (transformer full-load amperes) x 40 (multiplier) = $12,500$ (available short-circuit fault current). **Answer: 12,500 amperes**

What is the maximum available short-circuit fault current for a transformer with the following secondary nameplate rating: 75 kva, 120/208 volt, three phase wye, 1.2% Z?

The transformer full-load ampere rating is $75,000 \div (208 \times 1.732) = 208$. The multiplier is $100 \div 1.2 = 83.33$. The maximum available short-circuit fault current is 208 (transformer full-load amperes) x $83.33 = 17,333$ (available short-circuit fault current). **Answer: 17,333 amperes**

What is the maximum available short-circuit fault current for a transformer with the following nameplate rating: 750 kva, 277/480 volt, three phase wye, 2.75% Z?

The transformer full-load ampere rating is $750,000 \div (480 \times 1.732) = 902$. The multiplier is $100 \div 2.75 = 36.36$. The maximum available short-circuit fault current is 902 (transformer full-load amperes) x $36.36 = 32,797$ (available short-circuit fault current). **Answer: 32,797 amperes**

The examples illustrated above are for line-to-line faults. Line-to-neutral or line-to-ground faults will generally result in 10 to 15% higher available short-circuit fault currents.

Not considering any reduction based on circuit impedance or increase from motor load contribution, the equipment connected to the load side of the transformers in the illustrations above must have a short-circuit or interrupt rating not less than the calculated available short-circuit fault current for each question.

Additional information regarding short-circuit fault current calculations is available through many sources, including manufacturers of overcurrent devices.

Conduit Fill Calculations

Annex C of the National Electrical Code contains the Tables for conduit and tubing fill for conductors and fixture wires of the same size. Every type of conduit, flexible conduit or tubing in which conductors are field installed has two tables listing the maximum number of any given wire size (gauge) and type (insulation). These Tables apply to raceways longer than 2 feet.

Sample Question:

How many No.10 AWG, Type THWN conductors may be installed in trade size 1½, Schedule 80, Polyvinyl Chloride Conduit?

The answer is found using NEC Table C9. Find the portion of the table that applies to Type THWN conductors. Find No.10 AWG in the conductor size column and read the number of conductors for the appropriate, trade size raceway from the table. If you choose to calculate the number of conductors, rather than use the tables in Annex C, you must apply the provisions of Note 8.

Answer: 32 conductors

When a conduit or tubing contains several different size conductors or contains conductors with different types of insulation, a more complex procedure is to be followed. In general, this procedure involves three steps. First, determine the combined square inch area of all the conductors. Second, determine the percent of cross sectional area allowed for conductors based on the number of conductors to be installed in the conduit. Third, select the size conduit or tubing that has a “percent of area” determined in step one that exceeds the square inch area required for the conductors determined in step two. This information is found in the tables in NEC Chapter 9.

Sample Question:

What is the minimum trade size Rigid Metal Conduit required for six - No.3 AWG THW; six – No.6 AWG THWN; one – No.8 AWG THWN; and twelve - No.14 AWG XHHW conductors?

Using NEC Chapter 9, Table 1 it is determined that 40% of the cross sectional area of the rigid metal conduit may be used for conductor fill because it will contain over 2 conductors.

From NEC Chapter 9, Table 5, determine the square inch area of all the conductors, based on their size and insulation type.

No.3 THW - 0.1134 sq. in. times 6 conductors = 0.6804 sq. in.

No.6 THWN - 0.0507 sq. in. times 6 conductors = 0.3042 sq. in.

No.8 THWN - 0.0366 sq. in. times 1 conductor = 0.0366 sq. in.

No.14 XHHW - 0.0139 sq. in. times 12 conductors = 0.1668 sq. in.

The total cross-section area of the conductors is 1.1880 sq. in

Using NEC Chapter 9, Table 4 under the heading of Rigid Metal Conduit, determine from the 40% column, the minimum size conduit that exceeds 1.1880 square inches.

Answer: trade size 2

Where conduit or tubing nipples not longer than 24 in. are installed between boxes, cabinets or similar enclosures, the nipples shall be permitted to be filled to 60 percent of their total cross sectional area.

Conductor Ampacity

NEC Table 310.15(B)(16) lists the allowable ampacities of conductors rated 0 –2000 volts, 60°C through 90°C, based on an ambient temperature of 30°C and not more than three current-carrying conductors in a raceway, cable or directly buried in the earth. When conductors are used within these specific criteria it is simply a matter of selecting the ampacity from the table based on the conductor size, insulation type and material. These criteria limit the amount of heat generated by the current flowing through the conductor to a safe level. Conductors used outside of these criteria must have their ampacities adjusted accordingly.

There are two variables that may need to be considered. On occasion, conductors are used in environments that are warmer than an ambient temperature of 30°C (86°F). The higher temperature environments limit a conductor's ability to safely dissipate the heat generated by the conductor, so the ampacity must be reduced.

NEC Table 310.15(B)(2)(a) includes correction factors for ambient temperatures other than 30°C (86°F). To correct the conductor ampacity based on ambient temperature, multiply the allowable ampacities by the appropriate factor of the ambient in which the conductor will operate.

In addition, the temperature limitations equipment terminations described in NEC section 110.14 must be applied when conductor ampacity/overcurrent rating is determined.

Sample Question:

What is the allowable ampacity of a No.1/0 THWN copper conductor when installed in an ambient temperature of 107° F?

NEC Table 310.15(B)(16) lists the allowable ampacity of No.1/0 THWN copper, a 75°C rated conductor as 150 amperes. The correction factor is .82

$150 \times .82 = 123$ amperes **Answer: 123 amperes**

Often more than three current-carrying conductors are installed in a single raceway.

Once again the allowable ampacity of the conductors must be reduced to prevent overheating and damage to conductor insulation.

NEC Table 310.15(B)(3)(a) specifies the percentage of adjustment required based on the number of current-carrying conductors in the raceway or cable.

The percentages given in NEC Table 310.15(B)(3)(a) are applied to the allowable ampacities of Tables 310.16 through 310.19 **after** any correction for ambient temperature has been made.

Sample Question:

A trade size 1¼ conduit contains three, 3-phase motor circuits and an equipment grounding conductor. The motors run at the same time and the conductors are No.8 THHN copper. What is the allowable ampacity of these conductors?

From NEC Table 310.15(B)(16), the allowable ampacity of a No.8 THHN copper conductor is 55 amperes. The 55 ampere rating is based on not more than three current-carrying conductors in the raceway and an ambient temperature of 30°C. Because a different ambient temperature is not stated, no correction for ambient temperature is required, the percentages given in NEC Table 310.15(B)(3)(a) to the ampacity listed in the table are applied. In this case it is 70% based on the nine current-carrying conductors.

Note: NEC section 310.15(B)(6) provides that the equipment grounding conductor is not counted when applying the provisions of section 310.15(B)(3)(a).

$55 \times .70 = 38.5$ Amperes **Answer: 38.5 Amperes**

Box Fill Calculations

The Code requires that boxes and conduit bodies be of sufficient size to provide ample free space for conductors, connections and where applicable, wiring devices. These requirements are found in NEC section 314.16.

Sample Questions:

What is the maximum number of No.10 AWG THHN conductors that may be installed in a 4 x 2 $\frac{1}{8}$ square box?

This answer can be taken directly from NEC Table 314.16(A) as there are no other volume allowances required. **Answer: 12 conductors**

What is the maximum number of No.12 AWG conductors that may be installed in a box that is marked with a volume of 60 cubic inches?

NEC Table 314.16(B) gives the volume allowance required per conductor. In this case, 2.25 in.³ are required for each No.12 AWG conductor. Divide the volume of the box by the volume allowance of the conductor. Do **not** round up!

$60 \text{ in.}^3 \div 2.25 \text{ in.}^3 = N$ $N = 26.67$ **Answer: 26 conductors**

Boxes that contain devices, cable clamps, support fittings, equipment grounding conductors or different size conductors shall be sized in accordance with NEC section 314.16(B), sections (1) – (5). These five sections prescribe the number of volume allowance(s) required for each item listed above.

A 2-gang, nonmetallic box is to be used for a 3-way switch and duplex receptacle outlet. Type NM cable is used as the wiring method. The box contains a 14-2 and a 14-3 cable for the lighting circuit and two, 12-2 cables for the outlet circuit. The box has internal cable clamps to secure the cables. What is the minimum cubic inch volume of the box?

Determine the volume required for the conductors. Do **not** count the equipment grounding conductors at this time.

No.14 conductors: $5 \times 2.0 \text{ in.}^3 = 10 \text{ in.}^3$; No.12 conductors: $4 \times 2.25 \text{ in.}^3 = 9 \text{ in.}^3$. Combine the volume required for the conductors: $10 \text{ in.}^3 + 9 \text{ in.}^3 = 19 \text{ in.}^3$

Since the box has cable clamps, a single volume allowance, based on the size of the largest conductor in the box shall be made. The volume allowance shall be in accordance with NEC Table 314.16(B). The volume allowance for the clamps is 2.25 in.³, based on No.12 being the largest conductor.

A double volume allowance shall be made for each strap or yoke containing one or more devices or equipment, based on the size of the largest conductor connected to the device. The volume allowance for the 3-way switch is 4 in.³ ($2 \times 2 \text{ in.}^3$) and the volume allowance for the duplex receptacle is 4.5 in.³ ($2 \times 2.25 \text{ in.}^3$). The volume allowances shall be in accordance with NEC Table 314.16(B). The total of the volume allowances for the devices is 8.5 in.³ ($4 \text{ in.}^3 + 4.5 \text{ in.}^3 = 8.5 \text{ in.}^3$).

Where one or more equipment grounding conductors enter a box, a single volume allowance based on the largest equipment grounding conductor shall be made. Note that even though the equipment grounding conductors are from different circuits, a single volume allowance is made. The volume allowance for the equipment grounding conductors is 2.25 in.³, based on No.12 being the largest conductor.

Combine the volume allowance for the conductors, clamps, device and the equipment grounding conductors.

19 in.^3 (conductors) + 2.25 in.^3 (clamps) + 8.5 in.^3 (devices) + 2.25 in.^3 (ground wires) = 32 in.^3

Answer: 32 in.³

Motor Branch Circuit and Feeder Calculations

With limited exception, conductors that supply motor branch circuits shall be sized at 125% of the full-load current rating of the motor based on the values in NEC Tables 430.247 through 430.250, rather than that of the motor nameplate. NEC section 430.6(A)(1) requires these tables also be used to determine the ampere rating of switches and the branch-circuit short-circuit and ground-fault protection. The motor nameplate current rating is to be used only to size the overload protection.

Sample Questions:

What is the minimum size THWN copper, branch circuit conductors that may be used to supply a 40 HP, 230-volt, 3Ø alternating current motor with a nameplate current of 97.6 amperes?

As previously stated, the nameplate current is not to be used to size the branch circuit conductors, rather the value given in NEC Table 430.250 shall be used. The full-load current rating of a 40 HP, 230 volt, 3Ø motor is 104 amperes. In accordance with NEC section 430.22(A), the ampere rating of the branch circuit conductors shall be 125% of the rating found in Table 430.250. $104 \times 1.25 = 130$ amperes.

From the 75°C column of Table 310.16, select a copper conductor with an ampacity that equals or exceeds 130 amperes.

Answer: No.1 AWG

A motor control center serves the following 3Ø, 460 volt, AC motors: 1 – 100 HP; 6 – 15 HP; and 2 – 7.5 HP. What is the minimum ampacity of the feeder conductors that supply the motor control center? NEC section 430.24 requires conductors supplying several motors to have an ampacity at least equal to the sum of the full-load current ratings as determined by section 430.6(A)(1), plus 25% of the highest motor in the group.

$124 + (124 \times .25) + (6 \times 21) + (2 \times 11) = 303$ amperes

Answer: 303 amperes

Dual element, time-delay fuses are used to provide motor branch-circuit, short-circuit and ground-fault protection for a 75 HP, 230 volt, 3Ø, Squirrel cage, Design B, three phase motor. In general, what is the maximum size fuse that may be installed?

The Percentages of Full-Load Current found in NEC Table 430.52 are applied to the Full-Load Current, Three-Phase Alternating-Current Motors of Table 430.250.

A 75 HP, 230 volt, three-phase motor has a full-load current rating of 192 amperes. From the Dual Element (Time Delay) Fuse column of NEC Table 430.52, the maximum fuse is 175% of 192 amperes. $192 \times 1.75 = 336$ amperes.

Because 336 amperes is not a standard fuse rating as listed in 240.6, NEC section 430.52(C)(1) Exception No. 1, allows the next largest standard rating to be used as long as it does not exceed 225%, in this case, 350 amperes. **Answer: 350 amperes**

Examination Knowledge Areas

The following table generally identifies knowledge areas included in examinations by license type.

| Knowledge areas based on the 2011 National Electrical Code | | | | |
|--|-----------|-----------|-----------|-----------|
| | EM | EC | LM | LJ |
| Introduction | | | | |
| Mandatory rules, permissive rules and explanatory material | X | X | X | X |
| The authority having jurisdiction for enforcement of the Code | X | X | X | X |
| The purpose and adequacy of the NEC | X | X | X | X |
| The scope of the NEC: installations covered and not covered | X | X | X | X |
| Chapter 1 General | | | | |
| Definitions | X | X | X | X |
| Approval, listing and labeling of electrical equipment required | X | X | X | X |
| Mechanical execution of work | X | X | X | X |
| Electrical connections, terminals, splices and temperature limitations of equipment | X | X | X | X |
| Identification of disconnecting means | X | X | X | X |
| Working space about electrical equipment and dedicated equipment space | X | X | X | X |
| Chapter 2 Wiring and Protection | | | | |
| Means of identifying grounded circuit conductors | X | X | X | X |
| Use of conductors with white or gray color | X | X | X | X |
| Connection of grounded circuit conductors to equipment | X | X | X | X |
| Use of multiwire branch circuits; limitations and identification of ungrounded conductors | X | X | X | X |
| Ground-fault circuit-interrupter protection for personnel | X | X | X | X |
| Means of identifying a conductor with a higher voltage to ground | X | X | X | X |
| Marking of circuit breakers; interrupting rating; use as switches and voltage rating | X | X | X | X |
| Application of straight voltage rating; slash voltage rating; and series ratings of circuit breakers | X | X | X | X |
| Definitions of terms associated with grounding and bonding | X | X | X | X |
| General requirements for grounding and bonding | X | X | X | X |
| Grounding and bonding connections required to be made by listed means | X | X | X | X |

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| | EM | EC | LM | LJ |
|---|-----------|-----------|-----------|-----------|
| Equipment grounding and equipment grounding conductors | X | X | X | X |
| Types of equipment grounding conductors and means of identification of equipment grounding conductors | X | X | X | X |
| Size of equipment grounding conductors; multiple circuits, and conductors in parallel | X | X | X | X |
| Methods of equipment grounding | X | X | X | X |
| Connection of the receptacle grounding terminal to the outlet box; continuity and attachment of equipment grounding conductors to boxes | X | X | X | X |
| Chapter 3 Wiring Methods and Materials | | | | |
| All conductors of the same circuit contained in the same raceway, trench, cable, etc. | X | X | X | X |
| Conductors of different systems permitted in the same enclosure or raceway | X | X | X | X |
| Insulating fittings required for conductors 4 AWG and larger | X | X | X | X |
| Sealing raceways exposed to different temperatures, expansion fittings | X | X | X | X |
| Requirements for securing and supporting raceways, boxes, etc. | X | X | X | X |
| Boxes required at each outlet, switch, or splice point | X | X | X | X |
| Raceways installed in complete runs; number and size of conductors installed in raceways | X | X | X | X |
| Requirements for supporting conductors in vertical raceways | X | X | X | X |
| Conductors carrying alternating current in metal raceways arranged to avoid heating by induction | X | X | X | X |
| Spread of fire or products of combustion | X | X | X | X |
| Conductors in dry locations; damp locations; wet locations; conductors exposed to direct sunlight and temperature limitations of conductors | X | X | X | X |
| Selection of conductor ampacity from applicable tables, corrections for ambient temperature and adjustment factors | X | X | X | X |
| Conductors determined to be current carrying conductors | X | X | X | X |
| Conductors entering cabinets, panelboards and meter socket enclosures | X | X | X | X |
| Wire bending space at terminals and minimum width of wiring gutters | X | X | X | X |
| Installation and use of boxes and conduit bodies | X | X | X | X |
| Number of conductors permitted in outlet, device, junction boxes, and conduit bodies; application of volume allowances | X | X | X | X |
| Chapter 3 Wiring Methods and Materials | | | | |
| All conductors of the same circuit contained in the same raceway, trench, cable, etc. | X | X | X | X |
| Conductors of different systems permitted in the same enclosure or raceway | X | X | X | X |

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| | EM | EC | LM | LJ |
|--|-----------|-----------|-----------|-----------|
| Insulating fittings required for conductors 4 AWG and larger | X | X | X | X |
| Conductors entering boxes, conduit bodies, or fittings | X | X | X | X |
| Boxes installed in walls or ceilings, boxes required to supported by approved methods | X | X | X | X |
| Outlet boxes installed for luminaires | X | X | X | X |
| Requirements for enclosures and conduit bodies used as pull or junction boxes | X | X | X | X |
| Installation requirements for Type AC, MC, NM, and UF cable: Uses permitted, uses not permitted, exposed and concealed, securing and supporting | X | X | X | X |
| Installation requirements for Type IMC and RMC: uses permitted; uses not permitted; bends; threading and reaming; securing and supporting; number of conductors permitted | X | X | X | X |
| Installation requirements for Type RNC: uses permitted, uses not permitted, bends, securing and supporting and expansion fittings, number of conductors permitted | X | X | X | X |
| Installation requirements for Type FMC, LFMC, and LFNC: uses permitted; uses not permitted; securing and supporting; grounding and bonding; number of conductors permitted | X | X | X | X |
| Installation requirements for Type EMT: uses permitted; uses not permitted; bends; securing and supporting; number of conductors permitted | X | X | X | X |
| Sheet metal and nonmetallic auxiliary gutters; number of conductors; ampacity of conductors; splices and taps; support | X | X | X | X |
| Metal and nonmetallic wireways: uses permitted; uses not permitted; number and size of conductors; securing and supporting | X | X | X | X |
| Surface metal and surface nonmetallic raceways: uses permitted; uses not permitted; size and number of conductors; combination raceways | X | X | X | X |
| | | | | |
| Chapter 4 Equipment for General Use | | | | |
| Types of flexible cords and cables; ampacities for flexible cords and cables; uses permitted and uses not permitted | X | X | X | X |
| Receptacles required to grounding type and grounded; replacements, nongrounding type, GFCI requirements; wet locations | X | X | X | X |
| Motors, motor circuits and controllers: ampacity and motor rating determination (use tables); branch circuit conductors for a single motor | X | X | X | X |
| Conductors supplying several motors and other loads; motor overload protection required; | X | X | X | X |
| Motor branch-circuit short-circuit and ground-fault protection: individual motor circuit; several motors or loads on one branch-circuit | X | X | X | X |
| Motor feeder short-circuit and ground-fault protection: rating or setting for a specific load | X | X | X | X |
| Motor control circuits: definition; overcurrent protection required; control circuit transformers; disconnecting means required | X | X | X | X |

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| | EM | EC | LM | LJ |
|---|----|----|----|----|
| Disconnecting means required: location in relation to the controller; location in relation to the motor; ampere rating and interrupting capacity | X | X | X | X |
| Air conditioning and refrigeration equipment: branch-circuit conductor ampacity, short-circuit and ground-fault protection; disconnect required | X | X | X | X |
| | | | | |
| Chapter 9 Tables | | | | |
| Notes to tables: percent of cross section of raceways for conductors; use Annex C for conductors all the same size and insulation type; dimensions and percent area of conduit and tubing; dimensions of insulated conductors | X | X | X | X |
| Notes to tables: conductor properties; alternating-current resistance; Annex D, examples of branch-circuit, feeder, service, and motor circuit calculations; Annex E, types of construction | X | X | X | X |
| | | | | |
| Applied Electrical Theory, Electrical Systems and Equipment | | | | |
| General mathematics including transposing equations; calculating area, volume, and percentages | X | X | X | X |
| Ohm's law, Watt's law, and voltage drop calculations | X | X | X | X |
| Characteristics of series and parallel circuits | X | X | X | X |
| Voltage, current, and power of single-phase and three-phase systems | X | X | X | X |
| Motor and transformer connections: single-phase; three-phase; transformer taps; wye and delta configurations; 115/230, 230/460 volt connections | X | X | X | X |
| Trouble shooting common electrical problems | X | X | X | X |
| | | | | |
| Knowledge areas based on the 2004 ASME A17.1 | | | | |
| | | | | |
| Section 2.2 Pits | | | | |
| Pit access equipment, clearances | X | X | X | X |
| Stop switches in pits | X | X | X | X |
| | | | | |
| Section 2.4 Vertical Clearances | | | | |
| Vertical clearances and run-by | X | X | X | X |
| | | | | |
| Section 2.5 Horizontal Clearances | | | | |
| Horizontal car and counterweight clearances | X | X | X | X |
| | | | | |
| Section 2.6 Protection of spaces below hoistways | | | | |
| Entrances, panels, sills, tracks, hangers, and guides | X | X | X | X |
| | | | | |
| Section 2.7 Machine room | | | | |
| Section 2.7 Machine room access, access to equipment, headroom temperature requirements, and lighting. | X | X | X | X |

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| | EM | EC | LM | LJ |
|---|----|----|----|----|
| Section 2.10 Guarding | | | | |
| Where required, and construction of guarding | X | X | X | X |
| | | | | |
| Section 2.11 Hoistway Entrance Protection | | | | |
| Horizontal and vertical types; guides, retainers, panels, hangers and tracks | X | X | X | X |
| | | | | |
| Section 2.12 Door Locking Devices, Contacts and Access Switches | | | | |
| Understanding; the unlocking zone, operation of the elevator under certain conditions, closed position of the doors, and restrictors. | X | X | X | X |
| | | | | |
| Section 2.13 Power Operation for Car and Hoistway Doors | | | | |
| Forces required and sequential operation | X | X | X | X |
| | | | | |
| Section 2.14 Cab Enclosures | | | | |
| Requirements for: Materials, car top railing, and emergency exit | X | X | X | X |
| | | | | |
| Section 2.16 Capacity and Loading | | | | |
| Required signage and data plates | X | X | X | X |
| | | | | |
| Section 2.17 Safeties | | | | |
| Identification of the various types of car and counterweight safeties and where they would be used | X | X | X | X |
| | | | | |
| Section 2.18 Speed Governors | | | | |
| Over-speed switch operation, sealing and tagging a governor, tags for governor ropes | X | X | X | X |
| | | | | |
| Section 2.20 Suspension Ropes and their Connections | | | | |
| Requirements for Data Tags, shackles, Minimum number of ropes, Connections to drums | X | X | X | X |
| | | | | |
| Section 2.22 Buffers | | | | |
| Identification of Buffer types and their applications, marking plates | X | X | X | X |
| | | | | |
| Section 2.24 Driving machine and sheaves | | | | |
| Minimum pitch diameters and understanding undercutting limits | X | X | X | X |
| | | | | |
| Section 2.25 Terminal Stopping Devices | | | | |
| Identification of the different types and how they are used | X | X | X | X |

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|---|----|----|----|----|
| Section 2.26 Electrical Protective Devices | | | | |
| Identification of different types, Electrical equipment and wiring requirements. | X | X | X | X |
| | | | | |
| Section 2.27 Emergency Operations | | | | |
| Operation of two way communication devices, emergency power, and fire service. | X | X | X | X |
| | | | | |
| Section 3.4 Top and Bottom Clearances for hydraulic elevators | | | | |
| Runby, refuge areas, | X | X | X | X |
| | | | | |
| Section 3.17 Safeties and Plunger Grippers on Hydraulic Elevators | | | | |
| Application and release, clearance, deceleration, and marking plates | X | X | X | X |
| | | | | |
| Section 3.18 Hydraulic jacks | | | | |
| Cylinders buried in ground, plunger stops, and plunger following guides | X | X | X | X |
| | | | | |
| Section 3.19 Valves, Pressure Piping and Fittings | | | | |
| Component working pressures, supporting oil lines, shut off valves, Check valves, relief valves, and piping buried in the ground | X | X | X | X |
| | | | | |
| Section 3.26 Operating Devices and Control Equipment for Hydraulic Elevators | | | | |
| Identification of and understanding of devices that are specific to hydraulic installations. | X | X | X | X |
| | | | | |
| Section 5.1 Inclined Elevators | | | | |
| Inclined elevator hoistway enclosures, runway protection, Landing enclosures, Car enclosures, operating devices, and control equipment. | X | X | X | X |
| | | | | |
| Section 5.2 Limited Use Limited Application Elevators | | | | |
| Clearance requirements for cars and counterweights, Power operation of hoistway doors and car doors, Limitations on capacity, loading, speed, and rise, Operating devices and control equipment requirements. | X | X | X | X |
| | | | | |
| Section 5.3 Private Residence Elevators | | | | |
| Clearance requirements for doors and gates, hoistway door locking devices, Limitations on capacity, loading, speed, and rise, and operating devices, and control equipment. | X | X | X | X |

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|--|----|----|----|----|
| Section 5.4 Private Residence Inclined Elevators | | | | |
| Runway protection, Landing enclosures, Car enclosures, operating devices, and control equipment. | X | X | X | X |
| | | | | |
| Section 5.7 Special Purpose Personnel Elevators | | | | |
| Run-by clearance requirements, Limitations on capacity, loading, speed, and rise, Suspension ropes, Operation, operating devices, and control equipment | X | X | X | X |
| | | | | |
| Section 6 Escalators | | | | |
| Clearances of steps to skirts, step to step. Knowledge of escalator electrical protective devices and their reset requirements. | X | X | | |
| | | | | |
| Section 7 Moving Walks | | | | |
| Clearances of steps to skirts, step to step. Knowledge of moving walk electrical protective devices and their reset requirements. | X | X | | |
| | | | | |
| Section 8.1 Security | | | | |
| Levels of access to keys | X | X | X | X |
| | | | | |
| Sections 8.10 and 8.11 Inspections and Tests | | | | |
| Knowledge of the test procedures for the various types of equipment limited to the scope of the license issued. | X | X | X | X |
| | | | | |
| Knowledge areas of the 2002 ASME A17.3 Safety Code for Existing Elevators | | | | |
| | | | | |
| Part 2 Hoistways and Enclosures (Existing) | | | | |
| Identification of requirements for hoistways, machine rooms, pits, entrances, door locks, access to the hoistway, and power operation of doors. | X | X | | |
| | | | | |
| Part 3 Machinery and equipment for elevators (Existing) | | | | |
| Identification of the different equipment and machinery and their requirements including but not limited to buffers, car enclosures, platforms, safeties, governors, driving machines and brakes, emergency operation and signaling devices, operating and control devices, and terminal stopping devices. | X | X | | |
| | | | | |
| Part 4 Hydraulic elevators (Existing) | | | | |
| Identification of equipment and devices specific to the hydraulic system including connections to cars, jack assemblies, and piping. | X | X | | |

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| Part 5 Escalators (Existing) | | | | |
| Identification of minimum requirements with regard to guarding, brakes, operational safety devices, lighting and egress. | X | X | | |
| | | | | |
| Part 9 Moving Walks (Existing) | | | | |
| Identification of minimum requirements with regard to guarding, brakes, operational safety devices, lighting and egress. | X | X | | |
| | | | | |
| Knowledge areas of the 2005 ASME A18.1 | | | | |
| Section 2.1 Vertical Platform Lifts | | | | |
| Requirements within a runway or enclosure, Limitations on capacity, loading, speed, and rise, Operating devices, and control equipment | X | X | X | X |
| | | | | |
| Section 3 Inclined Platform Lifts | | | | |
| Requirements within a runway or enclosure, Limitations on capacity, loading, speed, and rise, Operating devices, and control equipment | X | X | X | X |
| | | | | |
| Section 5 Private Residence Vertical Platform Lifts | | | | |
| Requirements within a runway or enclosure, Limitations on capacity, loading, speed, and rise, Operating devices, and control equipment | X | X | X | X |
| | | | | |
| Section 6 Private Residence Inclined Platform Lifts | | | | |
| Requirements within a runway or enclosure, Limitations on capacity, loading, speed, and rise, Operating devices, and control equipment | X | X | X | X |
| | | | | |
| Section 7 Private Residence Inclined Stairway Chairlifts | | | | |
| Requirements within a runway or enclosure, Limitations on capacity, loading, speed, and rise, Operating devices, and control equipment | X | X | X | X |
| | | | | |
| Section 10 Inspection and testing requirements | | | | |
| Testing requirements for the various equipment | X | X | X | X |
| | | | | |
| Knowledge Areas of the 2003 ASME B20.1 Standard for Conveyors | | | | |
| Definitions: | | | | |
| Understanding of the definitions and the terms, | X | X | X | X |
| | | | | |
| General Safety Standards: | | | | |
| Understanding the application, maintenance, clearance, guarding, controls, and safety devices. | X | X | X | X |

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| | EM | EC | LM | LJ |
|---|----|----|----|----|
| Section 6 Vertical Reciprocating Conveyors | | | | |
| Guarding and safety considerations specific to VRC's. | X | X | X | X |
| | | | | |
| Knowledge Areas of the 2003 ASME A90.1 Standard for Belt Manlifts | | | | |
| Knowledge of the construction, operational safety devices and the testing of belt manlifts. | X | X | X | X |
| | | | | |
| Knowledge Areas of the Field Employee Safety Handbook (2011) | | | | |
| Applicants should be knowledgeable on general safety requirements in performing their duties. | X | X | X | X |
| | | | | |
| Minnesota Rules Chapter 1307 | | | | |
| Accidents and damaged equipment | X | X | X | X |
| Amendments to the ASME A17.1 Codes | X | X | X | X |
| Special provisions | X | X | X | X |
| Existing installations | X | X | X | X |
| Amendments to the ASME A18.1 Codes | X | X | X | X |
| | | | | |
| Minnesota Statutes 326B.163 through 326B.191 | | | | |
| Requirements for the different license types, including continuing education requirements. | X | X | X | X |
| Contractor requirements | X | | X | |
| Permit requirements | X | | X | |
| Responsibilities of license holders | X | X | X | X |

- The Department of Labor and Industry offers these study suggestions for the types of license examinations indicated. This study guide must not be construed to indicate that all questions will be from the knowledge areas indicated above or that all knowledge areas will be included on individual examinations. License applicants are expected to be familiar with all requirements that apply to the scope of the license they are applying for.

** The examinations administered by the Department are identified by the following abbreviations:

- EM – Master Elevator Constructor
- EJ – Journeyman elevator Constructor
- LM – Limited Master Elevator Constructor
- LJ – Limited Journeyman Elevator Constructor

A BRIEF SUMMARY OF YOUR RIGHTS UNDER THE

AMERICANS WITH DISABILITIES ACT

INTRODUCTION

The Americans with Disabilities Act (“ADA”) covers “public entities.” The Department of Labor and Industry (Department) is a “public entity” covered by the ADA. The Department may not refuse to allow a person with a disability to take the examination simply because the person has a disability. It must permit persons with disabilities to take the examination in an integrated setting unless separate or different measures are necessary to ensure equal opportunity. It must eliminate unnecessary eligibility standards or rules that deny individuals with disabilities an equal opportunity to take the examination.

WHO IS COVERED?

The ADA provides comprehensive civil rights protection for “qualified individuals with disabilities.” An “individual with a disability” is a person who: 1) has a physical or mental impairment that substantially limits a “major life activity,” 2) has a record of such an impairment, or 3) is regarded as having such a impairment. “Major life activities” include functions such as caring for oneself, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning, and working. Individuals who currently engage in the illegal use of drugs are not protected by the ADA when an action is taken on the basis of their current illegal use of drugs.

A “qualified” individual with a disability is one who meets the essential eligibility requirements for the examination. The Department is not required to take any action that would result in a fundamental alteration in the nature of the examination or an undue financial and administrative burden. However, the Department must take any other action, if available, that would not result in a fundamental alteration or undue burdens but would ensure that individuals with disabilities receive the benefits or services.

WHAT IS REQUIRED?

The Department is required to make reasonable modifications in any policies, practices, and procedures that deny equal access to individuals with disabilities, unless a fundamental alteration in the examination would result. To do so, it must furnish auxiliary aids and services when necessary to ensure effective communication, unless an undue burden or fundamental alteration would result. The Department may not place special charges on individuals with disabilities to cover the costs of measures necessary to ensure nondiscriminatory treatment, such as making modifications required to provide program accessibility or providing qualified interpreters. Finally, it must operate the examination so that, when viewed in its entirety, it is readily accessible to and usable by individuals with disabilities.

Integration of individuals with disabilities into the mainstream of society is fundamental to the purposes of the ADA. The Department may not provide the examination to individuals with disabilities through programs that are separate or different, unless the separate programs are necessary to ensure that the benefits and services are equally effective. Even when separate programs are permitted, an individual with a disability still has the right to choose to participate in the regular program. The Department cannot require an individual with a disability to accept a special accommodation or benefit if the individual chooses not to accept it.

QUESTIONS?

If you have any questions about the ADA we encourage you to call the United States Department of Justice which has an ADA information line, at (202) 514-0301 (voice) or (202) 514-0381/0383 (TTY). These telephone numbers are not toll-free numbers.

INFORMATION ABOUT THE EXAMINATIONS AND AVAILABILITY OF ALTERNATIVE ARRANGEMENTS FOR PERSONS WITH DISABILITIES

GENERAL INFORMATION

If you are a person with a disability, you have certain rights under the Americans with Disabilities Act (“ADA”). A brief summary of these rights is on the back of this sheet. It is not meant to be complete. If you have any questions about your rights under the ADA we encourage you to call the United States Department of Justice, which has an ADA Information Line, at (202) 514-0301 (voice) or (202) 514-0381/0383 (TTY). These telephone numbers are not toll-free numbers.

ABOUT THE EXAMINATIONS

A copy of the License Examination Guide may be obtained from the Department’s website at: <http://www.dli.mn.gov/cclld/PDF/LicensingExaminationGuide.pdf>

Examinations are held weekly, generally every Wednesday, at the Department of Labor and Industry Building located at 443 Lafayette Road North, Saint Paul, just north of the intersection of Interstate 94 and US Highway 52 (Lafayette Road North), on the northeast edge of downtown Saint Paul. The building is accessible to persons with physical disabilities.

Specify instructions for scheduling and appearing for an examination are included in the letter that is sent to approved applicants.

ALTERNATIVE ARRANGEMENTS

The ADA requires this agency to make “reasonable accommodations” for applicants with disabilities in giving the examinations. If you are a person with a disability which may affect your ability to enter the examination facility or to take any portion of the examination, the ADA may require the agency to provide alternative examination arrangements. We are not required to do so if we are unaware of your need for alternatives. Based on the above description of the examination facilities and the examination itself, we ask that you inform us of any alternative arrangements you may require to take and examination. Please describe in detail:

(Use additional paper if necessary and attach to this form)

SIGNATURE _____ **DATE** _____

IF YOU ARE REQUESTING ALTERNATIVE ARRANGEMENTS BASED ON A DISABILITY, PLEASE SUBMIT THIS FORM WITH YOUR APPLICATION FOR EXAMINATION FORM.

Examination Schedule/Scheduling Examinations

Before anyone may schedule an examination date, the individual's examination application must be approved by DLI. There are no exceptions.

Dates scheduled by individuals without written approval of their application will be rejected and not scheduled. Individuals retesting after a failed exam must apply for another examination date.

Detailed exam dates, location and scheduling information can be accessed at:
<http://www.dli.mn.gov/CCLD/Elevator.asp>

Applicants must schedule their examinations ahead of time. Walk-ins are not permitted to take an examination. Applicants may reschedule their examination one time. Applicants that fail to appear for a rescheduled examination as well as applicants that fail their examination must submit a new application and examination fee before being approved for examination or reexamination.

All examination types administered at the St. Paul office begin at 8:15 a.m. and end at 1:45 p.m. All examination types are allotted 5½ hours for completion. All applicants should arrive at the examination site not later than 30 minutes before their scheduled starting time. A picture ID must be presented by all applicants when they appear for examination.

Note: Food and drink are permitted during the exam.

The Department of Labor and Industry Building located at 443 Lafayette Road North, Saint Paul, just north of the intersection of Interstate 94 and US Highway 52 (Lafayette Road North), on the northeast edge of downtown Saint Paul. The following is a link to directions to the 443 Lafayette location:
<http://www.mapquest.com/maps/map.adp?country=US&addtohistory=&formtype=address&searchtype=address&cat=&address=443%20Lafayette%20Rd%20N&city=Saint%20Paul&state=MN&zipcode=55155%2d4301>

Specific instructions concerning the examinations in St. Paul are sent as a part of the "Approved for Examination" letter and specific instructions for out-state sites are sent to persons who schedule at those sites.

Qualifications for License Applicants

Military Experience

Applicants may receive experience credit for performing work in the military. Applicants with military experience should include a copy of their DD214 discharge documents with their application.

Practical Experience/Experience Requirements by License Type

Section 326B.164 identifies allowable experience credit, situations under which experience is acceptable to the Department, and experience requirements for all license categories. Applicants are encouraged to review these requirements prior to submitting an application. Application/examination fees for applicants that do not qualify for examination are not refundable.

Minnesota Elevator Statutes: <https://www.revisor.mn.gov/statutes/?id=326B>

Minnesota Elevator Statutes as amended by 2013 Session Laws Chapter 85:

<https://www.revisor.mn.gov/laws/?id=85&year=2013&type=0>

Minnesota Elevator Rules: <https://www.revisor.mn.gov/rules/?id=1307>

Obtaining Licenses Through Reciprocal Agreements

Although Section 326B.164 allows for reciprocity agreements with other states, there are no agreements established for elevators at this time.

Continuing Education Requirements

Upon obtaining a license, the license holder must earn minimum continuing education credits to renew and maintain a license.

Master elevator constructor and journeyman elevator constructor licenses are required to earn a minimum of 16 hours of continuing education credit prior to renewal of their licenses. Not less than 12 hours must be on the Minnesota Elevator Code or elevator technology, and not less than 4 hours must be on National Electrical Code.

Limited master elevator constructors and limited journeyman elevator constructors are required to earn 8 hours of continuing education credit prior to renewal of their licenses. Not less than 6 hours must be on the Minnesota Elevator Code or elevator technology, and not less than 2 hours must be on National Electrical Code.

Note: Master elevator constructor and limited master elevator constructor license holders are not required to meet continuing education credit requirements in their initial term, but must in subsequent license terms.

Continuing education credits may be used for renewal of more than one class of license, but may only be used once for renewal of each class of license. Continuing education credits in excess of those required for renewal and earned prior to expiration of a license do not carry over to the next license term.

Continuing education credit is only received for verified attendance/completion of department approved courses as provided in Section 326B.0981, subdivision 5. License holders may receive credit for completing courses not previously approved by the department by submitting a nonrefundable fee of \$20 and an application for approval of the course.

Personal License and Examination Application

Personal license applications are included in the hard-copy packet or may be downloaded from the Department's website at: <http://dli.mn.gov/CCLD/Elevator.asp>.

Upon request this document can be made available in alternative formats for people with disabilities.