

**NCEES**  
*advancing licensure for  
engineers and surveyors*

**PE** 

**control systems**  
practice exam

Copyright © 2022 by NCEES®. All rights reserved.

All NCEES sample questions and solutions are copyrighted under the laws of the United States. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means without the prior written permission of NCEES. Requests for permissions should be sent to [permissions@ncees.org](mailto:permissions@ncees.org).

**ISBN 978-1-947801-10-3**

Printed in the United States of America  
April 2022 First Printing

# CONTENTS

<b>Introduction to NCEES Exams .....</b>	<b>1</b>
About NCEES	
Exam format	
Examinee Guide	
Scoring and reporting	
Updates on exam content and procedures	
<b>Exam Specifications.....</b>	<b>3</b>
<b>PE Control Systems Practice Exam.....</b>	<b>9</b>
<b>PE Control Systems Solutions .....</b>	<b>57</b>

## About NCEES

NCEES is a nonprofit organization made up of the U.S. engineering and surveying licensing boards in all 50 states, the U.S. territories, and the District of Columbia. We develop and score the exams used for engineering and surveying licensure in the United States. NCEES also promotes professional mobility through its services for licensees and its member boards.

Engineering licensure in the United States is regulated by licensing boards in each state and territory. These boards set and maintain the standards that protect the public they serve. As a result, licensing requirements and procedures vary by jurisdiction, so stay in touch with your board ([ncees.org/licensing-boards](http://ncees.org/licensing-boards)).

## Exam format

The PE Control Systems exam is computer-based. It contains 85 questions and is administered one day per year via computer at approved Pearson VUE test centers. A 9.5-hour appointment time includes a nondisclosure agreement, a tutorial, the exam, and a break. You'll have 8.5 hours to complete the actual exam.

In addition to traditional multiple-choice questions with one correct answer, the PE Control Systems exam will use common alternative item types such as

- Multiple correct options—allows multiple choices to be correct
- Point and click—requires examinees to click on part of a graphic to answer
- Drag and drop—requires examinees to click on and drag items to match, sort, rank, or label
- Fill in the blank—provides a space for examinees to enter a response to the question

To familiarize yourself with the format, style, and navigation of a computer-based exam, view the demo on [ncees.org/ExamPrep](http://ncees.org/ExamPrep).

## Examinee Guide

The *NCEES Examinee Guide* is the official guide to policies and procedures for all NCEES exams. During exam registration and again on exam day, examinees must agree to abide by the conditions in the *Examinee Guide*, which includes the CBT Examinee Rules and Agreement. You can download the *Examinee Guide* at [ncees.org/exams](http://ncees.org/exams). It is your responsibility to make sure you have the current version.

## Scoring and reporting

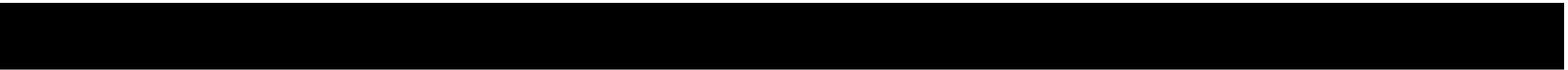
Results for computer-based exams are typically available 7–10 days after you take the exam. You will receive an email notification from NCEES with instructions to view your results in your MyNCEES account. All results are reported as pass or fail.

## Updates on exam content and procedures

Visit us at [ncees.org/exams](http://ncees.org/exams) for updates on everything exam-related, including specifications, exam-day policies, scoring, and corrections to published exam preparation materials. This is also where you will register for the exam and find additional steps you should follow in your state to be approved for the exam.



## **PE CONTROL SYSTEMS PRACTICE EXAM**



## PE CONTROL SYSTEMS PRACTICE EXAM

10. Which of the following flow measurement devices would be most accurate for measuring a natural gas flow at 100 MMscf/d, 240 psig, 120°F, and 0.6 specific gravity?
- A. Coriolis mass flowmeter
  - B. Concentric orifice plate and dP transmitter
  - C. Thermal probe mass flowmeter
  - D. Pitot tube
11. An orifice plate with a beta ratio of 0.63 is installed in a 24-in. Sch. 40 pipe. The orifice bore diameter (in.) is \_\_\_\_\_.

Enter your response in the blank.

## PE CONTROL SYSTEMS PRACTICE EXAM

53. According to ASME *Boiler and Pressure Vessel Code* Section VIII, to what temperature should a rupture disc be tested?
- A. Ambient temperature
  - B. Upset condition temperature
  - C. Normal operating temperature
  - D. The temperature at which the disc is expected to burst
54. To protect a steel safety-relief valve from a corrosive fluid in the pressure vessel, it is proposed to insert a Teflon-lined stainless steel rupture disc between the vessel and the relief valve. In order to comply with the ASME *Boiler and Pressure Vessel Code* Section VIII, Rules for Construction of Pressure Vessels, what must be done?

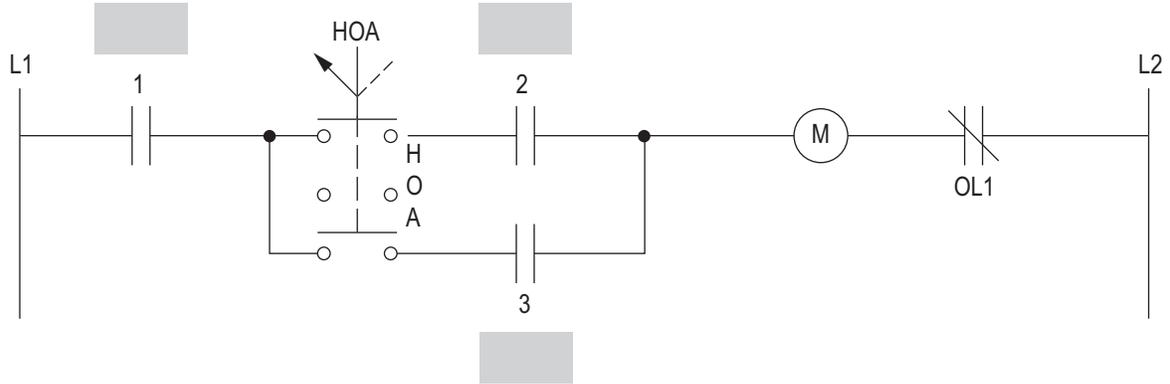
Select the **two** that apply.

- A. Install a pressure gauge, try cock, free vent, or tell-tale indicator between the disc and the relief valve.
- B. Install a rupture disc rated at 10% greater capacity than the relief valve.
- C. Derate the relief valve/rupture disc combination to 90% of the rated relieving capacity of the valve alone.
- D. Install a shutoff valve between the disc and the relief valve.
- E. Install a rupture disc rated at 20% greater capacity than the relief valve.
- F. Install a shutoff valve, with proper material compatibility to handle the corrosive liquid, between the rupture disc and the relief valve.

### PE CONTROL SYSTEMS PRACTICE EXAM

55. Safety requires an ESD trip of the motor shown in the figure. Operations wants to be able to start and stop the motor from the DCS. Maintenance wants to start the motor locally. What is the best location for the ESD and DCS contacts?

Match each term to its corresponding position.



DCS

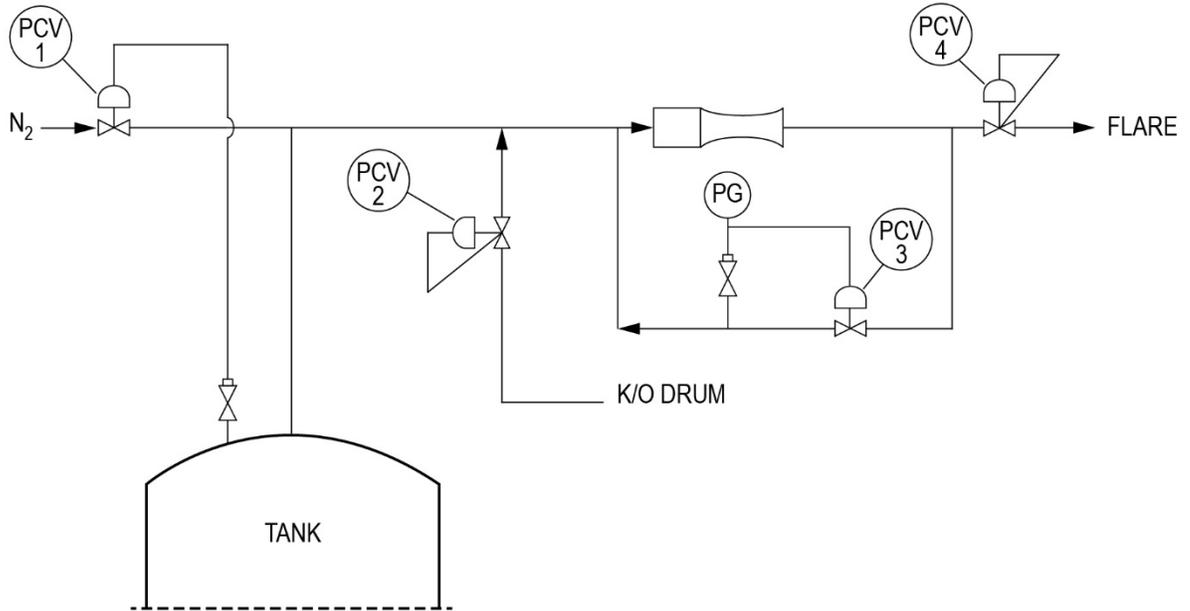
ESD

N/A

### PE CONTROL SYSTEMS PRACTICE EXAM

58. Per ISA 5.1 symbology, which of the PCVs in the diagram depicts a self-contained pressure-reducing pressure regulator?

Circle **all** the PCV that apply.



## PE CONTROL SYSTEMS PRACTICE EXAM

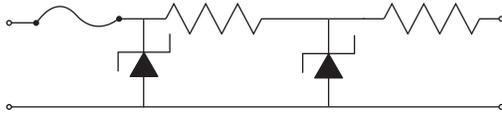
84. The set of activities involved in the design of safety instrumented systems, starting with the hazard and risk assessment and ending with decommissioning, is referred to as:
- A. the design life cycle
  - B. management of change
  - C. the safety requirements specification
  - D. the safety life cycle
85. What is the reason for performing management of change (MOC)?
- A. Recording all changes made to systems for tracking purposes
  - B. Ensuring that documentation reflects the actual plant design
  - C. Informing upper-level management of changes made to systems
  - D. Ensuring that safety is maintained, despite changes made to systems

## **PE CONTROL SYSTEMS SOLUTIONS**



## PE CONTROL SYSTEMS SOLUTIONS

9. A typical barrier is:



If the current rises to the danger point, the fuse blows and removes all power beyond the barrier.

**THE CORRECT ANSWER IS: D**

10. Of the technologies mentioned, Coriolis mass flowmeter is the most accurate.

**THE CORRECT ANSWER IS: A**

11. 24-in. Sch. 40 pipe I.D. is 22.624 in.

$$\begin{aligned} \frac{d}{D} &= \beta = 0.63 \\ d &= D \times 0.63 \\ &= 22.624 \times 0.63 \\ &= 14.253 \end{aligned}$$

**THE ACCEPTABLE RANGE IS: 14.2–14.3**

12. Transmitter range: 20 ft – 1 ft = 19 ft  
LAH alarm point: 17 ft – 1 ft – 1.5 ft = 14.5 ft  
LAL alarm point: 3 ft – 1 ft + 1.5 ft = 3.5 ft  
LAH:  $14.5/19 = 76.3\%$   
LAL:  $3.5/19 = 18.4\%$

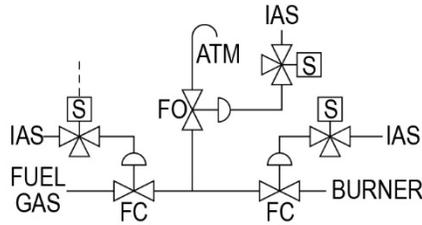
**THE CORRECT ANSWER IS: B**

13. Required process alarm % is  $\frac{85 \text{ gpm}}{100 \text{ gpm}} = 0.85$   
Required signal alarm =  $(0.85)(20 \text{ mA} - 4 \text{ mA}) + 4 \text{ mA} = 17.6 \text{ mA}$

**THE CORRECT ANSWER IS: C**

## PE CONTROL SYSTEMS SOLUTIONS

24. Option A is the correct answer for block-and-bleed arrangement in burner management systems.



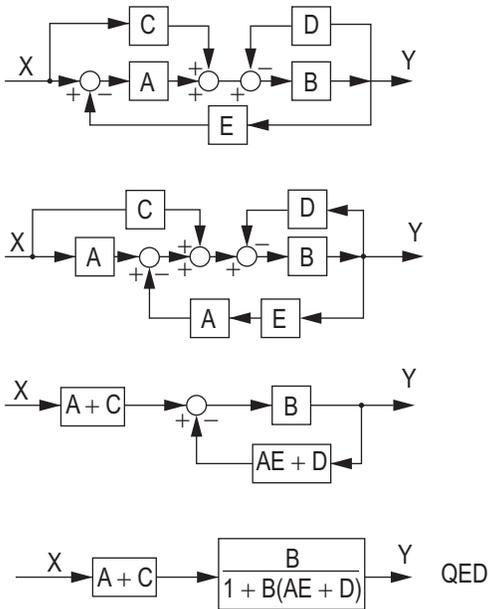
**Option A**

**THE CORRECT ANSWER IS: A**

25. A PFD provides the basic process flow scheme with simplified control devices. A piping and instrumentation diagram (P&ID) gives the process flow details. This includes all detailed devices such as inline instruments, valves, safety devices, and detailed controls, including sensing elements and final control devices such as control valves.

**THE CORRECT ANSWER IS: B**

- 26.



**THE CORRECT ANSWER IS: A**

## PE CONTROL SYSTEMS SOLUTIONS

53. ASME *Boiler and Pressure Vessel Code* Section VIII, UG-127, footnote 48, states that the rupture disc should be tested for the temperature at which the disc is expected to burst.

Other choices may be the expected burst temperature, but not necessarily.

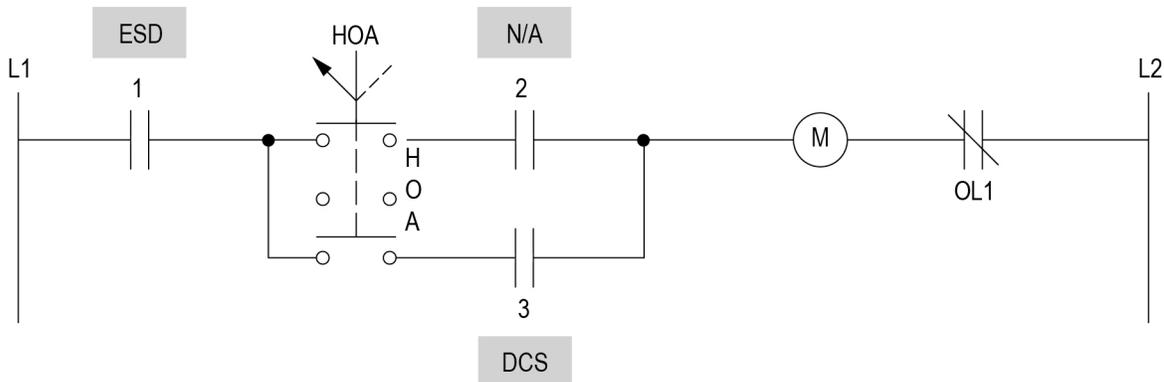
**THE CORRECT ANSWER IS: D**

54. Per ASME *Boiler and Pressure Vessel Code* Section VIII, UG-127, application of rupture discs: "The space between a rupture disc and a safety relief valve shall be provided with pressure gauge, try cock, free vent or suitable tell-tale indicator."

Per same section of ASME *Boiler and Pressure Vessel Code*: "The stamped capacity of a relief valve when installed with a rupture disc between the inlet of the valve and the vessel shall be multiplied by a factor of 0.90 of the rated relieving capacity of the valve alone."

**THE CORRECT ANSWERS ARE: A and C**

- 55.



**THE CORRECT ANSWER IS SHOWN ABOVE.**

56. 120 V ac and 24 V dc  
Motor control voltage = 120 V ac  
Control system discrete voltage = 24 V dc

**THE CORRECT ANSWER IS: A**

57. Insulation breakdown is not a consideration.

The parameter should be recorded during a test but is not a sizing consideration.

**THE CORRECT ANSWER IS: C**

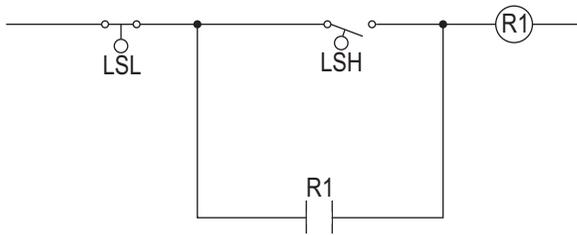
## PE CONTROL SYSTEMS SOLUTIONS

58. Self-contained pressure regulator, per ISA 5.1



**THE CORRECT ANSWER IS SHOWN ABOVE.**

59. Normally open LSH starts the sump pump. Relay R1 latches on the sump pump, keeping the pump running until normally closed LSL turns off the sump pump and unlatches the relay.



**THE CORRECT ANSWER IS: A**

60. Hermetically sealed switches are sometimes specified in lieu of using explosive-proof enclosures in Division 2 area classifications.

**THE CORRECT ANSWER IS: D**

61. The resolution is a function of whether the A/D converter is 8-, 12-, 16-bit, or higher. Once the input is converted, the processor and communication card resolution are irrelevant. The transmitter choice makes a difference if it is digital vs. analog, but scaling of the transmitter in a digital system is rarely chosen for resolution.

**THE CORRECT ANSWER IS: C**

62. Option A will not work because the 24-V dc will not operate the 120-V ac starter. Options C and D will not work because the transistors will not tolerate the 120-V ac. Option B uses an interposing relay to mitigate the voltage concern.

**THE CORRECT ANSWER IS: B**

63. NEMA 4 is the correct answer because it is the most appropriate for outdoor use. NEMA 4 provides protection against rain, sleet, snow, splashing water, and hose-directed water. NEMA 3R provides protection against rain, sleet, and snow. NEMA 7 and 12 are for indoor use.

**THE CORRECT ANSWER IS: B**

## PE CONTROL SYSTEMS SOLUTIONS

79. Safety integrity levels (SILs) are assigned to each safety instrumented function (SIF).

**THE CORRECT ANSWER IS: C**

80.  $MTTF_{\text{sensor}} = 30 \text{ years}$        $MTTF_{\text{relay}} = 1,000 \text{ years}$        $MTTF_{\text{valve}} = 40 \text{ years}$

$$\lambda_{\text{DU}} = \frac{1}{MTTF}$$

$$\left[ \frac{1}{30 \text{ years}} + \frac{1}{1,000 \text{ years}} + \frac{1}{40 \text{ years}} + \frac{1}{40 \text{ years}} \right] \times \frac{1}{2} = 4.22 \times 10^{-2}$$

**THE CORRECT ANSWER IS: D**

81. Ladder logic is specifically listed in the definition in Clause 3.2.81.1.2.

**THE CORRECT ANSWER IS: A**

82. NFPA 85, Figure 3.4.3.3.1 states: "Five-minute time delay or five volume changes, whichever is longer" before "reset master fuel trip relay(s)."

**THE CORRECT ANSWER IS: D**

83. Per ISA/IEC 61511, Clause 17.2

**THE CORRECT ANSWER IS: A**

84. Safety life cycle per Clause 6 of the standard ISA/IEC-61511.

**THE CORRECT ANSWER IS: D**

85. Based on Clause 17.1 of ISA/IEC-61511, ensuring that safety is maintained despite changes made to systems.

**THE CORRECT ANSWER IS: D**