

Wisconsin Contractors Institute
N16 W23217 Stone Ridge Drive
Suite 290
Waukesha, WI 53188

We have enclosed the following courses for you:

<u>Course Name</u>	<u>Course Hours</u>	<u>Price</u>
2017 NEC Code Change pt 1		
2017 NEC Code Change pt 2		
2017 NEC Article 250		
2017 NEC Article 517		
2017 NEC Article 680		
Total	24	\$195

Here are the 2 steps required to complete the courses:

1. Read the enclosed courses and fill out the answer sheets found in the booklets.
2. Submit your exams using your exam links after purchase.

Payment can be made on our website <https://wicontractorinstitute.com/> or by phone #262.409.4282

ATTENTION: Starting MARCH 31st, 2026 we will no longer be offering Walk In assistance answer sheets at our local office. Any and all information, or questions will need to be through Phone or Email.

If you have any other questions, please feel free to give us a call at 262-409-4282.

Thank you!

WCI
262-409-4282
www.wcittraining.com

ANSWER SHEET • 2017 NEC CODE CHANGE • PART 1

First Name: _____ Last Name: _____ Date: _____

Address: _____ City: _____ State: _____ ZIP: _____

License #: _____ Phone: _____ Email: _____

**** See instructions on the inside cover page to submit your exams and pay for your course**

- | | | | |
|---|---|---|--|
| 1. ☐ A ☐ B ☐ C ☐ D | 28. ☐ A ☐ B ☐ C ☐ D | 55. ☐ A ☐ B ☐ C ☐ D | 82. ☐ A ☐ B ☐ C ☐ D |
| 2. ☐ A ☐ B ☐ C ☐ D | 29. ☐ A ☐ B ☐ C ☐ D | 56. ☐ A ☐ B ☐ C ☐ D | 83. ☐ A ☐ B ☐ C ☐ D |
| 3. ☐ A ☐ B ☐ C ☐ D | 30. ☐ A ☐ B ☐ C ☐ D | 57. ☐ A ☐ B ☐ C ☐ D | 84. ☐ A ☐ B ☐ C ☐ D |
| 4. ☐ A ☐ B ☐ C ☐ D | 31. ☐ A ☐ B ☐ C ☐ D | 58. ☐ A ☐ B ☐ C ☐ D | 85. ☐ A ☐ B ☐ C ☐ D |
| 5. ☐ A ☐ B ☐ C ☐ D | 32. ☐ A ☐ B ☐ C ☐ D | 59. ☐ A ☐ B ☐ C ☐ D | 86. ☐ A ☐ B ☐ C ☐ D |
| 6. ☐ A ☐ B ☐ C ☐ D | 33. ☐ A ☐ B ☐ C ☐ D | 60. ☐ A ☐ B ☐ C ☐ D | 87. ☐ A ☐ B ☐ C ☐ D |
| 7. ☐ A ☐ B ☐ C ☐ D | 34. ☐ A ☐ B ☐ C ☐ D | 61. ☐ A ☐ B ☐ C ☐ D | 88. ☐ A ☐ B ☐ C ☐ D |
| 8. ☐ A ☐ B ☐ C ☐ D | 35. ☐ A ☐ B ☐ C ☐ D | 62. ☐ A ☐ B ☐ C ☐ D | 89. ☐ A ☐ B ☐ C ☐ D |
| 9. ☐ A ☐ B ☐ C ☐ D | 36. ☐ A ☐ B ☐ C ☐ D | 63. ☐ A ☐ B ☐ C ☐ D | 90. ☐ A ☐ B ☐ C ☐ D |
| 10. ☐ A ☐ B ☐ C ☐ D | 37. ☐ A ☐ B ☐ C ☐ D | 64. ☐ A ☐ B ☐ C ☐ D | 91. ☐ A ☐ B ☐ C ☐ D |
| 11. ☐ A ☐ B ☐ C ☐ D | 38. ☐ A ☐ B ☐ C ☐ D | 65. ☐ A ☐ B ☐ C ☐ D | 92. ☐ A ☐ B ☐ C ☐ D |
| 12. ☐ A ☐ B ☐ C ☐ D | 39. ☐ A ☐ B ☐ C ☐ D | 66. ☐ A ☐ B ☐ C ☐ D | 93. ☐ A ☐ B ☐ C ☐ D |
| 13. ☐ A ☐ B ☐ C ☐ D | 40. ☐ A ☐ B ☐ C ☐ D | 67. ☐ A ☐ B ☐ C ☐ D | 94. ☐ A ☐ B ☐ C ☐ D |
| 14. ☐ A ☐ B ☐ C ☐ D | 41. ☐ A ☐ B ☐ C ☐ D | 68. ☐ A ☐ B ☐ C ☐ D | 95. ☐ A ☐ B ☐ C ☐ D |
| 15. ☐ A ☐ B ☐ C ☐ D | 42. ☐ A ☐ B ☐ C ☐ D | 69. ☐ A ☐ B ☐ C ☐ D | 96. ☐ A ☐ B ☐ C ☐ D |
| 16. ☐ A ☐ B ☐ C ☐ D | 43. ☐ A ☐ B ☐ C ☐ D | 70. ☐ A ☐ B ☐ C ☐ D | 97. ☐ A ☐ B ☐ C ☐ D |
| 17. ☐ A ☐ B ☐ C ☐ D | 44. ☐ A ☐ B ☐ C ☐ D | 71. ☐ A ☐ B ☐ C ☐ D | 98. ☐ A ☐ B ☐ C ☐ D |
| 18. ☐ A ☐ B ☐ C ☐ D | 45. ☐ A ☐ B ☐ C ☐ D | 72. ☐ A ☐ B ☐ C ☐ D | 99. ☐ A ☐ B ☐ C ☐ D |
| 19. ☐ A ☐ B ☐ C ☐ D | 46. ☐ A ☐ B ☐ C ☐ D | 73. ☐ A ☐ B ☐ C ☐ D | 100. ☐ A ☐ B ☐ C ☐ D |
| 20. ☐ A ☐ B ☐ C ☐ D | 47. ☐ A ☐ B ☐ C ☐ D | 74. ☐ A ☐ B ☐ C ☐ D | 101. ☐ A ☐ B ☐ C ☐ D |
| 21. ☐ A ☐ B ☐ C ☐ D | 48. ☐ A ☐ B ☐ C ☐ D | 75. ☐ A ☐ B ☐ C ☐ D | 102. ☐ A ☐ B ☐ C ☐ D |
| 22. ☐ A ☐ B ☐ C ☐ D | 49. ☐ A ☐ B ☐ C ☐ D | 76. ☐ A ☐ B ☐ C ☐ D | 103. ☐ A ☐ B ☐ C ☐ D |
| 23. ☐ A ☐ B ☐ C ☐ D | 50. ☐ A ☐ B ☐ C ☐ D | 77. ☐ A ☐ B ☐ C ☐ D | 104. ☐ A ☐ B ☐ C ☐ D |
| 24. ☐ A ☐ B ☐ C ☐ D | 51. ☐ A ☐ B ☐ C ☐ D | 78. ☐ A ☐ B ☐ C ☐ D | 105. ☐ A ☐ B ☐ C ☐ D |
| 25. ☐ A ☐ B ☐ C ☐ D | 52. ☐ A ☐ B ☐ C ☐ D | 79. ☐ A ☐ B ☐ C ☐ D | 106. ☐ A ☐ B ☐ C ☐ D |
| 26. ☐ A ☐ B ☐ C ☐ D | 53. ☐ A ☐ B ☐ C ☐ D | 80. ☐ A ☐ B ☐ C ☐ D | 107. ☐ A ☐ B ☐ C ☐ D |
| 27. ☐ A ☐ B ☐ C ☐ D | 54. ☐ A ☐ B ☐ C ☐ D | 81. ☐ A ☐ B ☐ C ☐ D | 108. ☐ A ☐ B ☐ C ☐ D |



109. ☐ A ☐ B ☐ C ☐ D
110. ☐ A ☐ B ☐ C ☐ D
111. ☐ A ☐ B ☐ C ☐ D
112. ☐ A ☐ B ☐ C ☐ D
113. ☐ A ☐ B ☐ C ☐ D
114. ☐ A ☐ B ☐ C ☐ D
115. ☐ A ☐ B ☐ C ☐ D
116. ☐ A ☐ B ☐ C ☐ D
117. ☐ A ☐ B ☐ C ☐ D
118. ☐ A ☐ B ☐ C ☐ D
119. ☐ A ☐ B ☐ C ☐ D
120. ☐ A ☐ B ☐ C ☐ D
121. ☐ A ☐ B ☐ C ☐ D
122. ☐ A ☐ B ☐ C ☐ D
123. ☐ A ☐ B ☐ C ☐ D
124. ☐ A ☐ B ☐ C ☐ D
125. ☐ A ☐ B ☐ C ☐ D
126. ☐ A ☐ B ☐ C ☐ D
127. ☐ A ☐ B ☐ C ☐ D
128. ☐ A ☐ B ☐ C ☐ D
129. ☐ A ☐ B ☐ C ☐ D
130. ☐ A ☐ B ☐ C ☐ D
131. ☐ A ☐ B ☐ C ☐ D
132. ☐ A ☐ B ☐ C ☐ D
133. ☐ A ☐ B ☐ C ☐ D
134. ☐ A ☐ B ☐ C ☐ D
135. ☐ A ☐ B ☐ C ☐ D
136. ☐ A ☐ B ☐ C ☐ D
137. ☐ A ☐ B ☐ C ☐ D
138. ☐ A ☐ B ☐ C ☐ D
139. ☐ A ☐ B ☐ C ☐ D
140. ☐ A ☐ B ☐ C ☐ D
141. ☐ A ☐ B ☐ C ☐ D

142. ☐ A ☐ B ☐ C ☐ D
143. ☐ A ☐ B ☐ C ☐ D
144. ☐ A ☐ B ☐ C ☐ D
145. ☐ A ☐ B ☐ C ☐ D
146. ☐ A ☐ B ☐ C ☐ D
147. ☐ A ☐ B ☐ C ☐ D
148. ☐ A ☐ B ☐ C ☐ D
149. ☐ A ☐ B ☐ C ☐ D
150. ☐ A ☐ B ☐ C ☐ D
151. ☐ A ☐ B ☐ C ☐ D
152. ☐ A ☐ B ☐ C ☐ D
153. ☐ A ☐ B ☐ C ☐ D
154. ☐ A ☐ B ☐ C ☐ D
155. ☐ A ☐ B ☐ C ☐ D
156. ☐ A ☐ B ☐ C ☐ D
157. ☐ A ☐ B ☐ C ☐ D
158. ☐ A ☐ B ☐ C ☐ D
159. ☐ A ☐ B ☐ C ☐ D
160. ☐ A ☐ B ☐ C ☐ D
161. ☐ A ☐ B ☐ C ☐ D
162. ☐ A ☐ B ☐ C ☐ D
163. ☐ A ☐ B ☐ C ☐ D
164. ☐ A ☐ B ☐ C ☐ D
165. ☐ A ☐ B ☐ C ☐ D
166. ☐ A ☐ B ☐ C ☐ D
167. ☐ A ☐ B ☐ C ☐ D
168. ☐ A ☐ B ☐ C ☐ D
169. ☐ A ☐ B ☐ C ☐ D
170. ☐ A ☐ B ☐ C ☐ D
171. ☐ A ☐ B ☐ C ☐ D
172. ☐ A ☐ B ☐ C ☐ D
173. ☐ A ☐ B ☐ C ☐ D
174. ☐ A ☐ B ☐ C ☐ D

175. ☐ A ☐ B ☐ C ☐ D
176. ☐ A ☐ B ☐ C ☐ D
177. ☐ A ☐ B ☐ C ☐ D
178. ☐ A ☐ B ☐ C ☐ D
179. ☐ A ☐ B ☐ C ☐ D
180. ☐ A ☐ B ☐ C ☐ D
181. ☐ A ☐ B ☐ C ☐ D
182. ☐ A ☐ B ☐ C ☐ D
183. ☐ A ☐ B ☐ C ☐ D
184. ☐ A ☐ B ☐ C ☐ D
185. ☐ A ☐ B ☐ C ☐ D
186. ☐ A ☐ B ☐ C ☐ D
187. ☐ A ☐ B ☐ C ☐ D
188. ☐ A ☐ B ☐ C ☐ D
189. ☐ A ☐ B ☐ C ☐ D
190. ☐ A ☐ B ☐ C ☐ D
191. ☐ A ☐ B ☐ C ☐ D
192. ☐ A ☐ B ☐ C ☐ D
193. ☐ A ☐ B ☐ C ☐ D
194. ☐ A ☐ B ☐ C ☐ D
195. ☐ A ☐ B ☐ C ☐ D
196. ☐ A ☐ B ☐ C ☐ D
197. ☐ A ☐ B ☐ C ☐ D
198. ☐ A ☐ B ☐ C ☐ D
199. ☐ A ☐ B ☐ C ☐ D
200. ☐ A ☐ B ☐ C ☐ D
201. ☐ A ☐ B ☐ C ☐ D
202. ☐ A ☐ B ☐ C ☐ D
203. ☐ A ☐ B ☐ C ☐ D
204. ☐ A ☐ B ☐ C ☐ D
205. ☐ A ☐ B ☐ C ☐ D
206. ☐ A ☐ B ☐ C ☐ D
207. ☐ A ☐ B ☐ C ☐ D

208. ☐ A ☐ B ☐ C ☐ D
209. ☐ A ☐ B ☐ C ☐ D
210. ☐ A ☐ B ☐ C ☐ D
211. ☐ A ☐ B ☐ C ☐ D
212. ☐ A ☐ B ☐ C ☐ D
213. ☐ A ☐ B ☐ C ☐ D
214. ☐ A ☐ B ☐ C ☐ D
215. ☐ A ☐ B ☐ C ☐ D
216. ☐ A ☐ B ☐ C ☐ D
217. ☐ A ☐ B ☐ C ☐ D
218. ☐ A ☐ B ☐ C ☐ D
219. ☐ A ☐ B ☐ C ☐ D
220. ☐ A ☐ B ☐ C ☐ D
221. ☐ A ☐ B ☐ C ☐ D
222. ☐ A ☐ B ☐ C ☐ D
223. ☐ A ☐ B ☐ C ☐ D
224. ☐ A ☐ B ☐ C ☐ D
225. ☐ A ☐ B ☐ C ☐ D
226. ☐ A ☐ B ☐ C ☐ D
227. ☐ A ☐ B ☐ C ☐ D
228. ☐ A ☐ B ☐ C ☐ D
229. ☐ A ☐ B ☐ C ☐ D
230. ☐ A ☐ B ☐ C ☐ D
231. ☐ A ☐ B ☐ C ☐ D
232. ☐ A ☐ B ☐ C ☐ D
233. ☐ A ☐ B ☐ C ☐ D
234. ☐ A ☐ B ☐ C ☐ D
235. ☐ A ☐ B ☐ C ☐ D
236. ☐ A ☐ B ☐ C ☐ D
237. ☐ A ☐ B ☐ C ☐ D
238. ☐ A ☐ B ☐ C ☐ D
239. ☐ A ☐ B ☐ C ☐ D
240. ☐ A ☐ B ☐ C ☐ D



ANSWER SHEET • ARTICLE: 250

First Name: _____ Last Name: _____ Date: _____

Address: _____ City: _____ State: _____ ZIP: _____

License #: _____ Phone: _____ Email: _____

**** See instructions on the inside cover page to submit your exams and pay for your course**1. **A B C D**2. **A B C D**3. **A B C D**4. **A B C D**5. **A B C D**6. **A B C D**7. **A B C D**8. **A B C D**9. **A B C D**10. **A B C D**11. **A B C D**12. **A B C D**13. **A B C D**14. **A B C D**15. **A B C D**16. **A B C D**17. **A B C D**18. **A B C D**19. **A B C D**20. **A B C D**21. **A B C D**22. **A B C D**23. **A B C D**24. **A B C D**25. **A B C D**26. **A B C D**27. **A B C D**28. **A B C D**29. **A B C D**30. **A B C D**31. **A B C D**32. **A B C D**33. **A B C D**34. **A B C D**35. **A B C D**36. **A B C D**37. **A B C D**38. **A B C D**39. **A B C D**40. **A B C D**41. **A B C D**42. **A B C D**43. **A B C D**44. **A B C D**45. **A B C D**46. **A B C D**47. **A B C D**48. **A B C D**49. **A B C D**50. **A B C D**51. **A B C D**52. **A B C D**53. **A B C D**54. **A B C D**55. **A B C D**56. **A B C D**57. **A B C D**58. **A B C D**59. **A B C D**60. **A B C D**

ANSWER SHEET • ARTICLE 517

First Name: _____ Last Name: _____ Date: _____

Address: _____ City: _____ State: _____ ZIP: _____

License #: _____ Phone: _____ Email: _____

**** See instructions on the inside cover page to submit your exams and pay for your course**

- | | | | |
|---|---|---|---|
| 1. ☐ A ☐ B ☐ C ☐ D | 26. ☐ A ☐ B ☐ C ☐ D | 51. ☐ A ☐ B ☐ C ☐ D | 76. ☐ A ☐ B ☐ C ☐ D |
| 2. ☐ A ☐ B ☐ C ☐ D | 27. ☐ A ☐ B ☐ C ☐ D | 52. ☐ A ☐ B ☐ C ☐ D | 77. ☐ A ☐ B ☐ C ☐ D |
| 3. ☐ A ☐ B ☐ C ☐ D | 28. ☐ A ☐ B ☐ C ☐ D | 53. ☐ A ☐ B ☐ C ☐ D | 78. ☐ A ☐ B ☐ C ☐ D |
| 4. ☐ A ☐ B ☐ C ☐ D | 29. ☐ A ☐ B ☐ C ☐ D | 54. ☐ A ☐ B ☐ C ☐ D | 79. ☐ A ☐ B ☐ C ☐ D |
| 5. ☐ A ☐ B ☐ C ☐ D | 30. ☐ A ☐ B ☐ C ☐ D | 55. ☐ A ☐ B ☐ C ☐ D | 80. ☐ A ☐ B ☐ C ☐ D |
| 6. ☐ A ☐ B ☐ C ☐ D | 31. ☐ A ☐ B ☐ C ☐ D | 56. ☐ A ☐ B ☐ C ☐ D | 81. ☐ A ☐ B ☐ C ☐ D |
| 7. ☐ A ☐ B ☐ C ☐ D | 32. ☐ A ☐ B ☐ C ☐ D | 57. ☐ A ☐ B ☐ C ☐ D | 82. ☐ A ☐ B ☐ C ☐ D |
| 8. ☐ A ☐ B ☐ C ☐ D | 33. ☐ A ☐ B ☐ C ☐ D | 58. ☐ A ☐ B ☐ C ☐ D | 83. ☐ A ☐ B ☐ C ☐ D |
| 9. ☐ A ☐ B ☐ C ☐ D | 34. ☐ A ☐ B ☐ C ☐ D | 59. ☐ A ☐ B ☐ C ☐ D | 84. ☐ A ☐ B ☐ C ☐ D |
| 10. ☐ A ☐ B ☐ C ☐ D | 35. ☐ A ☐ B ☐ C ☐ D | 60. ☐ A ☐ B ☐ C ☐ D | 85. ☐ A ☐ B ☐ C ☐ D |
| 11. ☐ A ☐ B ☐ C ☐ D | 36. ☐ A ☐ B ☐ C ☐ D | 61. ☐ A ☐ B ☐ C ☐ D | 86. ☐ A ☐ B ☐ C ☐ D |
| 12. ☐ A ☐ B ☐ C ☐ D | 37. ☐ A ☐ B ☐ C ☐ D | 62. ☐ A ☐ B ☐ C ☐ D | 87. ☐ A ☐ B ☐ C ☐ D |
| 13. ☐ A ☐ B ☐ C ☐ D | 38. ☐ A ☐ B ☐ C ☐ D | 63. ☐ A ☐ B ☐ C ☐ D | 88. ☐ A ☐ B ☐ C ☐ D |
| 14. ☐ A ☐ B ☐ C ☐ D | 39. ☐ A ☐ B ☐ C ☐ D | 64. ☐ A ☐ B ☐ C ☐ D | 89. ☐ A ☐ B ☐ C ☐ D |
| 15. ☐ A ☐ B ☐ C ☐ D | 40. ☐ A ☐ B ☐ C ☐ D | 65. ☐ A ☐ B ☐ C ☐ D | 90. ☐ A ☐ B ☐ C ☐ D |
| 16. ☐ A ☐ B ☐ C ☐ D | 41. ☐ A ☐ B ☐ C ☐ D | 66. ☐ A ☐ B ☐ C ☐ D | |
| 17. ☐ A ☐ B ☐ C ☐ D | 42. ☐ A ☐ B ☐ C ☐ D | 67. ☐ A ☐ B ☐ C ☐ D | |
| 18. ☐ A ☐ B ☐ C ☐ D | 43. ☐ A ☐ B ☐ C ☐ D | 68. ☐ A ☐ B ☐ C ☐ D | |
| 19. ☐ A ☐ B ☐ C ☐ D | 44. ☐ A ☐ B ☐ C ☐ D | 69. ☐ A ☐ B ☐ C ☐ D | |
| 20. ☐ A ☐ B ☐ C ☐ D | 45. ☐ A ☐ B ☐ C ☐ D | 70. ☐ A ☐ B ☐ C ☐ D | |
| 21. ☐ A ☐ B ☐ C ☐ D | 46. ☐ A ☐ B ☐ C ☐ D | 71. ☐ A ☐ B ☐ C ☐ D | |
| 22. ☐ A ☐ B ☐ C ☐ D | 47. ☐ A ☐ B ☐ C ☐ D | 72. ☐ A ☐ B ☐ C ☐ D | |
| 23. ☐ A ☐ B ☐ C ☐ D | 48. ☐ A ☐ B ☐ C ☐ D | 73. ☐ A ☐ B ☐ C ☐ D | |
| 24. ☐ A ☐ B ☐ C ☐ D | 49. ☐ A ☐ B ☐ C ☐ D | 74. ☐ A ☐ B ☐ C ☐ D | |
| 25. ☐ A ☐ B ☐ C ☐ D | 50. ☐ A ☐ B ☐ C ☐ D | 75. ☐ A ☐ B ☐ C ☐ D | |



ANSWER SHEET • ARTICLE 680

First Name: _____ Last Name: _____ Date: _____

Address: _____ City: _____ State: _____ ZIP: _____

License #: _____ Phone: _____ Email: _____

**** See instructions on the inside cover page to submit your exams and pay for your course**

1. ☐ A ☐ B ☐ C ☐ D
2. ☐ A ☐ B ☐ C ☐ D
3. ☐ A ☐ B ☐ C ☐ D
4. ☐ A ☐ B ☐ C ☐ D
5. ☐ A ☐ B ☐ C ☐ D

6. ☐ A ☐ B ☐ C ☐ D
7. ☐ A ☐ B ☐ C ☐ D
8. ☐ A ☐ B ☐ C ☐ D
9. ☐ A ☐ B ☐ C ☐ D
10. ☐ A ☐ B ☐ C ☐ D
11. ☐ A ☐ B ☐ C ☐ D

12. ☐ A ☐ B ☐ C ☐ D
13. ☐ A ☐ B ☐ C ☐ D
14. ☐ A ☐ B ☐ C ☐ D
15. ☐ A ☐ B ☐ C ☐ D
16. ☐ A ☐ B ☐ C ☐ D
17. ☐ A ☐ B ☐ C ☐ D

18. ☐ A ☐ B ☐ C ☐ D
19. ☐ A ☐ B ☐ C ☐ D
20. ☐ A ☐ B ☐ C ☐ D
21. ☐ A ☐ B ☐ C ☐ D
22. ☐ A ☐ B ☐ C ☐ D
23. ☐ A ☐ B ☐ C ☐ D

24. ☐ A ☐ B ☐ C ☐ D
25. ☐ A ☐ B ☐ C ☐ D

26. ☐ A ☐ B ☐ C ☐ D
27. ☐ A ☐ B ☐ C ☐ D
28. ☐ A ☐ B ☐ C ☐ D
29. ☐ A ☐ B ☐ C ☐ D

30. ☐ A ☐ B ☐ C ☐ D
31. ☐ A ☐ B ☐ C ☐ D
32. ☐ A ☐ B ☐ C ☐ D
33. ☐ A ☐ B ☐ C ☐ D
34. ☐ A ☐ B ☐ C ☐ D
35. ☐ A ☐ B ☐ C ☐ D
36. ☐ A ☐ B ☐ C ☐ D

37. ☐ A ☐ B ☐ C ☐ D
38. ☐ A ☐ B ☐ C ☐ D
39. ☐ A ☐ B ☐ C ☐ D
40. ☐ A ☐ B ☐ C ☐ D
41. ☐ A ☐ B ☐ C ☐ D

42. ☐ A ☐ B ☐ C ☐ D
43. ☐ A ☐ B ☐ C ☐ D
44. ☐ A ☐ B ☐ C ☐ D
45. ☐ A ☐ B ☐ C ☐ D
46. ☐ A ☐ B ☐ C ☐ D

47. ☐ A ☐ B ☐ C ☐ D
48. ☐ A ☐ B ☐ C ☐ D
49. ☐ A ☐ B ☐ C ☐ D
50. ☐ A ☐ B ☐ C ☐ D

51. ☐ A ☐ B ☐ C ☐ D
52. ☐ A ☐ B ☐ C ☐ D
53. ☐ A ☐ B ☐ C ☐ D
54. ☐ A ☐ B ☐ C ☐ D

55. ☐ A ☐ B ☐ C ☐ D
56. ☐ A ☐ B ☐ C ☐ D
57. ☐ A ☐ B ☐ C ☐ D
58. ☐ A ☐ B ☐ C ☐ D
59. ☐ A ☐ B ☐ C ☐ D
60. ☐ A ☐ B ☐ C ☐ D

61. ☐ A ☐ B ☐ C ☐ D
62. ☐ A ☐ B ☐ C ☐ D
63. ☐ A ☐ B ☐ C ☐ D
64. ☐ A ☐ B ☐ C ☐ D
65. ☐ A ☐ B ☐ C ☐ D
66. ☐ A ☐ B ☐ C ☐ D

67. ☐ A ☐ B ☐ C ☐ D
68. ☐ A ☐ B ☐ C ☐ D
69. ☐ A ☐ B ☐ C ☐ D
70. ☐ A ☐ B ☐ C ☐ D
71. ☐ A ☐ B ☐ C ☐ D
72. ☐ A ☐ B ☐ C ☐ D

73. ☐ A ☐ B ☐ C ☐ D
74. ☐ A ☐ B ☐ C ☐ D
75. ☐ A ☐ B ☐ C ☐ D

76. ☐ A ☐ B ☐ C ☐ D

77. ☐ A ☐ B ☐ C ☐ D
78. ☐ A ☐ B ☐ C ☐ D
79. ☐ A ☐ B ☐ C ☐ D
80. ☐ A ☐ B ☐ C ☐ D

81. ☐ A ☐ B ☐ C ☐ D
82. ☐ A ☐ B ☐ C ☐ D
83. ☐ A ☐ B ☐ C ☐ D
84. ☐ A ☐ B ☐ C ☐ D

85. ☐ A ☐ B ☐ C ☐ D
86. ☐ A ☐ B ☐ C ☐ D
87. ☐ A ☐ B ☐ C ☐ D
88. ☐ A ☐ B ☐ C ☐ D
89. ☐ A ☐ B ☐ C ☐ D

90. ☐ A ☐ B ☐ C ☐ D



Wisconsin Contractors Institute

CONTINUING EDUCATION FOR WISCONSIN ELECTRICIANS



2017 NEC CODE CHANGE Part 1 ■ 8 Hours

WISCONSIN CONTRACTORS INSTITUTE

262-409-4282

www.wcittraining.com

DISCLAIMER NOTE: This course is APPROVED by the Wisconsin Department of safety and professional services for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes.

2017 NEC Code Change • Part 1

The following course will summarize many of the important changes to the NEC code.

This course covers the changes, revisions and additions made to the 2017 Code.

(Revised) 90.3 Code Arrangement. This Code is divided into the introduction and nine chapters, as shown in Figure 90.3. Chapters 1, 2, 3, and 4 apply generally. Chapters 5, 6, and 7 apply to special occupancies, special equipment, or other special conditions and may supplement or modify the requirements in Chapters 1 through 7.

(Revised) 90.7 Informational Note No. 3: Informative Annex A contains a list of product safety standards that are compatible with this Code.

(Revised) 100 Scope. This article contains only those definitions essential to the application of this Code. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. In general, only those terms that are used in two or more articles are defined in Article 100. Other definitions are included in the article in which they are used but may be referenced in Article 100. Part I of this article contains definitions intended to apply wherever the terms are used throughout this Code. Part II contains definitions applicable to installations and equipment operating at over 1000 volts, nominal.

(Revised) Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

(NEW) Informational Note: Use of keys is a common practice under controlled or supervised conditions and a common alternative to the ready access requirements under such supervised conditions as provided elsewhere in the NEC.



(Revised) Building. A structure that stands alone or that is separated from adjoining structures by fire walls.

(Revised) Cable Routing Assembly. A single channel or connected multiple channels, as well as associated fittings, forming a structural system that is used to support and route communications wires and cables, optical fiber cables, data cables associated with information technology and communications equipment, Class 2, Class 3, and Type PLTC cables, and power-limited fire alarm cables in plenum, riser, and general-purpose applications.

(Revised) Combustible Dust [as applied to Hazardous (Classified) Locations]. Dust particles that are 500 microns or smaller (i.e., material passing a U.S. No. 35 Standard Sieve as defined in ASTM E11-2015, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves), and present a fire or explosion hazard when dispersed and ignited in air.



(NEW) Informational Note: As the telecommunications network transitions to a more data-centric network, computers, routers, servers, and their powering equipment, are becoming essential to the transmission of audio, video, and data and are finding increasing application in communications equipment installations.

(NEW) Cord Connector [as applied to Hazardous (Classified) Locations]. A fitting intended to terminate a cord to a box or similar device and reduce the strain at points of termination and may include an explosionproof, a dust-ignitionproof, or a flameproof seal.

PART 1 EXAM QUESTIONS

1. In a hazardous location, the fitting intended to terminate a cord to a box or similar device and reduce the strain at points of termination and may include an explosionproof, a dust-ignitionproof, or a flameproof seal is best defined as?
 - A. "CGB"
 - B. "Kalum's" grip
 - C. Cord Connector
 - D. All listed answers
2. What chapter(s) of the 2017 Code apply to special conditions for electrical installations?
 - A. 8
 - B. 1, 2, 3, and 4
 - C. 5, 6, and 7
 - D. 7
3. What article covers the definitions portion of the 2017 Code?
 - A. 100
 - B. 110
 - C. 90
 - D. 200
4. What item is used as a common practice under controlled or supervised conditions regarding access to electrical equipment?
 - A. Screw driver
 - B. Key
 - C. Motion switch
 - D. Access code
5. What chapter(s) of the 2017 Code apply to general electrical installations?
 - A. 7
 - B. 5, 6, and 7
 - C. 8
 - D. 1, 2, 3, and 4
6. What best defines a structure that is separated from adjoining structures by fire walls?
 - A. Building
 - B. Tower structure
 - C. Network room
 - D. Telecommunications room
7. What is the minimum system voltage that part II of Article 100 covers?
 - A. 600
 - B. 1000
 - C. 575
 - D. 480
8. What type of cables are generally used in a cable routing assembly?
 - A. PLTC cables
 - B. Class 2 cables
 - C. Class 3 cables
 - D. All listed answers
9. What is the minimum size dust particle that is considered hazardous?
 - A. 200 microns
 - B. 50 microns
 - C. 500 microns
 - D. 35 microns
10. What annex contains a list of product safety standards that are compatible with the 2017 Code?
 - A. A
 - B. B
 - C. C
 - D. C

11. What is becoming essential to the transmission of audio, video, and data with regards to data-centric networks?

- A. Servers
- B. Routers
- C. Computers
- D. All listed answers

12. How many Chapters are in the 2017 NEC?

- A. 7
- B. 10
- C. 8
- D. 9

13. What best defines the ability of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth?

- A. Accessible, Readily (Readily Accessible)
- B. Accessible
- C. Open
- D. Guarded

(Revised) Dusttight. Enclosures constructed so that dust will not enter under specified test conditions.

(NEW) Informational Note No. 1: Enclosure Types 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13, per ANSI/NEMA 250-2014, Enclosures for Electrical Equipment, are considered dusttight and suitable for use in unclassified locations and in Class II, Division 2; Class III; and Zone 22 hazardous (classified) locations.

(NEW) Informational Note No. 2: For further information, see ANSI/ISA-12.12.01-2013, Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.

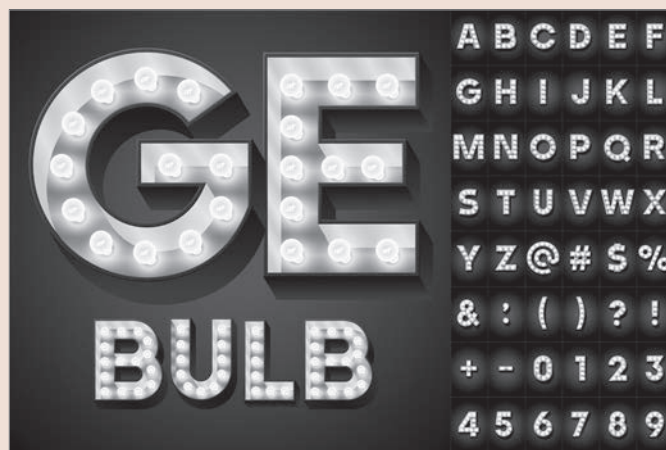
(Revised) Electric Sign. A fixed, stationary, or portable self-contained, electrically operated and/or electrically illuminated utilization equipment with words or symbols designed to convey information or attract attention.

(NEW) Field Evaluation Body (FEB). An organization or part of an organization that performs field evaluations of electrical or other equipment.

(NEW) Field Labeled (as applied to evaluated products). Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report.

(Revised) Information Technology Equipment (ITE). Equipment and systems rated 1000 volts or less, normally found in offices or other business establishments and similar environments classified as ordinary locations, that are used for creation and manipulation of data, voice, video, and similar signals that are not communications equipment as defined in Part I of Article 100 and do not process communications circuits as defined in 800.2.

(Revised) Receptacle. A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.



(NEW) Process Seal [as applied to Hazardous (Classified) Locations]. A seal between electrical systems and flammable or combustible process fluids where a failure could allow the migration of process fluids into the premises' wiring system.

(Revised) Show Window. Any window, including windows above doors, used or designed to be used for the display of goods or advertising material, whether it is fully or partly enclosed or entirely open at the rear and whether or not it has a platform raised higher than the street floor level.

PART 1 EXAM QUESTIONS

14. What ANSI/ ISA should be referenced when using Nonincendive electrical equipment in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations?
 - A. ANSI/ ISA-21.12.01-2013
 - B. ANSI/ ISA-12.21.01-2013
 - C. ANSI/ ISA-12.12.01-2013
 - D. Nonincendive electrical equipment is designed and approved for use in a telecommunication room only.
15. What are enclosures considered that are constructed so that dust will not enter under specified test conditions?
 - A. Dust proof
 - B. Dusttight
 - C. Dust resistant
 - D. Ignitionproof
16. What best defines a fixed, stationary, or portable self-contained, electrically operated and/or electrically illuminated utilization equipment with words or symbols designed to convey information or attract attention?
 - A. Billboard
 - B. Monument sign
 - C. Electric Sign
 - D. All listed answers
17. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report best defines what listed term?
 - A. Field Labeled
 - B. UL Listed
 - C. Field evaluated
 - D. Field tested label
18. How many contact devices on the same yoke would constitute a multiple receptacle?
 - A. One
 - B. Two or more
 - C. Six to nine
 - D. Contact devices are not required for a multiple receptacle.
19. What hazardous (classified) zone location is a type 3SX enclosure allowed to be installed?
 - A. A 3SX enclosure is NOT allowed to be installed in a hazardous (classified) location
 - B. Zone 250
 - C. Zone 13
 - D. Zone 22
20. What best defines a seal between electrical systems and combustible process fluids where a failure could allow the migration of process fluids into the premises' wiring system?
 - A. Seal off
 - B. "Chico"
 - C. Process Seal
 - D. Neutralizing process liquid
21. What organization performs field evaluations of electrical or other equipment?
 - A. CMP-7
 - B. Underwriter Laboratories
 - C. AHJ
 - D. Field Evaluation Body
22. Any window above doors used for the display of goods or advertising material best defines what listed term?
 - A. Window display
 - B. Show window
 - C. Display Window
 - D. All listed answers

23. **Data, voice, video, and similar signals that are not communications equipment as defined in Part I of Article 100 and do not process communications circuits as defined in 800.2 would fall under what listed term?**

- A. Information Technology Equipment
- B. Data processing equipment
- C. Digital communications equipment
- D. Data communications equipment

(Revised) Structure. That which is built or constructed, other than equipment.

110.3 (A)(1)(NEW) Informational Note No.

1: Equipment may be new, reconditioned, refurbished, or remanufactured.

(NEW) 110.3 (C) Listing. Product testing, evaluation, and listing (product certification) shall be performed by recognized qualified electrical testing laboratories and shall be in accordance with applicable product standards recognized as achieving equivalent and effective safety for equipment installed to comply with this Code.



(Revised) 110.5 Conductors. Conductors normally used to carry current shall be of copper or aluminum unless otherwise provided in this Code. Where the conductor material is not specified, the sizes given in this Code shall apply to copper conductors. Where other materials are used, the size shall be changed accordingly.

(Revised) 110.9 Interrupting Rating. Equipment intended to interrupt current at fault levels shall have an interrupting rating at nominal circuit voltage at least equal to the current that is available at the line terminals of the equipment. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage at least equal to the current that must be interrupted.

(NEW) 110.11 Informational Note No. 4: Minimum flood provisions are provided in NFPA 5000-2015 Building Construction and Safety Code, the International Building Code (IBC), and the International Residential Code for One- and Two-Family Dwellings (IRC).

(NEW) 110.14 (D) Installation. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool shall be used to achieve the indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

(NEW) 110.16 (B) Service Equipment. In other than dwelling units, in addition to the requirements in (A), a permanent label shall be field or factory applied to service equipment rated 1200 amps or more. The label shall meet the requirements of 110.21(B) and contain the following information:

- (1) Nominal system voltage
- (2) Available fault current at the service overcurrent protective devices
- (3) The clearing time of service overcurrent protective devices based on the available fault current at the service equipment



(4) The date the label was applied

Exception: Service equipment labeling shall not be required if an arc flash label is applied in accordance with acceptable industry practice.

Informational Note No. 1: NFPA 70E -2015, Standard for Electrical Safety in the Workplace, provides guidance, such as determining severity of potential exposure, planning safe work practices, arc flash labeling, and selecting personal protective equipment.

Informational Note No. 2: ANSI Z535.4-2011, Product Safety Signs and Labels, provides guidelines for the design of safety signs and labels for application to products.

Informational Note No. 3: Acceptable industry practices for equipment labeling are described in NFPA 70E -2015 Standard for Electrical Safety in the Workplace. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.

PART 1 EXAM QUESTIONS

24. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating of what circuit voltage?
 - A. 125% at continuous duty
 - B. Nominal
 - C. Instantaneous short circuit condition voltage
 - D. 135% of the equipment inrush voltage
25. What listed publication provides guidelines for the design of safety signs and labels for application to products?
 - A. NFPA 5000-2015 Building Construction and Safety Code
 - B. NFPA 70E -2015, Standard for Electrical Safety in the Workplace
 - C. International Building Code (IBC)
 - D. ANSI Z535.4-2011, Product Safety Signs and Labels
26. If a conductor material is not specified, the sizes given in the 2017 Code shall apply to what type of conductor(s)?
 - A. Aluminum
 - B. Copper
 - C. Nickel
 - D. CO/AL
27. What listed term is built or constructed other than equipment?
 - A. Stage
 - B. Building
 - C. Platform
 - D. Structure
28. Where can you find information regarding minimum flood provisions?
 - A. NFPA 5000-2015 Building Construction and Safety Code
 - B. International Residential Code for One- and Two-Family Dwellings (IRC).
 - C. International Building Code (IBC)
 - D. All Listed answer
29. What new section was added to the 2017 Code regarding tightening torque?
 - A. 110.41 (D)
 - B. 110.16 (B)
 - C. 110.14 (D)
 - D. 110.61 (B)
30. What listed publication can be used to select personal protective equipment for electrical professionals?
 - A. NFPA 5000-2015 Building Construction and Safety Code
 - B. ANSI Z535.4-2011, Product Safety Signs and Labels
 - C. International Building Code (IBC)
 - D. NFPA 70E -2015, Standard for Electrical Safety in the Workplace
31. What is the minimum current in other than dwelling units where a permanent label is required to be field or factory applied to service equipment?
 - A. 1200 amps
 - B. 1000 amps
 - C. 800 amps
 - D. 600 amps

32. What can equipment be listed as?

- A. Reconditioned
- B. New
- C. Remanufactured
- D. All listed answers

33. How many items are required to be listed on the label required by 110.21(B)?

- A. 2
- B. 3
- C. 5
- D. 4

34. What would allow an individual to disregard the requirements of 110.16 (B)?

- A. A fence is surrounding the service equipment
- B. An arc flash label is already applied
- C. A controlled access point is established around the equipment
- D. A qualified individual is in direct supervision of the equipment

35. Who does the 2017 code require to do product certification?

- A. The state electrical board
- B. The AHJ
- C. Field evaluation body
- D. A recognized qualified electrical testing laboratory

(NEW) 110.21(2) Reconditioned Equipment. Reconditioned equipment shall be marked with the name, trademark, or other descriptive marking by which the organization responsible for reconditioning the electrical equipment can be identified, along with the date of the reconditioning.

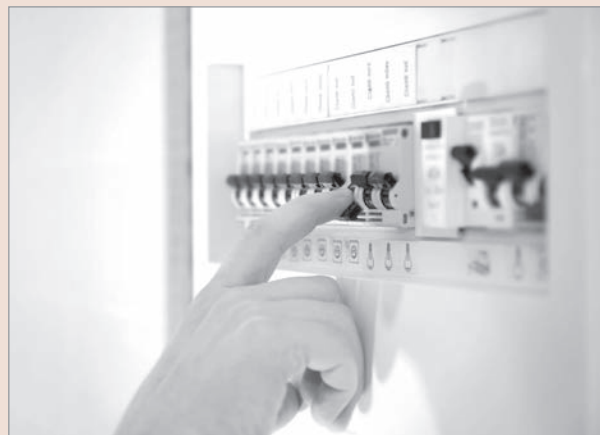
(Revised) 110.21(B)(1) Field-Applied Hazard Markings. The marking shall warn of the hazards using effective words, colors, symbols, or any combination thereof.

(Revised) 110.22(C) Informational Note: See IEEE 3004.5-2014 Recommended Practice for the Application of Low-Voltage Circuit Breakers in Industrial and Commercial Power Systems, for further information on series tested systems.

(Revised) 110.24 Available Fault Current. (A) Field Marking. Service equipment at other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault-current calculation was performed and be of sufficient durability to withstand the environment involved. The calculation shall be documented and made available to those authorized to design, install, inspect, maintain, or operate the system.

(Revised) 110.26 (A) Working Space. Working space for equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of 110.26(A)(1), (A)(2), (A)(3), and (A)(4) or as required or permitted elsewhere in this Code.

(NEW) 110.26 (A) (4) Limited Access. Where equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized is required by installation instructions or function to be located in a space with limited access, all of the following shall apply:



(Revised) Table 110.26(A)(1) Working Spaces

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition 1	Condition 2	Condition 3
0–150	900 mm(3 ft)	900 mm(3 ft)	900 mm(3 ft)
151-600	900 mm(3 ft)	1.0m(3ft.6in.)	1.2M (4ft)
601-1000	900 mm(3 ft)	1.2M (4ft)	1.5m (5ft)

Note: Where the conditions are as follows:

Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.

Condition 2 — Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.

Condition 3 — Exposed live parts on both sides of the working space.

(NEW) 110.26 (A) (5) Separation from High-Voltage Equipment. Where switches, cutouts, or other equipment operating at 1000 volts, nominal, or less are installed in a vault, room, or enclosure where there are exposed live parts or exposed wiring operating over 1000 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low voltage equipment by a suitable partition, fence, or screen.

PART 1 EXAM QUESTIONS

36. What is the minimum working distance from exposed live parts on one side of the working space and grounded parts on the other side of the working space if operating at 480 volts?
 - A. 5ft
 - B. 4ft
 - C. 3ft 6in
 - D. 3ft
37. How is service equipment, other than at dwelling units, required to be marked in the field?
 - A. With the maximum available short circuit fault current
 - B. With the nominal voltage
 - C. With the maximum Service voltage
 - D. With the maximum available fault current
38. 110.26(A)(1) through (A)(4) covers the working space for equipment operating at a maximum of how many volts nominal or less to ground?
 - A. 600 Volts
 - B. 1000 Volts
 - C. 575 Volts
 - D. 480 Volts
39. What is the minimum voltage where exposed live parts need to be separated by a partition from electrical equipment in a vault?
 - A. 1000 volts
 - B. 600 volts
 - C. 480 volts
 - D. 240 volts
40. What are Field-Applied Hazard Markings required to use to warn of a hazard?
 - A. Words
 - B. Symbols
 - C. Colors
 - D. All listed answers
41. What is the minimum working distance from exposed live parts on both sides of the working space if operating at 480 volts?
 - A. 3ft 6in
 - B. 4ft
 - C. 5ft
 - D. 3ft

42. How is reconditioned electrical equipment required to be marked?
- Date of the reconditioning
 - Name of organization responsible for reconditioning
 - Trademark of organization responsible for reconditioning
 - All listed answers
43. What is the minimum working distance from exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials supplied by 480 volts?
- 5ft
 - 4ft
 - 3ft
 - 3ft 6in
44. What listed publication provides information for the recommended practice for the application of low-voltage circuit breakers in industrial and commercial power systems?
- IEEE 3004.5-2014
 - NFPA 70E -2015, Standard for Electrical Safety in the Workplace
 - ANSI Z535.4-2011, Product Safety Signs and Labels
 - NFPA 5000-2015 Building Construction and Safety Code

(Revised) 110.26(D) Illumination. Illumination shall be provided for all working spaces about service equipment, switchboards, switchgear, panelboards, or motor control centers installed indoors. Control by automatic means only shall not be permitted. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source or as permitted by 210.70(A)(1), Exception No. 1, for switched receptacles.

(Revised) 110.26(E) (2) Outdoor. Outdoor installations shall comply with 110.26(E)(2)(a) through (c).

(a) Installation Requirements. Outdoor electrical equipment shall be the following:

- Installed in identified enclosures
- Protected from accidental contact by unauthorized personnel or by vehicular traffic
- Protected from accidental spillage or leakage from piping systems

(b) Work Space. The working clearance space shall include the zone described in 110.26(A). No architectural appurtenance or other equipment shall be located in this zone.

Exception: Structural overhangs or roof extensions shall be permitted in this zone.

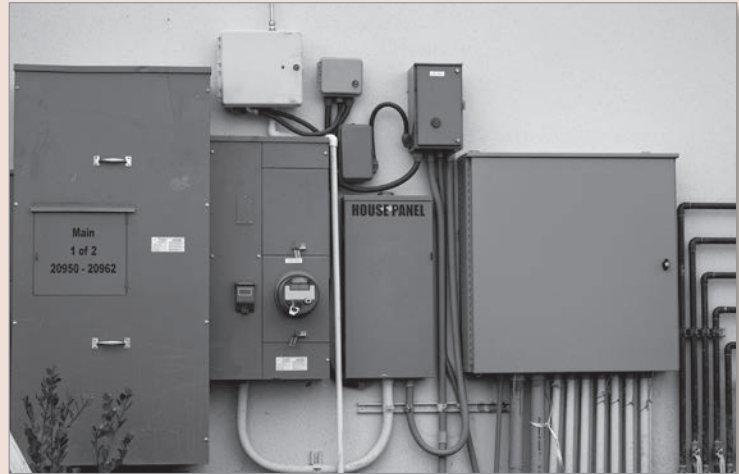


(Revised) 110.27 Guarding of Live Parts. (A) Live Parts Guarded Against Accidental Contact. Except as elsewhere required or permitted by this Code, live parts of electrical equipment operating at 50 to 1000 volts, nominal shall be guarded against accidental contact by approved enclosures or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- By permanent, substantial partitions or screens arranged so that only qualified persons have access to the space within reach of the live parts. Any openings in such partitions or screens shall be sized and located so that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.
- By location on a balcony, gallery, or platform elevated and arranged so as to exclude unqualified persons.

- (4) By elevation above the floor or other working surface as follows:
- A minimum of 2.5 m (8 ft) for 50 volts to 300 volts between ungrounded conductors
 - A minimum of 2.6 m (8 ft 6 in.) for 301 volts to 600 volts between ungrounded conductors
 - A minimum of 2.62 m (8 ft 7 in.) for 601 volts to 1000 volts between ungrounded conductors

(Revised) 110.28 Enclosure Types. Enclosures (other than surrounding fences or walls covered in 110.31) of switchboards, switchgear, panelboards, industrial control panels, motor control centers, meter sockets, enclosed switches, transfer switches, power outlets, circuit breakers, adjustable-speed drive systems, pullout switches, portable power distribution equipment, termination boxes, general-purpose transformers, fire pump controllers, fire pump motors, and motor controllers, rated not over 1000 volts nominal and intended for such locations, shall be marked with an enclosure-type number as shown in Table 110.28.



(Revised) 110.30 General. Conductors and equipment used on circuits over 1000 volts, nominal, shall comply with Part I of this article and with 110.30 through 110.41, which supplement or modify Part I. In no case shall the provisions of this part apply to equipment on the supply side of the service point.

PART 1 EXAM QUESTIONS

45. How far above the finished floor are live parts considered protected from accidental contact if there are 240 volts between ungrounded conductors?
 - 8 ft
 - 8 ft 6 in.
 - 8 ft 7in.
 - Live parts must be guarded no matter their height
46. How are outdoor installations of electrical equipment required to be installed?
 - Protected from accidental contact by unauthorized personnel or by vehicular traffic
 - Protected from accidental spillage or leakage from piping systems
 - In enclosures that are identified
 - All listed answers
47. What table is required to be used to mark fire pump controllers rated not over 1000 volts nominal?
 - 110.27
 - 110.16
 - 110.28
 - 110.31
48. How far above the finished floor are live parts considered protected from accidental contact if there are 480 volts between ungrounded conductors?
 - 9 ft
 - 8 ft
 - 8 ft 7in.
 - 8 ft 6 in.
49. What part of Article 110 are conductors and equipment operating on circuits over 1000 volts required to comply with?
 - Part I
 - Part II
 - Part III
 - Part IV
50. How far above the finished floor are live parts considered protected from accidental contact if there are 760 volts between ungrounded conductors?
 - 8 ft
 - 8 ft 7in.
 - 8 ft 6 in.
 - 7 ft

51. What is required to be provided for all working spaces about service equipment, switchboards, switchgear, panelboards, or motor control centers installed indoors?
- A. Dedicated service receptacles
 - B. Lock out tag out box
 - C. Illumination
 - D. All listed answers

(Revised) 110.31 (A) Electrical Vaults. Where an electrical vault is required or specified for conductors and equipment 110.31(A)(1) to (A)(5) shall apply.

(Revised) 110.31 (B) (1) In Places Accessible to Unqualified Persons. Indoor electrical installations that are accessible to unqualified persons shall be made with metal-enclosed equipment. Switchgear, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. Openings in ventilated dry-type transformers or similar openings in other equipment shall be designed so that foreign objects inserted through these openings are deflected from energized parts.



(Revised) 110.31 (D) Enclosed Equipment Accessible to Unqualified Persons. Ventilating or similar openings in equipment shall be designed such that foreign objects inserted through these openings are deflected from energized parts. Where exposed to physical damage from vehicular traffic, suitable guards shall be provided. Equipment located outdoors and accessible to unqualified persons shall be designed such that exposed nuts or bolts cannot be readily removed, permitting access to live parts. Where equipment is accessible to unqualified persons and the bottom of the enclosure is less than 2.5 m (8 ft) above the floor or grade level, the enclosure door or hinged cover shall be kept locked. Doors and covers of enclosures used solely as pull boxes, splice boxes, or junction boxes shall be locked, bolted, or screwed on. Underground box covers that weigh over 45.4 kg (100 lb) shall be considered as meeting this requirement.

(Revised) 110.33 (A)(2) Guarding. Where bare energized parts at any voltage or insulated energized parts above 1000 volts, nominal, are located adjacent to such entrance, they shall be suitably guarded.

(Revised) 110.34(B) Separation from Low-Voltage Equipment. Where switches, cutouts, or other equipment operating at 1000 volts, nominal, or less are installed in a vault, room, or enclosure where there are exposed live parts or exposed wiring operating at over 1000 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen.

Exception: Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within the high-voltage vault, room, or enclosure shall be permitted to be installed in the high-voltage vault, room, or enclosure without a partition, fence, or screen if accessible to qualified persons only.

(Revised) 110.34 (C) Locked Rooms or Enclosures. The entrance to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 1000 volts, nominal, shall be kept locked unless such entrances are under the observation of a qualified person at all times.

(Revised) 110.34 (D) Illumination. Illumination shall be provided for all workspaces about electrical equipment. Control by automatic means only shall not be permitted. The lighting outlets shall be arranged

so that persons changing lamps or making repairs on the lighting system are not endangered by live parts or other equipment.

(NEW) 110.41 (A) Pre-energization and Operating Tests. Where required elsewhere in this Code, the complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the authority having jurisdiction and shall be tested when first installed on-site.



PART 1 EXAM QUESTIONS

52. What is the minimum voltage where insulated energized parts located adjacent to enclosures and access to working space entrances are required to be suitably guarded?
 - A. 240
 - B. 600
 - C. 1000
 - D. Any voltage where energized insulated parts are located adjacent to an entrance for electrical equipment
53. When can lighting above electrical equipment be controlled by automatic means only?
 - A. There are no special requirements for illumination above electrical equipment
 - B. If accessible to qualified persons only
 - C. If an access control policy is established
 - D. At no time can lighting above electrical equipment be controlled by automatic means only
54. What type of equipment is required to be used for indoor electrical installations if accessible to unqualified persons?
 - A. Lockable enclosures and equipment
 - B. Metal-enclosed equipment
 - C. Controlled access equipment
 - D. Remotely monitored equipment
55. What is required for doors and covers of enclosures used solely as pull boxes, splice boxes, or junction boxes installed outdoors and accessible to unqualified persons?
 - A. Screwed on
 - B. Locked
 - C. Bolted on
 - D. All listed answers
56. At what voltage are exposed insulated conductors considered high voltage and required to be effectively separated from the space occupied by the low-voltage conductors in an enclosure?
 - A. 240 volts to 480 volts
 - B. 1000 volts to 480 volts
 - C. 1000 volts or more
 - D. Any voltage over 50 volts is considered high voltage
57. When is a pre-energization test required to be performed?
 - A. When the equipment is first installed on-site
 - B. After all service terminations have been completed
 - C. After the primary service transformer conductors have passed and undergone a high-pot test
 - D. After the service lateral conductors have been terminated
58. What circumstance would allow high voltage and low voltage conductors to share the same enclosure without being separated?
 - A. Arc fault zone signage is installed
 - B. Accessible to qualified persons only
 - C. The main service disconnect is GFCI protected
 - D. Arc blast zones are established using the appropriate methods
59. How many provisions are electrical vaults required to comply with if specified for conductors and equipment?
 - A. 3
 - B. 4
 - C. 6
 - D. 5

60. What is the entrance to a vault containing exposed conductors operating at over 1000 volts required to be?

- A. Guarded
- B. Locked
- C. Identified with a plaque
- D. Identified with Red or Orange paint

61. What is required for the door of an electric panel installed outdoors and accessible to unqualified persons with the bottom of the panel installed at 8ft 6in. above finish grade?

- A. Must be installed with self-drilling screws
- B. Door must be hinged
- C. Locked
- D. Nothing

(NEW) 110.41 (B) Test Report. A test report covering the results of the tests required in 110.41(A) shall be available to the authority having jurisdiction prior to energization and made available to those authorized to install, operate, test, and maintain the system.

(Revised) 110.73 Equipment Work Space. Where electrical equipment with live parts that is likely to require examination, adjustment, servicing, or maintenance while energized is installed in a manhole, vault, or other enclosure designed for personnel access, the work space and associated requirements in 110.26 shall be met for installations operating at 1000 volts or less. Where the installation is over 1000 volts, the work space and associated requirements in 110.34 shall be met. A manhole access cover that weighs over 45.4 kg (100 lb) shall be considered as meeting the requirements of 110.34(C).

(Revised) 110.74 (A) 1000 Volts, Nominal, or Less. Wire bending space for conductors operating at 1000 volts or less shall be provided in accordance with the requirements of 314.28.

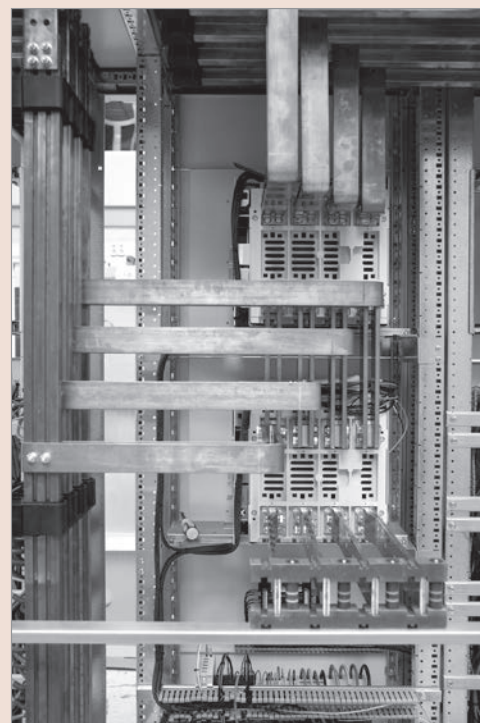
(Revised) 110.74 (B) Over 1000 Volts, Nominal. Conductors operating at over 1000 volts shall be provided with bending space in accordance with 314.71(A) and (B), as applicable.

(Revised) 210.3 Other Articles for Specific-Purpose Branch Circuits. Table 210.3 lists references for specific equipment and applications not located in Chapters 5, 6, and 7 that amend or supplement the requirements of this article.

(Revised) 210.5 (C)(1)(b) Posting of Identification Means. The method utilized for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment. The label shall be of sufficient durability to withstand the environment involved and shall not be handwritten.

(Revised) 210.4 (D) Grouping. The ungrounded and grounded circuit conductors of each multiwire branch circuit shall be grouped in accordance with 200.4(B).

(NEW) Exception: In existing installations where a voltage system(s) already exists and a different voltage system is being added, it shall be permissible to mark only the new system voltage. Existing unidentified



systems shall not be required to be identified at each termination, connection, and splice point in compliance with 210.5(C)(1)(a) and (b). Labeling shall be required at each voltage system distribution equipment to identify that only one voltage system has been marked for a new system(s). The new system label(s) shall include the words "other unidentified systems exist on the premises."

(Revised) 210.5 (C)(2) Branch Circuits Supplied from Direct-Current Systems. Where a branch circuit is supplied from a dc system operating at more than 60 volts, each ungrounded conductor of 4 AWG or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 6 AWG or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 210.5(C)(2)(a) and (b). The identification methods utilized for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment.

PART 1 EXAM QUESTIONS

62. What section(s) of the 2017 code requires the ungrounded and grounded circuit conductors of each multiwire branch circuit to be grouped?
 - A. 200.4(B)
 - B. 210.4 (D)
 - C. 210.3
 - D. 220.3
63. What work space requirement must be met for energized systems of 1000 volts or more in a vault where maintenance of the energized equipment is likely?
 - A. 110.41
 - B. 110.26
 - C. 110.34
 - D. 110.34(B)
64. What requirement(s) must be met for DC branch circuits to be identified by polarity at all connection and termination points?
 - A. The conductors must be 4 AWG or Larger
 - B. Must be over 60 volts DC
 - C. The conductors must be 6 AWG or smaller
 - D. All listed answers
65. What section should be consulted to determine the wire bending space for conductors operating at voltages of 1000 or less?
 - A. 318.24
 - B. 314.71(A) and (B)
 - C. 110.74 (B)
 - D. 314.28
66. What table lists specific-purpose branch circuits not listed in Chapters 5, 6, and 7 that amend or supplement the requirements of Article 210?
 - A. Table 215.3
 - B. Table 210.3
 - C. Table 310.16(A)(1)
 - D. Table 310.15(B)(2)
67. What section should be consulted to determine the wire bending space for conductors operating at voltages of 1000 or more?
 - A. 110.74 (B)
 - B. 314.28
 - C. 314.71(A) and (B)
 - D. 318.24
68. What section requires a test report to be made available to the AHJ, and individuals who install, operate, and maintain the system?
 - A. 110.41 (A)
 - B. 110.41 (B)
 - C. 110.34 (D)
 - D. 110.73
69. How are conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment NOT allowed to be labeled?
 - A. Printed shrink labels
 - B. Phenolic labeling
 - C. Handwritten label
 - D. Printed label on double sided tape

70. In existing installations where a voltage system(s) already exists and a different voltage system is being added, how is the wording on the new system label required to read?

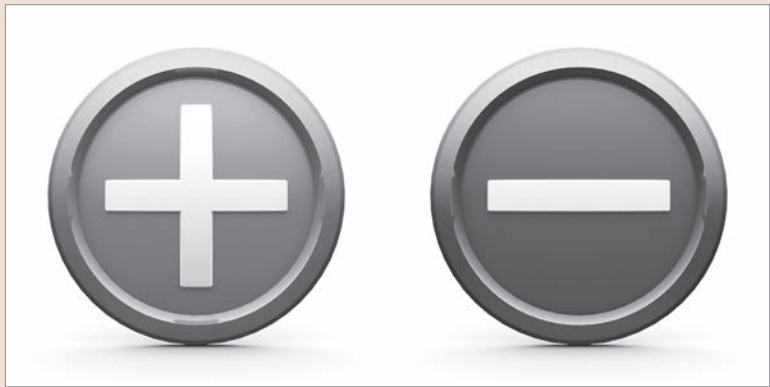
- A. "Other unidentified circuits exist on the premises."
- B. "Other unidentified systems exist on the premises."
- C. "Non Labeled branch circuits exist inside the equipment."
- D. "Labeled and Non-labeled systems exist on the premises."

71. What work space requirement must be met for energized systems of 1000 volts or less in a vault where maintenance of the energized equipment is likely?

- A. 110.41
- B. 110.34
- C. 110.26
- D. 110.34(B)

(NEW) 210.5 (C)(2)(a)(4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black.

(NEW) 210.5 (C)(2)(b)(4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red.



(Revised) 210.7 Multiple Branch Circuits. Where two or more branch circuits supply devices or equipment on the same yoke or mounting strap, a means to simultaneously disconnect the ungrounded supply conductors shall be provided at the point at which the branch circuits originate.

(Revised) 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel. Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (E). The ground-fault circuit interrupter shall be installed in a readily accessible location.

Informational Note No. 1: See 215.9 for ground-fault circuit interrupter protection for personnel on feeders.

Informational Note No. 2: See 422.5(A) for GFCI requirements for appliances. For the purposes of this section, when determining distance from receptacles the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

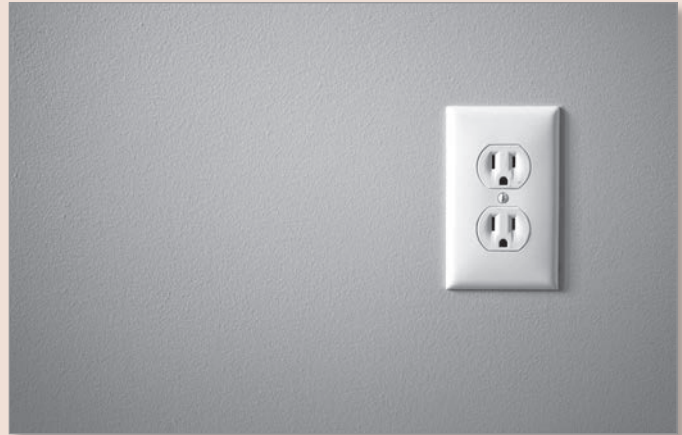
(Revised) 210.8(B) Other Than Dwelling Units. All single-phase receptacles rated 150 volts to ground or less, 50 amperes or less and three phase receptacles rated 150 volts to ground or less, 100 amperes or less installed in the following locations shall have ground-fault circuit-interrupter protection for personnel.

(NEW) 210.8(E) Crawl Space Lighting Outlets. GFCI protection shall be provided for lighting outlets not exceeding 120 volts installed in crawl spaces.

(Revised) 210.11 Branch Circuits Required (C)(3) Bathroom Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be provided to supply the bathroom(s) receptacle outlet(s). Such circuits shall have no other outlets.

(Revised) 210.12 (B) Dormitory Units. All 120-volt, single-phase, 15- and 20- ampere branch circuits supplying outlets and devices installed in dormitory unit bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms shall be protected by any of the means described in 210.12(A)(1) through (6).

(New) 210.12 (C) Guest Rooms and Guest Suites. All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed in guest rooms and guest suites of hotels and motels shall be protected by any of the means described in 210.12(A)(1) through (6).



PART 1 EXAM QUESTIONS

72. What is the maximum voltage of a branch circuit located in a hotel guest room room that can be protected by any of the means described in 210.12(A)(1) through (6)?
 - A. 220 Volts
 - B. 115 Volts
 - C. 120 Volts
 - D. 240 Volts
73. How many 20-amp branch circuits are required to supply the receptacle outlets for a bathroom?
 - A. There are no special requirements for amperage to feed the branch circuit for bathrooms
 - B. Two 20-amp
 - C. Only one 15-amp circuit is required
 - D. One 20-amp
74. How is a 120-volt light located in a crawl space required to be protected?
 - A. AFCI protection
 - B. GFCI protection
 - C. Wire basket around the bulb
 - D. There are no special requirements for lighting installed in crawl spaces
75. What color(s) cannot be used to mark polarity of the negative conductor on the sleeving or shrink tube used for DC systems?
 - A. Blue
 - B. Yellow
 - C. Orange
 - D. Red
76. What is the maximum amperage of a branch circuit located in a dormitory living room that can be protected by any of the means described in 210.12(A)(1) through (6)?
 - A. 15 Amps
 - B. 20 Amps
 - C. 25 Amps
 - D. 30 Amps
77. What section of the 2017 code would you look to determine the ground-fault circuit interrupter protection for personnel on feeders?
 - A. 215.9
 - B. 422.5(A)
 - C. 210.7
 - D. 210.5 (C)(2)(b)(4)
78. What conductor(s) must be simultaneously disconnected where two or more branch circuits supply devices or equipment on the same yoke or mounting strap?
 - A. Equipment Grounding Conductor(s)
 - B. Grounded Conductor(s)
 - C. Grounding Conductor(s)
 - D. Ungrounded Supply Conductor(s)
79. How is a three phase 60-amp receptacle located in an unfinished basement required to be protected?
 - A. Solder pot over loads
 - B. AFCI protection
 - C. GFCI protection
 - D. Bi metal over load protection

80. What color(s) cannot be used to mark polarity of the positive conductor on the sleeving or shrink tube used for DC systems?

- A. White
- B. Green
- C. Gray
- D. Black

81. What section of the 2017 code would you look to determine the ground-fault circuit interrupter requirements for appliances?

- A. 215.9
- B. 422.5(A)
- C. 210.7
- D. 210.5 (C)(2)(b)(4)

(NEW) 210.18 Rating. Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The rating for other than individual branch circuits shall be 15, 20, 30, 40, and 50 amperes. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

(Revised) 210.52(A)(2) Wall Space. As used in this section, a wall space shall include the following:

- (1) Any space 600 mm (2 ft) or more in width (including space measured around corners) and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets that do not have countertops or similar work surfaces
- (2) The space occupied by fixed panels in walls, excluding sliding panels
- (3) The space afforded by fixed room dividers, such as freestanding bar-type counters or railings.

(Revised) 210.52(C) (3) Peninsular Countertop Spaces. At least one receptacle outlet shall be installed at each peninsular countertop long

dimension space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater. A peninsular countertop is measured from the connected perpendicular wall.

(Revised) 210.52(C)(5) Receptacle Outlet Location. Receptacle outlets shall be located on or above, but not more than 500 mm (20 in.) above, the countertop or work surface. Receptacle outlet assemblies listed for use in countertops or work surfaces shall be permitted to be installed in countertops or work surfaces. Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, or range tops as covered in 210.52(C)(1), Exception, or appliances occupying dedicated space shall not be considered as these required outlets.

(Revised) 210.52 (D) Bathrooms. At least one receptacle outlet shall be installed in bathrooms within 900 mm (3 ft) of the outside edge of each basin. The receptacle outlet shall be located on a wall or partition that is adjacent to the basin or basin countertop, located on the countertop, or installed on the side or face of the basin cabinet. In no case shall the receptacle be located more than 300 mm (12 in.) below the top of the basin or basin countertop. Receptacle outlet assemblies listed for use in countertops shall be permitted to be installed in the countertop.

Informational Note: See 406.5(E) and 406.5(G) for requirements for installation of receptacles in countertops.

(Revised) 210.52(G)(1) Garages. In each attached garage and in each detached garage with electric power, at least one receptacle outlet shall be installed in each vehicle bay and not more than 1.7 m (5 1/2 ft) above the floor.



(Revised) 210.64 Electrical Service Areas. At least one 125-volt, singlephase, 15- or 20-ampere-rated receptacle outlet shall be installed in an accessible location within 7.5 m (25 ft) of the indoor electrical service equipment. The required receptacle outlet shall be located within the same room or area as the service equipment.

(Revised) 210.70(A) (1) Habitable Rooms. At least one wall switch-controlled lighting outlet shall be installed in every habitable room, kitchen, and bathroom.

(Revised) 210.70 (C) All Occupancies. For attics and underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch shall be installed where these spaces are used for storage or contain equipment requiring servicing. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing.



PART 1 EXAM QUESTIONS

82. What is the maximum distance from indoor electrical service equipment in other than one or two family dwellings that a service receptacle is required to be installed?
 - A. Within 25ft
 - B. Within 7ft 6 in
 - C. Within line of sight
 - D. As close as practical to the service equipment
83. What is the maximum height a receptacle can be located above a work surface or countertop?
 - A. 24 Inches
 - B. 18 Inches
 - C. 20 Inches
 - D. 30 Inches
84. Where are switch controlled lighting circuits required for a dwelling unit?
 - A. Habitable rooms
 - B. Kitchens
 - C. Bathrooms
 - D. All listed answers
85. How do you determine the measurement of a peninsular countertop space?
 - A. Measure from the adjacent wall
 - B. Measure from the perpendicular wall
 - C. Measure from the unbroken wall
 - D. Measure from the outside edges of the peninsular countertop
86. What is the maximum distance from the outside edge of a basin that a receptacle can be installed in a bathroom?
 - A. 12 Inches
 - B. 18 Inches
 - C. 2ft
 - D. 3ft
87. How many wall switched lights are required for under floor spaces used for storage?
 - A. 1
 - B. 2
 - C. Under floor storage spaces do not require a wall switched light
 - D. No listed answers
88. What is the minimum width for an area to be considered wall space?
 - A. 6ft
 - B. 3ft
 - C. 2ft
 - D. 18 inches
89. What is the maximum distance a receptacle can be placed below the top of a basin or basin countertop in a bathroom?
 - A. 12 Inches
 - B. 18 Inches
 - C. 2ft
 - D. 3ft

90. What is the maximum height above finished floor that a receptacle can be installed in a 2 car detached garage?

- A. 6ft
- B. 5ft 6in
- C. 5ft
- D. 48 inches

91. How are Branch circuits recognized by article 210 rated?

- A. In accordance with the minimum permitted voltage rating or setting of the overcurrent device
- B. In accordance with the minimum permitted ampere rating or setting of the overcurrent device
- C. In accordance with the maximum permitted voltage rating or setting of the overcurrent device
- D. In accordance with the maximum permitted ampere rating or setting of the overcurrent device

92. How many receptacles are required to be installed in a 3 car attached garage?

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

(Revised) 215.1 Scope. This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders.

(NEW) 215.2(A)(1) Exception No. 1: If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the allowable ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.



(NEW) 215.2(A)(1) Exception No. 2: Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections as covered in 110.14(C)(2), it shall be permitted to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load. No portion of a feeder installed under the provisions of this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 110.14(C)(1).

(NEW) 215.2(A)(1) Exception No. 3: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

(Revised) 215.3 Overcurrent Protection. Exception No. 2: Overcurrent protection for feeders between 600 and 1000 volts shall comply with Parts I through VIII of Article 240. Feeders over 1000 volts, nominal, shall comply with Part IX of Article 240.

(Revised) 215.12 (A) Grounded Conductor. The grounded conductor of a feeder, if insulated, shall be identified in accordance with 200.6.

(Revised) 220.1 Scope. This article provides requirements for calculating branch-circuit, feeder, and service loads. Part I provides general requirements for calculation methods. Part II provides calculation methods for branch-circuit loads. Parts III and IV provide calculation methods for feeder and service loads. Part V provides calculation methods for farm loads.

(Revised) 220.3 Other Articles for Specific-Purpose Calculations. Table 220.3 shall provide references for specific-purpose calculation requirements not located in Chapters 5, 6, or 7 that amend or supplement the requirements of this article.

(Revised) 225.1 Informational Note: For additional information on wiring over 1000 volts, see ANSI/IEEE C2-2012, National Electrical Safety Code.

(Revised) 225.4 Conductor Covering. Where within 3.0 m (10 ft) of any building or structure other than supporting poles or towers, open individual (aerial) overhead conductors shall be insulated for the nominal voltage. The insulation of conductors in cables or raceways, except Type MI cable, shall be of thermoset or thermoplastic type and, in wet locations, shall comply with 310.10(C). The insulation of conductors for festoon lighting shall be of the rubber-covered or thermoplastic type.

(Revised) 225.7 (D) 1000 Volts Between Conductors. Circuits exceeding 277 volts, nominal, to ground and not exceeding 1000 volts, nominal, between conductors shall be permitted to supply the auxiliary equipment of electric-discharge lamps in accordance with 210.6(D)(1).

(Revised) 225.12 Open-Conductor Supports. Open conductors shall be supported on knobs, racks, brackets, or strain insulators, that are made of glass, porcelain, or other approved materials.

(Revised) 225.17 (A) Strength. The mast shall have adequate strength or be supported by braces or guys to safely withstand the strain imposed by the overhead feeder or branch-circuit conductors. Hubs intended for use with a conduit serving as a mast for support of feeder or branch-circuit conductors shall be identified for use with a mast.



PART 1 EXAM QUESTIONS

- | | |
|---|---|
| <p>93. How is the hub intended for use with a conduit serving as a mast for support of feeder or branch-circuit conductors required to be identified?</p> <ul style="list-style-type: none"> A. For use with a mast B. With an imprinted weight maximum C. For use outdoors D. All listed answers | <p>95. What is the maximum voltage between conductors that can supply the auxiliary equipment of electric-discharge lamps in accordance with 210.6(D)(1)?</p> <ul style="list-style-type: none"> A. 480 B. 277 C. 1000 D. 600 |
| <p>94. Grounded conductors that are not connected to an overcurrent device are permitted to be sized at what percent of the continuous and noncontinuous load?</p> <ul style="list-style-type: none"> A. 100% B. 125% C. 135% D. 150% | <p>96. What section(s) are you required to comply with when identifying insulated grounded feeder conductor(s)?</p> <ul style="list-style-type: none"> A. 210.70 B. 240 C. 215.3 D. 200.6 |

97. What part of Article 220 provides calculation methods for farm loads?

- A. IV
- B. V
- C. VI
- D. III

98. What does Article 215 cover?

- A. Conductor over current protection
- B. Conductor correction factors
- C. Conductor ambient air correction values
- D. Feeders

99. What ANSI should be referenced for additional information on wiring over 1000 volts?

- A. ANSI/IEEE C2-2013
- B. ANSI/IEEE C2-2012
- C. ANSI/IEEE C3-2012
- D. ANSI/IEEE C4-2014

100. What is a common material used to make open conductor supports?

- A. Porcelain
- B. Aluminum
- C. Copper
- D. Lead

101. The overcurrent protection for feeders between 600 and 1000 volts is required comply with what Parts of Article 240?

- A. I through VII
- B. I
- C. I through VIII
- D. I through IV

102. What table lists specific-purpose calculation requirements not located in Chapters 5, 6, and 7 that amend or supplement the requirements of Article 220?

- A. Table 210.3
- B. Table 220.3
- C. Table 310.16(A)(1)
- D. Table 310.15(B)(2)

103. What voltage are open individual (aerial) overhead conductors required to be insulated for within 10ft of any structure or building?

- A. The nominal voltage
- B. The inrush voltage
- C. The start-up voltage
- D. All listed answers

(Revised) 225.18 Clearance for Overhead Conductors and Cables. Overhead spans of open conductors and open multiconductor cables of not over 1000 volts, nominal, shall have a clearance of not less than the following:

- (1) 3.0 m (10 ft) — above finished grade, sidewalks, or from any platform or projection that will permit personal contact where the voltage does not exceed 150 volts to ground and accessible to pedestrians only
- (2) 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground
- (3) 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground
- (4) 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles, such as cultivated, grazing, forest, and orchard
- (5) 7.5 m (24 1/2 ft) — over track rails of railroads

(Revised) 225.19 (A) Above Roofs. Overhead spans of open conductors and open multiconductor cables shall have a vertical clearance of not less than 2.7 m (8 ft 6 in.) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance not less than 900 mm (3 ft) in all directions from the edge of the roof.



(Revised) 225.19(B)(2) Vertical Clearance. The vertical clearance of final spans above or within 900 mm (3 ft) measured horizontally of platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 225.18.

(Revised) 225.20 Protection Against Physical Damage. Conductors installed on buildings, structures, or poles shall be protected against physical damage as provided for services in 230.50.

(Revised) 225.27 Raceway Seal. Where a raceway enters a building or structure from outside, it shall be sealed. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with cable insulation, conductor insulation, bare conductor, shield, or other components.

(Revised) 230.7 Other Conductors in Raceway or Cable. Conductors other than service conductors shall not be installed in the same service raceway or service cable in which the service conductors are installed.

(Revised) 230.10 Vegetation as Support. Vegetation such as trees shall not be used for support of overhead service conductors or service equipment.

(Revised) 230.29 Supports over Buildings. Service conductors passing over a roof shall be securely supported by substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. Where practicable, such supports shall be independent of the building.

(Revised) 230.42 (A) General. Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized to carry not less than the largest of 230.42(A)(1) or (A)(2). Loads shall be determined in accordance with Part III, IV, or V of Article 220, as applicable. Ampacity shall be determined from 310.15. The maximum allowable current of busways shall be that value for which the busway has been listed or labeled.

(Revised) 230.42 (A)(1) Where the service-entrance conductors supply continuous loads or any combination of noncontinuous and continuous loads, the minimum service-entrance conductor size shall have an allowable ampacity not less than the sum of the noncontinuous loads plus 125 percent of continuous loads.



PART 1 EXAM QUESTIONS

104. How are service conductors passing over a roof required to be supported?

- A. With a messenger wire
- B. Independently
- C. When possible
- D. By substantial structures

105. What is required of a raceway that enters a building from the outside?

- A. Install an expansion joint
- B. Seal it
- C. Install a Class 1 Division 1 seal off within 10ft
- D. Install a form 7 C conduit at the transition

106. What is the minimum vertical distance above a roof that an overhead open multi conductor cable is required to be installed?

- A. 12ft
- B. 8ft 6in
- C. 9ft 6in
- D. 10ft

107. What cannot be installed in the same raceway as service conductors?

- A. Yellow 77 pulling soap
- B. Sealing Compound
- C. Fire Alarm branch circuit
- D. Strain relief bushing

108. What is the minimum height above a railroad track that an open multi conductor overhead cable can be installed?

- A. 10ft
- B. 12ft
- C. 15ft
- D. 24ft 6in

109. In general, how much current are service-entrance conductors required to be capable of handling?

- A. 125% of the continuous load
- B. Not less than the maximum load to be served
- C. 135% of the continuous load
- D. 80% of the maximum load

110. What section of the 2017 code is required to be referenced for protecting outside branch circuit open conductors from physical damage when installed on a building?

- A. 230.40
- B. 225.19
- C. 230.50
- D. 225.18

111. If service entrance conductors supply noncontinuous and continuous loads, how is the minimum service-entrance allowable ampacity required to be calculated?

- A. Add the noncontinuous loads then multiply by 125%
- B. Add the sum of the noncontinuous and continuous loads then multiply by 125%
- C. Add the continuous loads then multiply by 125%
- D. Add the sum of the noncontinuous loads plus 125 percent of continuous loads

112. What is the minimum height above a sidewalk that an open multi conductor overhead cable can be installed?

- A. 10ft
- B. 12ft
- C. 15ft
- D. 24ft 6in

113. What cannot be used as support for overhead service conductors?

- A. Strain relief system
- B. Overhead rigid conduit
- C. Trees
- D. Uni-strut support rack

114. How close does an overhead open multi conductor cable, when measured horizontally from a balcony that will permit personal contact, need to be installed in accordance with section 225.18?

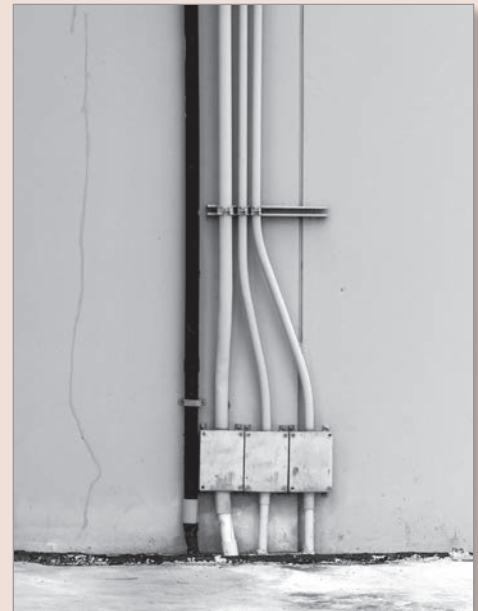
- A. Within 3ft
- B. Within 4ft
- C. Within 5ft
- D. Within 6ft

(Revised) 230.53 Raceways to Drain. Where exposed to the weather, raceways enclosing service-entrance conductors shall be listed or approved for use in wet locations and arranged to drain. Where embedded in masonry, raceways shall be arranged to drain.

(Revised) 230.54 (C) Service Heads and Goosenecks Above Service-Drop or Overhead Service Attachment. Service heads on raceways or service-entrance cables and goosenecks in service-entrance cables shall be located above the point of attachment of the service-drop or overhead service conductors to the building or other structure.

(Revised) 230.66 Marking. Service equipment rated at 1000 volts or less shall be marked to identify it as being suitable for use as service equipment. All service equipment shall be listed or field labeled. Individual meter socket enclosures shall not be considered service equipment but shall be listed and rated for the voltage and ampacity of the service.

Exception: Meter sockets supplied by and under the exclusive control of an electric utility shall not be required to be listed.



(Revised) 230.91 Location. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto. Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the fuses.

(Revised) 230.95 (C) Performance Testing. The ground-fault protection system shall be performance tested when first installed on site. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

(Revised) 240.6 (A) Fuses and Fixed-Trip Circuit Breakers. The standard ampere ratings for fuses and inverse time circuit breakers shall be considered as shown in Table 240.6(A). Additional standard ampere ratings for fuses shall be 1, 3, 6, 10, and 601. The use of fuses and inverse time circuit breakers with non-standard ampere ratings shall be permitted.

(NEW) 240.67 Arc Energy Reduction. Where fuses rated 1200 A or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective January 1, 2020.

(NEW) 240.87 (B) Informational Note No. 3: An instantaneous trip is a function that causes a circuit breaker to trip with no intentional delay when currents exceed the instantaneous trip setting or current level. If arcing currents are above the instantaneous trip level, the circuit breaker will trip in the minimum possible time.

(NEW) 240.87 (B) Informational Note No. 4: IEEE 1584–2002, IEEE Guide for Performing Arc Flash Hazard Calculations, is one of the available methods that provide guidance in determining arcing current.

(NEW) 250.4(A)(1) Informational Note No. 2: See NFPA 780-2014, Standard for the Installation of Lightning Protection Systems, for information on installation of grounding and bonding for lightning protection systems.

PART 1 EXAM QUESTIONS

115. When is a ground-fault protection system performance test required to be performed?

- A. When first installed on site
- B. When all terminations are complete
- C. After the primary service transformer conductors have passed the High-pot test
- D. After the current transformers have been installed

116. If arcing currents are above the instantaneous trip level, how fast will the circuit breaker trip?

- A. In 2 mili seconds
- B. In the maximum possible time
- C. In the minimum possible time
- D. In 1 quarter cycle

117. Service equipment rated at 1000 volts or less required to be marked as being suitable for use as what?

- A. Suitable for use indoors
- B. Suitable for use as service equipment
- C. Suitable for use outdoors
- D. Suitable for use in automatic controlled areas

118. Where are goosenecks in service-entrance cables required to be located?

- A. Perpendicular to the point of attachment of the service-drop
- B. Below the point of attachment of the service-drop
- C. Above the point of attachment of the service-drop
- D. There are no special requirements for goosenecks in service-entrance cables

119. Where is the disconnecting means required to be located where fuses are used as the service overcurrent device?

- A. Located downstream of the supply side of the fuses
- B. Located ahead of the supply side of the fuses
- C. Inside the first service enclosure
- D. Adjacent to the service transformer service laterals

120. What new table shows the standard ampere ratings for inverse time circuit breakers?

- A. 230.53
- B. 240.6
- C. 240.5(B)(2)
- D. 240.6(A)

121. What listed publication is referenced for information on the installation of grounding and bonding for lightning protection systems?

- A. IEEE 1584–2002
- B. NFPA 780-2014
- C. IEEE 1548–2017
- D. ANSI/IEEE C3-2012

122. Raceways that contain service entrance conductors installed outdoors are required to be listed for what type of location(s)?

- A. Class I division II
- B. Weather proof
- C. Weather resistant
- D. Wet

123. What listed publication is referenced for performing arc flash hazard calculations?

- A. IEEE 1584–2002
- B. ANSI/IEEE C2-2012
- C. IEEE 1548–2017
- D. ANSI/IEEE C3-2012

124. When is the Arc energy reduction requirement going to become effective?

- A. 1/1/17
- B. 2/1/20
- C. 1/1/20
- D. 2/1/17

(Revised) 250.24(C)(2) Parallel Conductors in Two or More Raceways or Cables. If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or cables, the grounded conductor shall also be installed in parallel. The size of the grounded conductor in each raceway or cable shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or cable, as indicated in 250.24(C)(1), but not smaller than 1/0 AWG.

(Revised) 250.30(A)(4) The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C).

Exception: If a separately derived system originates in equipment that is listed and identified as suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

(Revised) 250.30(A)(6)(C) Connections. All tap connections to the common grounding electrode conductor shall be made at an accessible location by one of the following methods:

- (1) A connector listed as grounding and bonding equipment.
- (2) Listed connections to aluminum or copper busbars not smaller than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate the number of terminations necessary for the installation. If aluminum busbars are used, the installation shall also comply with 250.64(A).
- (3) The exothermic welding process.

(New) 250.52 (A)(2) Metal In-ground Support Structure(s). One or more metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or a structure, it shall be permissible to bond only one into the grounding electrode system.

Informational note: Metal in-ground support structures include, but are not limited to pilings, casings, and other structural metal.

(Revised) 250.52 (A)(7) Plate Electrodes. Each plate electrode shall expose not less than 0.186 m² (2 ft²) of surface to exterior



soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (1/4 in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

(Revised) 250.53(F) Ground Ring. The ground ring shall be installed not less than 750 mm (30 in.) below the surface of the earth.

(Revised) 250.64 (B)(1) Not Exposed to Physical Damage. A 6 AWG or larger copper or aluminum grounding electrode conductor not exposed to physical damage shall be permitted to be run along the surface of the building construction without metal covering or protection.

(Revised) 250.64 (B)(2) Exposed to Physical Damage. A 6 AWG or larger copper or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit Type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

(Revised) 250.64 (B)(3) Smaller Than 6 AWG. Grounding electrode conductors smaller than 6 AWG shall be protected in RMC, IMC, PVC, RTRC-XW, EMT, or cable armor.

(Revised) 250.64 (B)(4) In Contact with the Earth. Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth shall not be required to comply with 300.5, but shall be buried or otherwise protected if subject to physical damage.



PART 1 EXAM QUESTIONS

125. What is the minimum size a grounding electrode conductor not exposed to physical damage can be run along the surface of a building without metal covering or protection?
 - A. 1/0
 - B. 4 AWG
 - C. 2 AWG
 - D. 6 AWG
126. If using an aluminum busbar for the tap connections to a common grounding electrode conductor, what section is required to be referenced for this installation?
 - A. 250.30(A)(4)
 - B. 250.24(C)(2)
 - C. 250.64(A)
 - D. 240.67
127. What is the minimum size grounding electrode conductor that must be protected from physical damage by RMC, IMC, PVC, RTRC-XW, EMT, or cable armor?
 - A. 8
 - B. 6
 - C. 4
 - D. Either A or B
128. What is the minimum depth that a ground ring is required to be installed below finish grade?
 - A. 36 in
 - B. 18 in
 - C. 24 in
 - D. 30 in
129. In general, if a new transformer is being added to an existing system, how do you establish the grounding electrode for the new transformer?
 - A. Use one ground rod installed within 6ft of the new transformer
 - B. Tie into the building's existing grounding electrode system
 - C. Install a ground grid with a minimum of 4 contact points
 - D. Use two ground rods installed within 6ft of the new transformer

130. What is the minimum thickness required for a plate electrode?

- A. 1/2 in
- B. 1/4 in
- C. 3/4 in
- D. 1/8 in

131. What can a metal casing with or without concrete encasement in contact with the earth vertically for 12ft be used for?

- A. Inter system bond
- B. Equipment grounding conductor
- C. Bonding Jumper
- D. Grounding electrode

132. What is the smallest conductor allowed by the 2017 code to be run in parallel?

- A. 1/0
- B. 1 AWG
- C. 250 mcm
- D. 8 AWG

(Revised) 250.66 (A) Connections to a Rod, Pipe, or Plate Electrode(s). If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

(Revised) 250.66 (B) Connections to Concrete-Encased Electrodes. If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrode(s), as described in 250.52(A)(3), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.

(Revised) 250.66 (C) Connections to Ground Rings. If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 250.52(A)(4), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.

(Revised) 250.68 (C) Grounding Electrode Conductor Connections. Grounding electrode conductors and bonding jumpers shall be permitted to be connected at the following locations and used to extend the connection to an electrode(s):

(Revised) (1) Interior metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 1.52 m (5 ft) from the point of entrance to the building shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building shall not be used as a conductor to interconnect electrodes of the grounding electrode system.

(Revised) (2) The metal structural frame of a building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor. Hold-down bolts securing the structural steel column that are connected to a concrete-encased electrode that complies with 250.52(A)(3) and is located in the support footing or foundation shall be permitted to connect the metal structural frame of a building or structure to the concrete encased grounding electrode. The hold-down bolts



shall be connected to the concrete-encased electrode by welding, exothermic welding, the usual steel tie wires, or other approved means.

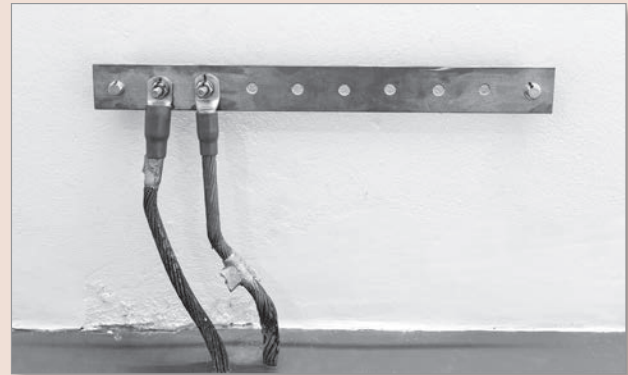
(Revised) (3) A rebar-type concrete-encased electrode installed in accordance with 250.52(A)(3) with an additional rebar section extended from its location within the concrete to an accessible location that is not subject to corrosion shall be permitted for connection of grounding electrode conductors and bonding jumpers. The rebar extension shall not be exposed to contact with the earth without corrosion protection.

(Revised) 250.94 Bonding for Communication Systems. Communications system bonding terminations shall be connected in accordance with (A) or (B).

(New) 250.94 (B) Other Means. Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate at least three terminations for communication systems in addition to other connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 250.64(A).

(Revised) 250.102 Grounded Conductor, Bonding Conductors, and Jumpers. (A) Material. Bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

(Moved) 250.102 (C)(2) Informational Note No. 2: See Chapter 9, Table 8, for the circular mil area of conductors 18 AWG through 4/0 AWG.



PART 1 EXAM QUESTIONS

133. What table shows the circular mil area for conductors 18 AWG through 4/0 AWG?

- A. Table 8
- B. Table 250.102(C)(1)
- C. Table 5
- D. 250.122

134. How are the hold-down bolts securing a structural steel column required to be connected to a concrete-encased electrode?

- A. Steel tie wires
- B. Exothermic welding
- C. Welding
- D. All listed answers

135. If using a conductor for a concrete encased electrode, what type of conductor does it have to be?

- A. Zinc alloy
- B. Aluminum
- C. Copper
- D. All listed answers

136. Where are communications system bonding terminations required to be installed if using a busbar?

- A. At each server rack for testing and maintenance
- B. In the communications room
- C. In the main electrical service room next to the service concrete encased electrode
- D. In an accessible location

137. How many sections are listed with regards to terminating communications system bonding conductors?

- A. 1
- B. 2
- C. 6
- D. 7

138. If a bonding jumper connected to a plate electrode does not extend on to other types of electrodes that require a larger size conductor, what is the maximum size aluminum grounding electrode conductor required to be run?
- 2 AWG
 - 6 AWG
 - 4 AWG
 - 1/0
139. What type of material can a bonding jumper be made of?
- Copper
 - Aluminum
 - Copper-clad aluminum
 - All listed answers
140. What is the maximum distance to make the connection to an interior metal water pipe that enters a building so it can be used to extend the connection to an electrode?
- 4ft
 - 5ft
 - 6ft
 - 3ft
141. What type of protection is a rebar extension from a concrete encased electrode that is in direct contact with the earth required to have?
- Corrosion protection
 - Protected with a conduit sleeve
 - Must be installed in a 18 in x 24 in cut out
 - No protection is required for this scenario
142. If a grounding electrode conductor connected to a ground ring does not extend on to other types of electrodes that require a larger size conductor, what is the maximum size conductor required to be used for the ground ring?
- Once conductor size smaller than the conductor used for the ground ring
 - One conductor size larger than the conductor used for the ground ring
 - Not larger than the conductor used for the ground ring
 - There are no specific requirements for a grounding electrode conductor to a ground ring

(Revised) 250.104 Bonding of Piping Systems and Exposed Structural Metal. (A) Metal Water Piping. The metal water piping system shall be bonded as required in (A)(1), (A)(2), or (A)(3) of this section.

(1) General. Metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

- (1) Service equipment enclosure
- (2) Grounded conductor at the service
- (3) Grounding electrode conductor if of sufficient size
- (4) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size. The bonding jumper(s) shall be installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The points of attachment of the bonding jumper(s) shall be accessible. The bonding jumper(s) shall be sized in accordance with Table 250.102(C)(1) except as permitted in 250.104(A)(2) and 250.104(A)(3).

(Revised) 250.104 (A)(3) Multiple Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s). The metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

- (1) Building or structure disconnecting means enclosure where located at the building or structure
- (2) Equipment grounding conductor run with the supply conductors



(3) One or more grounding electrodes used. The bonding jumper(s) shall be sized in accordance with Table 250.102(C)(1), based on the size of the feeder or branch circuit conductors that supply the building or structure. The bonding jumper shall not be required to be larger than the largest ungrounded feeder or branch-circuit conductor supplying the building or structure.

(Revised) 250.104 (B) Other Metal Piping. If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

- (1) Equipment grounding conductor for the circuit that is likely to energize the piping system
- (2) Service equipment enclosure
- (3) Grounded conductor at the service
- (4) Grounding electrode conductor, if of sufficient size
- (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size. The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.122, and equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

(Revised) 250.104 (C) Structural Metal. Exposed structural metal that is interconnected to form a metal building frame and is not intentionally grounded or bonded and is likely to become energized shall be bonded to any of the following:

- (1) Service equipment enclosure
- (2) Grounded conductor at the service
- (3) Disconnecting means for buildings or structures supplied by a feeder or branch circuit
- (4) Grounding electrode conductor, if of sufficient size
- (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size. The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.102(C)(1) and installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 250.68(A) Exception No. 2.

(Revised) (D)(2) Structural Metal. If exposed structural metal that is interconnected to form the building frame exists in the area served by the separately derived system, it shall be bonded to the grounded conductor of each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 250.102(C)(1) based on the largest ungrounded conductor of the separately derived system.

250.119 (C) Flexible Cord. Equipment grounding conductors in flexible cords shall be insulated and shall have a continuous outer finish that is either green or green with one or more yellow stripes.

PART 1 EXAM QUESTIONS

143. What is the bonding jumper connection that is connected to exposed structural metal that is interconnected to form a metal building required to be?

- A. Accessible
- B. Readily accessible
- C. Secured
- D. Exothermic welded

144. What is the equipment grounding conductor installed in a flexible cord required to be?

- A. 12 AWG minimum
- B. Compact copper
- C. Insulated
- D. All listed answers

145. What table should be used to size the bonding jumpers for metal gas piping systems?

- A. 250.64(A)
- B. 250.102(C)(1)
- C. 250.104(A)(2)
- D. 250.122

146. Where do you make the connection inside a transformer for the conductor that bonds the exposed structural metal that is interconnected to form a building frame?

- A. At the equipment grounding conductor connection
- B. At the grounding electrode conductor connection
- C. On the transformer case
- D. To all corners where the isolation pads are being installed

147. What table should be used to size bonding jumpers for metal water piping systems?

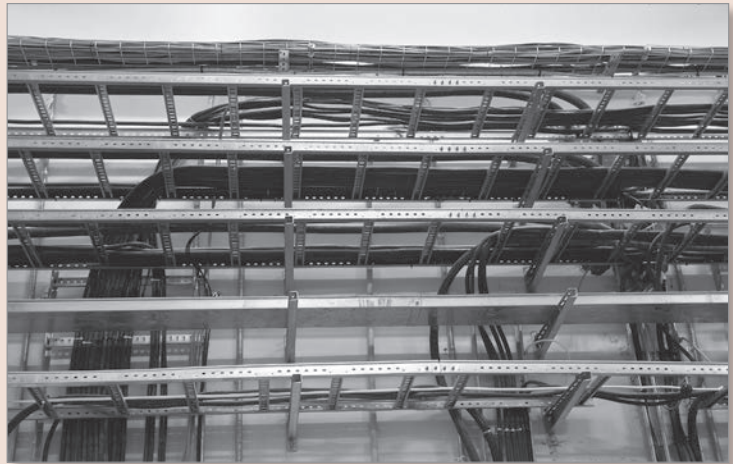
- A. 250.104(A)(2)
- B. 250.122
- C. 250.102(C)(1)
- D. 250.64(A)

148. What is the bonding jumper connection that is connected to a metal water pipe installed in a building required to be?

- A. Exothermic welded
- B. Readily accessible
- C. Secured
- D. Accessible

(NEW)250.122 (F)(1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays.

(a) Single Raceway or Cable Tray. If conductors are installed in parallel in the same raceway or cable tray, a single wiretype conductor shall be permitted as the equipment grounding conductor. The wire-type equipment grounding conductor shall be sized in accordance with 250.122, based on the overcurrent protective device for the feeder or branch circuit. Wiretype equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.



(b) Multiple Raceways. If conductors are installed in parallel in multiple raceways, wire-type equipment grounding conductors, where used, shall be installed in parallel in each raceway. The equipment grounding conductor installed in each raceway shall be sized in compliance with 250.122 based on the overcurrent protective device for the feeder or branch circuit. Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

(NEW)250.122 (F)(2) Multiconductor Cables.

(a) If multiconductor cables are installed in parallel, the equipment grounding conductor(s) in each cable shall be connected in parallel.

(b) If multiconductor cables are installed in parallel in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with 250.122 shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all be connected together.

(c) Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Cable trays complying with 392.60(B), metal raceways in accordance with 250.118, or auxiliary gutters shall be permitted as the equipment grounding conductor.

(d) Except as provided in 250.122(F)(2)(b) for raceway or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.

(Revised) 250.187 (B) Identified and Insulated. The neutral conductor shall comply with both of the following:

- (1) The neutral conductor shall be identified.
- (2) The neutral conductor shall be insulated for the maximum neutral voltage.

Informational Note: The maximum neutral voltage in a threephase wye system is 57.7 percent of the phase-to-phase voltage.

(Revised) 285.3 Uses Not Permitted. An SPD device shall not be installed in the following:

- (1) Circuits over 1000 volts
- (2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems
- (3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.

(Revised) 300.5(G) Raceway Seals. Conduits or raceways through which moisture may contact live parts shall be sealed or plugged at either or both ends. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, conductor insulation, bare conductor, shield, or other components.

(NEW) 300.4 Informational note: Minor damage to a raceway, cable armor, or cable insulation does not necessarily violate the integrity of either the contained conductors or the conductors' insulation.

(Revised) 300.7 (B) Expansion, Expansion-Deflection, and Deflection Fittings. Raceways shall be provided with expansion, expansion deflection, or deflection fittings where necessary to compensate for thermal expansion, deflection, and contraction.

(Revised) 300.19(A) Spacing Intervals — Maximum. Conductors in vertical raceways shall be supported if the vertical rise exceeds the values in Table 300.19(A). At least one support method shall be provided for each conductor at the top of the vertical raceway or as close to the top as practical. Intermediate supports shall be provided as necessary to limit supported conductor lengths to not greater than those values specified in Table 300.19(A).



PART 1 EXAM QUESTIONS

149. What should the maximum neutral voltage in a threephase wye system be?

- A. 125% of the primary voltage
- B. 57.7 percent of the phase-to-ground voltage
- C. 125% of the primary neutral voltage
- D. 57.7 percent of the phase-to-phase voltage

150. What table is required to be used to size a wire type equipment grounding conductor used in a cable tray?

- A. 250.104(A)(2)
- B. 250.102(C)(1)
- C. 250.122
- D. 250.66

151. What are you required to do with spare conduits?

- A. Seal them
- B. Extend 3ft
- C. Identify with tape
- D. All listed answers

152. What is the maximum circuit voltage that an SPD can be installed?

- A. 480 volts
- B. 600 volts
- C. 575 volts
- D. 1000 volts

153. What section should be referenced to determine the minimum installation requirements for equipment grounding conductors installed in a cable tray?

- A. 250.122(F)(2)(b)
- B. 392.10(B)(1)(c).
- C. 250.118
- D. 392.60(B)

154. What are raceway expansion fittings used for?

- A. Earth erosion
- B. Seismic activity
- C. Thermal expansion
- D. House boats

155. What section describes how minor damage to a cable's insulation affects the contained conductors or the conductors' insulation?

- A. 300.5
- B. 285.3
- C. 300.4
- D. 285.5

156. How many support methods are required to be used to support vertical cables in a cable tray that exceed the values in 300.19(A)?

- A. At least one
- B. Two
- C. Three
- D. There are no requirements for vertical cable tray runs

(NEW) 300.22(C)(3) Informational note: One method to determine low smoke and heat release properties is that the equipment exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100kW or less when tested in accordance with ANSI/UL 2043-2013, Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

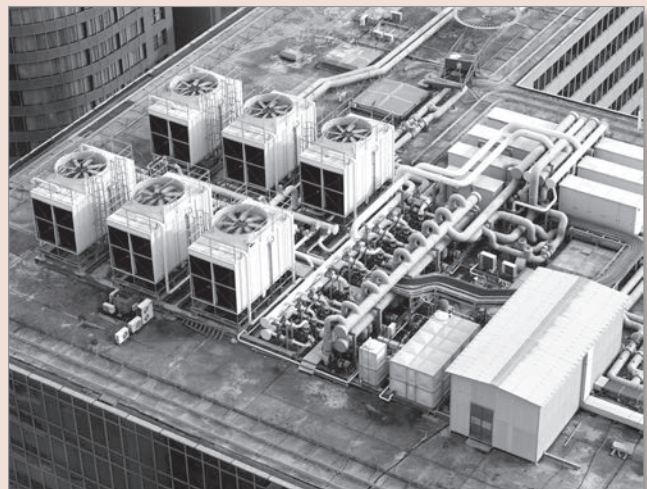
(Revised) 310.10(H)(5) Equipment Grounding Conductors. Where parallel equipment grounding conductors are used, they shall be sized in accordance with 250.122. Sectioned equipment grounding conductors smaller than 1/0 AWG shall be permitted in multiconductor cables, if the combined circular mil area of the sectioned equipment grounding conductors in each cable complies with 250.122.

(Revised) 310.15(A)(2) Selection of Ampacity. Where more than one ampacity applies for a given circuit length, the lowest value shall be used.

Exception: Where different ampacities apply to portions of a circuit, the higher ampacity shall be permitted to be used if the total portion(s) of the circuit with lower ampacity does not exceed the lesser of 3.0 m (10 ft) or 10 percent of the total circuit.

(Revised) 310.15(B)(3) Informational Note No. 2: See 366.23 for adjustment factors for conductors and ampacity for bare copper and aluminum bars in auxiliary gutters and 376.22(B) for adjustment factors for conductors in metal wireways.

(Revised) 310.15(B)(3) (c) Raceways and Cables Exposed to Sunlight on Rooftops. Where raceways or cables are exposed to direct sunlight on or above



rooftops, raceways or cables shall be installed a minimum distance above the roof to the bottom of the raceway or cable of 23 mm (7/8 in.). Where the distance above the roof to the bottom of the raceway is less than 23 mm (7/8 in.), a temperature adder of 33°C (60°F) shall be added to the outdoor temperature to determine the applicable ambient temperature for application of the correction factors in Table 310.15(B)(2)(a) or Table 310.15(B)(2)(b).

(Revised) 310.60(C)(2) (a) Where burial depths are increased in part(s) of an electrical duct run, a decrease in ampacity of the conductors shall not be required, provided the total length of parts of the duct run increased in depth is less than 25 percent of the total run length.

(Revised) 310.60(C)(2) (b) Where burial depths are deeper than shown in a specific underground ampacity table or figure, an ampacity derating factor of 6 percent per 300 mm (1 ft) increase in depth for all values of rho shall be permitted. No ampacity adjustments shall be required where the burial depth is decreased.

(Revised) 312.1 Scope. This article covers the installation and construction specifications of cabinets, cutout boxes, and meter socket enclosures. It does not apply to equipment operating at over 1000 volts, except as specifically referenced elsewhere in the Code.

(Revised) 312.8 Switch and Overcurrent Device Enclosures. The wiring space within enclosures for switches and overcurrent devices shall be permitted for other wiring and equipment subject to limitations for specific equipment as provided in (A) and (B).

(NEW) 312.8 (B) Power Monitoring Equipment. The wiring space of enclosures for switches or overcurrent devices shall be permitted to contain power monitoring equipment where all of the following conditions are met:

- (1) The power monitoring equipment is identified as a field installable accessory as part of the listed equipment, or is a listed kit evaluated for field installation in switch or overcurrent device enclosures.
- (2) The total area of all conductors, splices, taps, and equipment at any cross section of the wiring space does not exceed 75 percent of the cross-sectional area of that space.

(Revised) 312.6(A) Note: 2. This column shall be permitted to be used to determine the minimum wire-bending space for compact stranded aluminum conductors in sizes up to 1000 kcmil and manufactured using AA-8000 series electrical grade aluminum alloy conductor material in accordance with 310.106(B). The minimum width of the wire gutter space shall be determined using the all other conductors value in this table.

PART 1 EXAM QUESTIONS

157. What value is required to be used where more than one ampacity applies for a given circuit length?

- A. Lowest value
- B. Highest value
- C. Medium Value
- D. Nominal Value

158. What is the maximum peak optical density for a piece of equipment to be considered having low smoke and heat release properties?

- A. 0.50
- B. 0.30
- C. 0.70
- D. 0.80

159. What section should be referenced to determine adjustment factors for conductors and ampacity for bare copper and aluminum bars in auxiliary gutters?

- A. 250.122
- B. 376.22(B)
- C. 310.10(H)(5)
- D. 366.23

160. What table shows the minimum wire-bending space for compact stranded aluminum conductors in sizes up to 1000 kcmil?

- A. 310.10(H)(5)
- B. 366.23
- C. 312.6(A)
- D. 250.122

161. What is the minimum distance above a roof that a raceway can be installed if exposed to direct sunlight?
- A. 3 inches
 - B. 3/4 in
 - C. 1 in
 - D. 7/8 in
162. How many conditions must be met for power monitoring equipment to be installed in the wiring space for overcurrent devices?
- A. 3
 - B. 2
 - C. 1
 - D. 4
163. What ampacity derating factor is required to be used if a duct bank burial depth is deeper than that shown in a specific underground ampacity table or figure?
- A. 5% per foot increase in depth over
 - B. 6% per foot decrease in depth under
 - C. 6% per foot increase in depth over
 - D. 5% per foot decrease in depth over
164. In general, Article 312 does not apply to equipment operating at over what voltage?
- A. 300 volts
 - B. 600 volts
 - C. 240 volts
 - D. 1000 volts
165. What is the maximum depth increase an electrical duct run can be extended where the ampacity of the conductors does not require a decrease?
- A. 24%
 - B. 25%
 - C. 30%
 - D. 27%
166. What table is required to be used when sizing equipment grounding conductors in parallel?
- A. 250.104(A)(2)
 - B. 250.102(C)(1)
 - C. 250.122
 - D. 250.66

(Revised) 314.15 Damp or Wet Locations. In damp or wet locations, boxes, conduit bodies, outlet box hoods, and fittings shall be placed or equipped so as to prevent moisture from entering or accumulating within the box, conduit body, or fitting. Boxes, conduit bodies, outlet box hoods, and fittings installed in wet locations shall be listed for use in wet locations. Approved drainage openings not smaller than 3 mm (1/8 in.) and not larger than 6 mm (1/4 in.) in diameter shall be permitted to be installed in the field in boxes or conduit bodies listed for use in damp or wet locations. For installation of listed drain fittings, larger openings are permitted to be installed in the field in accordance with manufacturer's instructions.

(Revised) 314.16 (B) Box Fill Calculations. The volumes in paragraphs 314.16(B)(1) through (B)(5), as applicable, shall be added together. No allowance shall be required for small fittings such as locknuts and bushings. Each space within a box installed with a barrier shall be calculated separately.

(Revised) 314.17 (B) Metal Boxes and Conduit Bodies. Where metal boxes or conduit bodies are installed with messenger-supported wiring, open wiring on insulators, or concealed knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support to not less than 6 mm (1/4 in.) inside the box and beyond any cable clamps. Where nonmetallic-sheathed cable or multiconductor Type UF cable is used, the sheath shall extend not less than 6 mm (1/4 in.) inside the box and beyond any cable clamp. Except as provided in 300.15(C), the wiring shall be firmly secured to the box or conduit body. Where raceway or cable is installed with metal boxes or conduit bodies, the raceway or cable shall be secured to such boxes and conduit bodies.



(Revised) 314.23 (B) (1) Nails and Screws. Nails and screws, where used as a fastening means, shall secure boxes by using brackets on the outside of the enclosure, or by using mounting holes in the back or in a single side of the enclosure, or they shall pass through the interior within 6 mm (1/4 in.) of the back or ends of the enclosure. Screws shall not be permitted to pass through the box unless exposed threads in the box are protected using approved means to avoid abrasion of conductor insulation. Mounting holes made in the field shall be approved.

(Revised) 314.27 (A)(2) Ceiling Outlets. At every outlet used exclusively for lighting, the box shall be designed or installed so that a luminaire or lampholder may be attached. Boxes shall be required to support a luminaire weighing a minimum of 23 kg (50 lb). A luminaire that weighs more than 23 kg (50 lb) shall be supported independently of the outlet box, unless the outlet box is listed for not less than the weight to be supported. The interior of the box shall be marked by the manufacturer to indicate the maximum weight the box shall be permitted to support.

(NEW) 314.27 (E) Separable Attachment Fittings. Outlet boxes required in 314.27 shall be permitted to support listed locking support and mounting receptacles used in combination with compatible attachment fittings. The combination shall be identified for the support of equipment within the weight and mounting orientation limits of the listing. Where the supporting receptacle is installed within a box, it shall be included in the fill calculation covered in 314.16(B)(4).

(Revised) 314.28 (E) (1) Installation. Power distribution blocks installed in boxes shall be listed. Power distribution blocks installed on the line side of the service equipment shall be listed and marked "suitable for use on the line side of service equipment" or equivalent.

(NEW) 320.6 Listing Requirements. Type AC cable and associated fittings shall be listed.

(Revised) 320.30 (B) Securing. Unless otherwise permitted, Type AC cable shall be secured within 300 mm (12 in.) of every outlet box, junction box, cabinet, or fitting and at intervals not exceeding 1.4 m (4 1/2 ft).

(Revised) 320.30 (C) Supporting. Unless otherwise permitted, Type AC cable shall be supported at intervals not exceeding 1.4 m (4 1/2 ft). Horizontal runs of Type AC cable installed in wooden or metal framing members or similar supporting means shall be considered supported where such support does not exceed 1.4 m (4 1/2 ft) intervals.

(NEW) 322.6 Listing Requirements. Type FC and associated fittings shall be listed.



PART 1 EXAM QUESTIONS

167. At what distance does type AC cable need to be supported when run horizontally?

- A. 7 1/2 ft
- B. 4 1/2 ft
- C. 5 1/2 ft
- D. 5 ft

168. How are spaces within a box divided by a barrier required to be calculated?

- A. As a whole
- B. Separately
- C. Each barrier counts as a 10% deration factor in the calculation
- D. Barrier sections count only as one space in a common box or enclosure

- 169. What are mounting holes made in the field for mounting a box required to be?**
- A. Approved
 - B. Listed
 - C. Readily accessible
 - D. Accessible
- 170. What is the minimum weight that a box installed for a luminaire is required to support?**
- A. 30 lb
 - B. 25 lb
 - C. 50 lb
 - D. 75 lb
- 171. What is type AC cable required to be?**
- A. Identified
 - B. Listed
 - C. Rated
 - D. All listed answers
- 172. If listed locking support and mounting receptacles are installed in a box, what section requires this to be added into the fill calculation?**
- A. 314.23 (B)(1)
 - B. 312.6(A)
 - C. 314.16(B)(4)
 - D. 314.15
- 173. Within how many inches to a junction box does type AC cable need to be supported?**
- A. 12 in
 - B. 14 in
 - C. 20 in
 - D. 18 in
- 174. How far beyond the last cable clamp does messenger-supported open wiring need to extend when using a metal box?**
- A. 6 in
 - B. 1/2 in
 - C. 3/8 in
 - D. 1/4 in
- 175. What is type FC cable required to be?**
- A. Identified
 - B. Listed
 - C. Rated
 - D. All listed answers
- 176. What is the smallest allowable drainage opening that can be installed in a box listed for wet locations?**
- A. 5/16 in
 - B. 1/4 in
 - C. 3/16 in
 - D. 1/8 in
- 177. How are power distribution blocks installed in a box on the line side of service equipment required to be marked?**
- A. For use on the line side of service equipment
 - B. Suitable for use on service equipment
 - C. Suitable for use on the line side of service equipment
 - D. Suitable for use on the load side of service equipment

(Revised) 324.12 Uses Not Permitted. FCC systems shall not be used in the following locations:

- (1) Outdoors or in wet locations
- (2) Where subject to corrosive vapors
- (3) In any hazardous (classified) location
- (4) In residential buildings
- (5) In school and hospital buildings, other than administrative office areas

(Revised) 326.24 Bending Radius. Where the coillable nonmetallic conduit and cable are bent for installation purposes or are flexed or bent during shipment or installation, the radius of the curve of the inner edge measured to the inside of the bend shall not be less than specified in table 326.24

(NEW) 328.30 Support. Type MV cable terminated in equipment or installed in pull boxes or vaults shall be secured and supported by metallic or nonmetallic supports suitable to withstand the weight by cable ties

listed and identified for securement and support, or other approved means, at intervals not exceeding 1.5 m (5 ft) from terminations or a maximum of 1.8 m (6 ft) between supports.

(NEW) 330.15 Exposed Work. Exposed runs of cable, except as provided in 300.11 (A), shall closely follow the surface of the building finish or of running boards. Exposed runs shall also be permitted to be installed on the underside of joists where supported at each joist and located so as not to be subject to physical damage.

(NEW) 332.6 Listing Requirements. Type MI cable and associated fittings shall be listed.

(NEW) 334.6 Listing Requirements. Type NM, Type NMC, and Type NMS cables and associated fittings shall be listed.

(Revised) 334.30 Securing and Supporting. Nonmetallic-sheathed cable shall be supported and secured by staples; cable ties listed and identified for securement and support; or straps, hangers, or similar fittings designed and installed so as not to damage the cable, at intervals not exceeding 1.4 m (4½ ft) and within 300 mm (12 in.) of every cable entry into enclosures such as outlet boxes, junction boxes, cabinets, or fittings. Flat cables shall not be stapled on edge.

The ampacity of types NM, NMC, and NMS cable shall be determined in accordance with 310.15. The allowable ampacity shall not exceed that of a 60°C (140°F) rated conductor. The 90°C (194°F) rating shall be permitted to be used for ampacity adjustment and correction calculations, provided the final calculated ampacity does not exceed that of a 60°C (140°F) rated conductor. The ampacity of Types NM, NMC, and NMS cable installed in cable trays shall be determined in accordance with 392.80(A).

(NEW) 336.6 Listing Requirements. Type TC cables and associated fittings shall be listed.

(NEW) 336.10 (9) In one- and two-family dwelling units, Type TC-ER cable containing both power and control conductors that is identified for pulling through structural members shall be permitted. Type TC-ER cable used as interior wiring shall be installed per the requirements of Part II of Article 334.

(NEW) 336.10 (9) Exception: Where used to connect a generator and associated equipment having terminals rated 75°C (140°F) or higher, the cable shall not be limited in ampacity by 334.80 or 340.80.

(NEW) 336.10 (9) Informational Note No. 1: TC-ER cable that is suitable for pulling through structural members is marked "JP."

(NEW) 336.10 (9) Informational Note No. 2: See 725.136 for limitations on Class 2 or 3 circuits contained within the same cable with conductors of electric light, power, or Class 1 circuits.

(NEW) 336.10 (10) Direct buried, where identified for such use.



PART 1 EXAM QUESTIONS

178. What is the maximum distance nonmetallic-sheathed cable can be supported from a termination box?

- A. 8 in
- B. 6 in
- C. 18 in
- D. 12 in

179. What location can type FCC cable be installed?

- A. Patient bed location
- B. Wet location
- C. Damp location
- D. In residential buildings

180. What are the associated fittings used with type NMS cables required to be?

- A. Listed
- B. Identified
- C. Rated
- D. All listed answers

181. What is the maximum distance type MV cable can be supported from a termination box?

- A. 4ft
- B. 6ft
- C. 3ft
- D. 5ft

182. MC cable can be run on the underside of joists if what listed requirement is met?

- A. Installed where foot traffic is likely to occur
- B. Not subject to physical damage
- C. Installed in an accessible location
- D. Installed in a readily accessible location

183. What table shows the minimum bending radius for coilaible cable?

- A. 314.23 (B)(1)
- B. 324.26
- C. 326.24
- D. 314.15

184. What is type MI cable required to be?

- A. Identified
- B. Listed
- C. Rated
- D. All listed answers

185. What is the maximum allowable distance between supports for type MV cable?

- A. 6ft
- B. 5ft
- C. 3ft
- D. 4ft

186. What is the maximum allowable distance between supports for nonmetallic-sheathed cable?

- A. 4ft
- B. 5ft
- C. 3ft
- D. 4 ft 6 in

187. What section should be used to determine the limitations on Class 2 or 3 circuits contained within the same cable with conductors of electric light, power, or Class 1 circuits?

- A. 752.136
- B. 725.136
- C. 832.74
- D. 823.47

188. What are the associated fittings used with type TC cables required to be?

- A. Rated
- B. Identified
- C. Listed
- D. All listed answers

189. What must the marking on a TC-ER cable indicate when being installed in a single family dwelling through structural members?

- A. JP
- B. UV
- C. RS
- D. JS

190. What section is required to be referenced to determine the ampacity of Romex installed in a cable tray?

- A. 310.15
- B. 392.80(A)
- C. 326.24
- D. 314.16(B)(4)

191. If installing type TC-ER cable as interior wiring in a single family dwelling, what part of Article 334 is required to be followed?

- A. V
- B. IV
- C. II
- D. III

(NEW) 338.6 Listing Requirements. Type SE and USE cables and associated fittings shall be listed.

(NEW) 340.6 Listing Requirements. Type UF cable and associated fittings shall be listed.

(Revised) 342.14 Dissimilar Metals. Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action. Aluminum fittings and enclosures shall be permitted to be used with galvanized steel IMC where not subject to severe corrosive influences. Stainless steel IMC shall only be used with stainless steel fittings and approved accessories, outlet boxes, and enclosures.

(NEW) 342.100 Construction. IMC shall be made of one of the following:

- (1) Steel, with protective coatings
- (2) Stainless steel

(Revised) 342.120 Marking. Each length shall be clearly and durably marked at least every 1.5 m (5 ft) with the letters IMC. Each length shall be marked as required in the first sentence of 110.21(A).

(Revised) 344.14 Dissimilar Metals. Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action. Aluminum fittings and enclosures shall be permitted to be used with galvanized steel RMC, and galvanized steel fittings and enclosures shall be permitted to be used with aluminum RMC where not subject to severe corrosive influences. Stainless steel RMC shall only be used with stainless steel fittings and approved accessories, outlet boxes, and enclosures.

(Revised) 344.100 Construction. RMC shall be made of one of the following:

- (1) Steel with protective coatings
- (2) Aluminum
- (3) Red brass
- (4) Stainless steel

(Revised) 348.30 (A) Securely Fastened. FMC shall be securely fastened in place by an approved means within 300 mm (12 in.) of each box, cabinet, conduit body, or other conduit termination and shall be supported and secured at intervals not to exceed 1.4 m (4 1/2 ft). Where used, cable ties shall be listed and be identified for securement and support.

(Revised) 350.10 Uses Permitted. LFMC shall be permitted to be used in exposed or concealed locations as follows:

- (1) Where conditions of installation, operation, or maintenance require flexibility or protection from liquids, vapors, or solids
- (2) In hazardous (classified) locations where specifically permitted by Chapter 5
- (3) For direct burial where listed and marked for the purpose liquidtight flexible metal conduit

(NEW) 350.28 Trimming. All cut ends of conduit shall be trimmed inside and outside to remove rough edges.

(Revised) 358.10 (A) Exposed and Concealed. The use of EMT shall be permitted for both exposed and concealed work for the following:

- (1) In concrete, in direct contact with the earth or in areas subject to severe corrosive influences where installed in accordance with 358.10(B)
- (2) In dry, damp, and wet locations
- (3) In any hazardous (classified) location as permitted by other articles in this Code



PART 1 EXAM QUESTIONS

- 192. What are you required to do to the cut ends of all liquidtight flexible metal conduit?**
- A. Trim inside and outside to remove rough edges
 - B. Rough the edges and interior
 - C. Cut the ends at a 45 degree angle
 - D. Mark the ends with white phase tape
- 193. What section applies to service entrance cable identified for use underground?**
- A. 338
 - B. 336
 - C. 334
 - D. 340
- 194. What term is used when two dissimilar metals are in contact with each other?**
- A. Lock set
 - B. Pluribus Unum
 - C. Galvanic action
 - D. Top set
- 195. What section is required to be followed when installing EMT in direct contact with the earth or in areas subject to severe corrosive influences?**
- A. 358.10(D)
 - B. 385.10(A)
 - C. 358.10(B)
 - D. 358.14
- 196. What section describes the construction of Intermediate Metal Conduit?**
- A. 342.14
 - B. 342.100
 - C. 336.10
 - D. 342.140
- 197. What is the maximum allowable distance between supports for flexible metal conduit?**
- A. 4 ft 6 in
 - B. 5ft
 - C. 3ft
 - D. 4ft
- 198. What is rigid metal conduit typically made from?**
- A. Red brass
 - B. Stainless steel
 - C. Aluminum
 - D. All listed answers
- 199. At what interval does Intermediate Metal Conduit need to be durably marked?**
- A. 4 ft 6 in
 - B. 5ft
 - C. 3ft
 - D. 4ft
- 200. What is the maximum distance from an electrical cabinet that 3/4-inch flexible metal conduit needs to be supported?**
- A. 8 in
 - B. 6 in
 - C. 18 in
 - D. 12 in
- 201. What Chapter of the 2017 code allows liquidtight flexible metal conduit to be installed in specific hazardous areas?**
- A. 6
 - B. 7
 - C. 5
 - D. 4
- 202. What article applies to the installation requirements of underground feeder and branch-circuit cable?**
- A. 340
 - B. 336
 - C. 334
 - D. 338
- 203. What section should be referenced to determine if stainless steel rigid metal conduit and galvanized steel fittings can be used together?**
- A. 342.120
 - B. 342.100
 - C. 344.14
 - D. 344.41

(NEW) 358.10 (B) (1) Galvanized Steel and Stainless Steel EMT, Elbows, and Fittings. Galvanized steel and stainless steel EMT, elbows, and fittings shall be permitted to be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences where protected by corrosion protection and approved as suitable for the condition.

(NEW) 358.10 (B) (2) Supplementary Protection of Aluminum EMT. Aluminum EMT shall be provided with approved supplementary corrosion protection where encased in concrete or in direct contact with the earth.



(NEW) 358.10 (B) (C) Cinder Fill. Galvanized steel and stainless steel EMT shall be permitted to be installed in cinder concrete or cinder fill where subject to permanent moisture when protected on all sides by a layer of noncinder concrete at least 50 mm (2 in.) thick or when the tubing is installed at least 450 mm (18 in.) under the fill.

(NEW) 358.14 Dissimilar Metals. Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action. Aluminum fittings and enclosures shall be permitted to be used with galvanized steel EMT, and galvanized steel fittings and enclosures shall be permitted to be used with aluminum EMT where not subject to severe corrosive influences. Stainless steel EMT shall only be used with stainless steel fittings and approved accessories, outlet boxes, and enclosures.

(Revised) 358.30 (A) Securely Fastened. EMT shall be securely fastened in place at intervals not to exceed 3 m (10 ft). In addition, each EMT run between termination points shall be securely fastened within 900 mm (3 ft) of each outlet box, junction box, device box, cabinet, conduit body, or other tubing termination.

(Revised) 360.2 Flexible Metallic Tubing (FMT). A metal raceway that is circular in cross section, flexible, and liquidtight without a nonmetallic jacket.

(Revised) 362.30 (A) Securely Fastened. ENT shall be securely fastened at intervals not exceeding 900 mm (3 ft). In addition, ENT shall be securely fastened in place within 900 mm (3 ft) of each outlet box, device box, junction box, cabinet, or fitting where it terminates. Where used, cable ties shall be listed as suitable for the application and for securing and supporting.



(Revised) 366.30 (A) Sheet Metal Auxiliary Gutters. Sheet metal auxiliary gutters shall be supported and secured throughout their entire length at intervals not exceeding 1.5 m (5 ft).

(NEW) 372.18 Cellular Concrete Floor Raceways Installation. Installation of cellular concrete floor raceways shall comply with 372.18(A) through 372.18(E).

(MOVED/Revised) 372.23 Ampacity of Conductors. The ampacity adjustment factors as provided in 310.15(B) (3) shall apply to conductors installed in cellular concrete floor raceways.

(NEW) 374.18 Cellular Metal Floor Raceways Installations. Installation of cellular metal floor raceways shall comply with 374.18(A) through 374.18(D).

PART 1 EXAM QUESTIONS

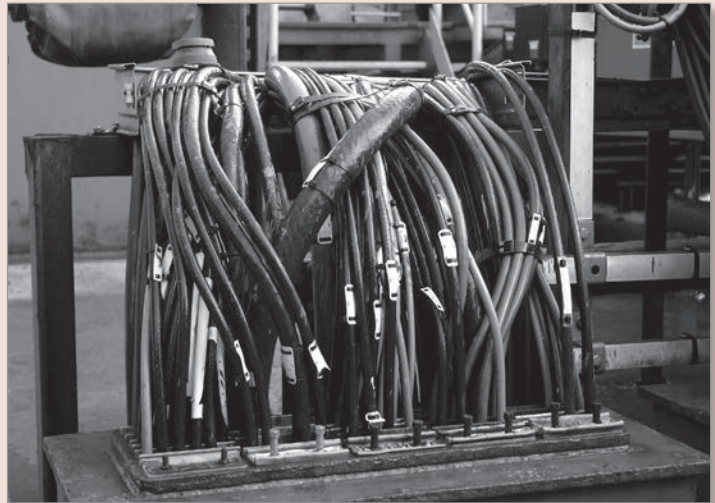
- 204. What is the maximum distance from a device box that 1/2-inch EMT conduit needs to be supported?**
- A. 18 in
 - B. 6 in
 - C. 3ft
 - D. 2ft
- 205. What does Aluminum EMT have to be protected with if installed in concrete?**
- A. A PVC Conduit sleeve
 - B. No Locks
 - C. Supplementary corrosion protection
 - D. There is no requirement as EMT is not made from aluminum
- 206. What section should be referenced to determine if galvanized steel EMT and aluminum EMT fittings can be used together?**
- A. 385.10(A)
 - B. 358.14
 - C. 358.10(D)
 - D. 358.10(B)
- 207. What is the minimum thickness of noncinder concrete that needs to protect Galvanized steel EMT installed in cinder concrete?**
- A. 4 inches
 - B. 2 inches
 - C. 18 inches
 - D. 3 inches
- 208. What is the maximum distance between supports that ENT conduit can be supported?**
- A. 6ft
 - B. 5ft
 - C. 10ft
 - D. 3ft
- 209. Where are you directed to find the ampacity adjustment factors for conductors installed in cellular concrete floor raceways?**
- A. 316.16(B)(3)
 - B. 310.10(H)
 - C. 310.15(B)(3)
 - D. 315.15(A)(3)
- 210. What is the maximum allowable distance between supports for EMT conduit?**
- A. 5ft
 - B. 10ft
 - C. 3ft
 - D. 6ft
- 211. How far from a junction box does 1-inch ENT conduit need to be supported?**
- A. 3ft
 - B. 6 in
 - C. 18 in
 - D. 2ft
- 212. What is the maximum allowable distance between supports for sheet metal auxiliary gutters?**
- A. 10ft
 - B. 3ft
 - C. 5ft
 - D. 6ft
- 213. How many installation provisions are cellular metal floor raceways required to comply with?**
- A. 5
 - B. 6
 - C. 4
 - D. 3
- 214. How many installation provisions are cellular concrete floor raceways required to comply with?**
- A. 5
 - B. 6
 - C. 4
 - D. 3
- 215. What best defines a metal raceway that is circular in cross section, flexible, and liquidtight without a nonmetallic jacket?**
- A. Flexible Non-Metallic Conduit (FNC)
 - B. Flexible Non-Metallic Tubing (FNT)
 - C. Buss duct
 - D. Flexible Metallic Tubing (FMT)
- 216. Where are galvanized steel and stainless steel EMT, elbows, and fittings permitted to be installed?**
- A. In areas subject to severe corrosive influences where protected by corrosion protection
 - B. In concrete
 - C. In direct contact with the earth
 - D. All listed answers

(NEW) 376.20 Conductors Connected in Parallel.

Where single conductor cables comprising each phase, neutral, or grounded conductor of an alternating-current circuit are connected in parallel as permitted in 310.10(H), the conductors shall be installed in groups consisting of not more than one conductor per phase, neutral, or grounded conductor to prevent current imbalance in the paralleled conductors due to inductive reactance.

(Revised) 376.22 (A) Cross-Sectional Areas of Wireway.

The sum of the crosssectional areas of all contained conductors and cables at any cross section of a wireway shall not exceed 20 percent of the interior crosssectional area of the wireway.



(Revised) 376.56 (B) (1) Installation. Power distribution blocks installed in metal wireways shall be listed. Power distribution blocks installed on the line side of the service equipment shall be marked "suitable for use on the line side of service equipment" or equivalent.

(NEW) 378.20 Conductors Connected in Parallel. Where single conductor cables comprising each phase, neutral, or grounded conductor of an alternating-current circuit are connected in parallel as permitted in 310.10(H), the conductors shall be installed in groups consisting of not more than one conductor per phase, neutral, or grounded conductor to prevent current imbalance in the paralleled conductors due to inductive reactance.

(NEW) 392.10 (E) Airfield Lighting Cable Tray. In airports where maintenance and supervision conditions ensure that only qualified persons can access, install, or service the cable, airfield lighting cable used in series circuits that are rated up to 5000 volts and are powered by constant current regulators shall be permitted to be installed in cable trays.

(NEW) 392.80 (A) Informational Note: See 110.14(C) for conductor temperature limitations due to termination provisions.

(NEW) 400.1 Informational Note: UL 817, Cord Sets and Power-Supply Cords, allows the use of flexible cords manufactured in accordance with UL 62, Flexible Cords and Cables. See 400.10 and 400.12 for flexible cords that are part of a listed cord set or power-supply cord.

(Revised) 400.12 Uses Not Permitted. Unless specifically permitted in 400.10, flexible cables, flexible cord sets, and power supply cords shall not be used for the following:

- (1) As a substitute for the fixed wiring of a structure
- (2) Where run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings, or floors
- (3) Where run through doorways, windows, or similar openings
- (4) Where attached to building surfaces

Exception to (4): Flexible cord and flexible cable shall be permitted to be attached to building surfaces in accordance with 368.56(B) .

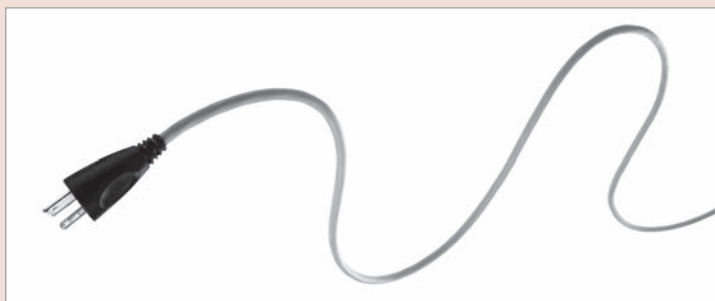
- (5) Where concealed by walls, floors, or ceilings or located above suspended or dropped ceilings

Exception to (5): Flexible cord and flexible cable shall be permitted if contained within an enclosure for use in Other Spaces Used for Environmental Air as permitted by 300.22(C)(3).

(6) Where installed in raceways, except as otherwise permitted in this Code

(7) Where subject to physical damage

(Revised) 400.21 (A) Conductors. The individual conductors of a flexible cord or flexible cable shall have copper flexible stranding and shall not be smaller than the sizes specified in Table 400.4.



PART 1 EXAM QUESTIONS

- 217. What table specifies the minimum size for individual conductors in flexible cords?**
- A. 400.21
 - B. 400.4
 - C. 300.22(C)(3)
 - D. 110.14(C)
- 218. What is the maximum rated cable voltage that airfield lighting cable used in series circuits can be installed in a cable tray?**
- A. 3000 volts
 - B. 1000 volts
 - C. 600 volts
 - D. 5000 volts
- 219. What is the maximum interior cross-sectional area at any cross section that cables installed in a metal wireway can account for?**
- A. 20%
 - B. 40%
 - C. 80%
 - D. 25%
- 220. Where can a flexible power supply cord not be installed?**
- A. Prevention of the transmission of noise or vibration
 - B. Wiring of luminaires
 - C. Where run through doorways, windows, or similar openings
 - D. For powering pendants
- 221. What causes a current imbalance with regards to conductors in parallel?**
- A. Inductive Capacitance
 - B. Inductive reactance
 - C. Resonance
 - D. Eddy currents
- 222. What are power distribution blocks installed in metal wireways required to be?**
- A. Accessible
 - B. Readily accessible
 - C. Guarded
 - D. Listed
- 223. How many sections are referenced in the 2017 code for information pertaining to flexible cords that are part of a listed cord set or power-supply cord?**
- A. 2
 - B. 3
 - C. 1
 - D. 4
- 224. What section would you find conductor temperature limitations due to termination provisions with regards to cable trays?**
- A. 310.15(B)(3)
 - B. 110.14(C)
 - C. 358.14
 - D. 310.10(H)
- 225. If installing single conductor cables connected in parallel in a metal wireway as permitted in 310.10(H), the conductors have to be installed a certain way as to prevent what?**
- A. Eddy currents
 - B. Inductive Capacitance
 - C. Resonance
 - D. Current imbalance

(Revised) 404.2 (C) Switches Controlling Lighting Loads. The grounded circuit conductor for the controlled lighting circuit shall be installed at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit serving bathrooms, hallways, stairways, or rooms suitable for human habitation or occupancy as defined in the applicable building code. Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall only be required at one location. A grounded conductor shall not be required to be installed at lighting switch locations under any of the following conditions:

- (1) Where conductors enter the box enclosing the switch through a raceway, provided that the raceway is large enough for all contained conductors, including a grounded conductor
- (2) Where the box enclosing the switch is accessible for the installation of an additional or replacement cable without removing finish materials
- (3) Where snap switches with integral enclosures comply with 300.15(E)
- (4) Where lighting in the area is controlled by automatic means
- (5) Where a switch controls a receptacle load



(Revised) 404.9 (B) Grounding. Snap switches, including dimmer and similar control switches, shall be connected to an equipment grounding conductor and shall provide a means to connect metal faceplates to the equipment grounding conductor, whether or not a metal faceplate is installed. Metal faceplates shall be grounded. Snap switches shall be considered to be part of an effective ground-fault current path if either of the following conditions is met:

- (1) The switch is mounted with metal screws to a metal box or metal cover that is connected to an equipment grounding conductor or to a nonmetallic box with integral means for connecting to an equipment grounding conductor.
- (2) An equipment grounding conductor or equipment bonding jumper is connected to an equipment grounding termination of the snap switch.

(Revised) 404.13 (B) To Interrupt Currents. To interrupt currents over 1200 amperes at 250 volts, nominal, or less, or over 600 amperes at 251 to 1000 volts, nominal, a circuit breaker or a switch listed for such purpose shall be used.

(Revised) 404.22 Electronic lighting control switches shall be listed. Electronic lighting control switches shall not introduce current on the equipment grounding conductor during normal operation. The requirement to not introduce current on the equipment grounding conductor shall take effect on January 1, 2020.

(NEW) 406.2 Outlet Box Hood. A housing shield intended to fit over a faceplate for flush mounted wiring devices, or an integral component of an outlet box or of a faceplate for flush-mounted wiring devices. The hood does not serve to complete the electrical enclosure; it reduces the risk of water coming in contact with electrical components within the hood, such as attachment plugs, current taps, surge protective devices, direct plugin transformer units, or wiring devices.

(Revised) 406.3 (E) Controlled Receptacle Marking. All nonlocking-type, 125-volt, 15- and 20-ampere receptacles that are controlled by an automatic control device, or that incorporate control features that remove power from the receptacle for the purpose of energy management or building automation, shall be permanently marked with the symbol shown in Figure 406.3(E) and the word "controlled."

PART 1 EXAM QUESTIONS

226. What is a metal faceplate used with a snap switch required to be?
- Listed
 - Bonded
 - Insulated
 - Grounded
227. What conductor is required to be at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit?
- The grounded circuit conductor
 - The grounding electrode conductor
 - Bonding Jumper
 - Each phase conductor of a 3 phase system
228. How is the receptacle controlled by an automatic control device, or that incorporates control features that remove power from the receptacle for the purpose of energy management or building automation required to be identified?
- The word "controlled"
 - The word "automated"
 - With a "red" triangle
 - With the letters "BMS"
229. What is the switch or circuit breaker used to interrupt currents over 1200 amperes at 250 volts, nominal, or less, or over 600 amperes at 251 to 1000 volts required to be?
- Identified
 - Bonded
 - Listed
 - Grounded
230. What does a housing shield intended to fit over a faceplate for flush mounted wiring devices installed to protect against?
- Completes the electrical enclosure
 - Reduces the risk of water coming in contact with electrical components
 - Grounds an attachment plug to the EGC
 - All listed answers
231. When is the requirement to not introduce current on the equipment grounding conductor required to take effect?
- January 1, 2020
 - January 1, 2017
 - July 1, 2020
 - October 1, 2017

(NEW) 406.3 (F) Receptacle with USB Charger. A 125-volt 15- or 20-ampere receptacle that additionally provides Class 2 power shall be listed and constructed such that the Class 2 circuitry is integral with the receptacle.

(Revised) 406.5 (E) Receptacles in Countertops. Receptacle assemblies for installation in countertop surfaces shall be listed for countertop applications. Where receptacle assemblies for countertop applications are required to provide ground-fault circuit-interrupter protection for personnel in accordance with 210.8, such assemblies shall be permitted to be listed as GFCI receptacle assemblies for countertop applications.

(NEW) 406.5 (F) Receptacles in Work Surfaces. Receptacle assemblies and GFCI receptacle assemblies listed for work surface or countertop applications shall be permitted to be installed in work surfaces.

(NEW) 406.5 (G) Receptacle Orientation. Receptacles shall not be installed in a face-up position in or on countertop surfaces or work surfaces unless listed for countertop or work surface applications.

(NEW) 406.6 (D) Receptacle Faceplate (Cover Plates) with Integral Night Light and/or USB Charger. A flush device cover plate that additionally provides a night light and/or Class 2 output connector(s) shall be listed and constructed such that the night light and/or Class 2 circuitry is integral with the flush device cover plate.



(Revised) 406.9 (B) (1) Receptacles of 15 and 20 Amperes in a Wet Location. Receptacles of 15 and 20 amperes, 125 and 250 volts installed in a wet location shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted. An outlet box hood installed for this purpose shall be listed and shall be identified as "extra-duty." Other listed products, enclosures, or assemblies providing weatherproof protection that do not utilize an outlet box hood need not be marked "extra duty." All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles shall be listed and so identified as the weather resistant type.

(Revised) 406.9 (B) (1) Informational Note No. 1: Requirements for extra-duty outlet box hoods are found in ANSI/UL 514D–2013, Cover Plates for Flush-Mounted Wiring Devices. "Extra duty" identification and requirements are not applicable to listed receptacles, faceplates, outlet boxes, enclosures, or assemblies that are identified as either being suitable for wet locations or rated as one of the outdoor enclosure-type numbers of Table 110.28 that does not utilize an outlet box hood.

(Revised) 406.12 Tamper-Resistant Receptacles. All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in the areas specified in 406.12(1) through (7) shall be listed tamper resistant receptacles.

(1) Dwelling units in all areas specified in 210.52 and 550.13

(2) Guest rooms and guest suites of hotels and motels

(3) Child care facilities

(4) Preschools and elementary education facilities

(5) Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities

(6) Subset of assembly occupancies described in 518.2 to include places of waiting transportation, gymnasiums, skating rinks, and auditoriums

(7) Dormitories



Informational Note: This requirement would include receptacles identified as 5-15, 5-20, 6-15, and 6-20 in ANSI/NEMA WD 6-2016, Wiring Devices — Dimensional Specifications.

PART 1 EXAM QUESTIONS

232. What are receptacles installed in counter top surfaces required to be listed as?

- A. Listed for use with an AFCI breaker
- B. Listed as water proof
- C. Listed as water resistant
- D. Listed for countertop applications

233. Where are the requirements for extra-duty outlet box hoods found?

- A. ANSI/UL 514C–2017
- B. ANSI/UL 514D–2013
- C. IEEE/UL 514B–2013
- D. ANSI/IEE 514D–2017

234. What section of the 2017 code should be referenced when installing receptacles in work surfaces?

- A. 406.5 (G)
- B. 406.5 (E)
- C. 406.5 (F)
- D. 406.3 (F)

235. What type are all 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles required to be listed and identified as?

- A. Weather resistant
- B. Weatherproof
- C. Waterproof
- D. Water resistant

236. What listed voltage class is required to be integral to a night light/USB receptacle?

- A. 1
- B. 2
- C. 3
- D. All listed answers

237. How many general areas are listed in the 2017 code where tamper resistant receptacles are required to be installed?

- A. 8
- B. 9
- C. 7
- D. 6

238. What is the enclosure that houses a 20-amp receptacle, and is installed in a wet location, required to be?

- A. Water resistant
- B. Weather resistant
- C. Waterproof
- D. Weatherproof

239. What position are general receptacles not allowed to be installed in?

- A. Ground up
- B. Face-up position
- C. Horizontally
- D. Vertically

240. What has to be integral for a USB receptacle?

- A. Class 2 circuitry
- B. Class 1 circuitry
- C. An isolation transformer
- D. A Wheatstone bridge

ANSWER SHEET • 2017 NEC CODE CHANGE • PART 2

First Name: _____ Last Name: _____ Date: _____

Address: _____ City: _____ State: _____ ZIP: _____

License #: _____ Phone: _____ Email: _____

**** See instructions on the inside cover page to submit your exams and pay for your course**

- | | | | |
|---|---|---|--|
| 1. ☐ A ☐ B ☐ C ☐ D | 28. ☐ A ☐ B ☐ C ☐ D | 55. ☐ A ☐ B ☐ C ☐ D | 82. ☐ A ☐ B ☐ C ☐ D |
| 2. ☐ A ☐ B ☐ C ☐ D | 29. ☐ A ☐ B ☐ C ☐ D | 56. ☐ A ☐ B ☐ C ☐ D | 83. ☐ A ☐ B ☐ C ☐ D |
| 3. ☐ A ☐ B ☐ C ☐ D | 30. ☐ A ☐ B ☐ C ☐ D | 57. ☐ A ☐ B ☐ C ☐ D | 84. ☐ A ☐ B ☐ C ☐ D |
| 4. ☐ A ☐ B ☐ C ☐ D | 31. ☐ A ☐ B ☐ C ☐ D | 58. ☐ A ☐ B ☐ C ☐ D | 85. ☐ A ☐ B ☐ C ☐ D |
| 5. ☐ A ☐ B ☐ C ☐ D | 32. ☐ A ☐ B ☐ C ☐ D | 59. ☐ A ☐ B ☐ C ☐ D | 86. ☐ A ☐ B ☐ C ☐ D |
| 6. ☐ A ☐ B ☐ C ☐ D | 33. ☐ A ☐ B ☐ C ☐ D | 60. ☐ A ☐ B ☐ C ☐ D | 87. ☐ A ☐ B ☐ C ☐ D |
| 7. ☐ A ☐ B ☐ C ☐ D | 34. ☐ A ☐ B ☐ C ☐ D | 61. ☐ A ☐ B ☐ C ☐ D | 88. ☐ A ☐ B ☐ C ☐ D |
| 8. ☐ A ☐ B ☐ C ☐ D | 35. ☐ A ☐ B ☐ C ☐ D | 62. ☐ A ☐ B ☐ C ☐ D | 89. ☐ A ☐ B ☐ C ☐ D |
| 9. ☐ A ☐ B ☐ C ☐ D | 36. ☐ A ☐ B ☐ C ☐ D | 63. ☐ A ☐ B ☐ C ☐ D | 90. ☐ A ☐ B ☐ C ☐ D |
| 10. ☐ A ☐ B ☐ C ☐ D | 37. ☐ A ☐ B ☐ C ☐ D | 64. ☐ A ☐ B ☐ C ☐ D | 91. ☐ A ☐ B ☐ C ☐ D |
| 11. ☐ A ☐ B ☐ C ☐ D | 38. ☐ A ☐ B ☐ C ☐ D | 65. ☐ A ☐ B ☐ C ☐ D | 92. ☐ A ☐ B ☐ C ☐ D |
| 12. ☐ A ☐ B ☐ C ☐ D | 39. ☐ A ☐ B ☐ C ☐ D | 66. ☐ A ☐ B ☐ C ☐ D | 93. ☐ A ☐ B ☐ C ☐ D |
| 13. ☐ A ☐ B ☐ C ☐ D | 40. ☐ A ☐ B ☐ C ☐ D | 67. ☐ A ☐ B ☐ C ☐ D | 94. ☐ A ☐ B ☐ C ☐ D |
| 14. ☐ A ☐ B ☐ C ☐ D | 41. ☐ A ☐ B ☐ C ☐ D | 68. ☐ A ☐ B ☐ C ☐ D | 95. ☐ A ☐ B ☐ C ☐ D |
| 15. ☐ A ☐ B ☐ C ☐ D | 42. ☐ A ☐ B ☐ C ☐ D | 69. ☐ A ☐ B ☐ C ☐ D | 96. ☐ A ☐ B ☐ C ☐ D |
| 16. ☐ A ☐ B ☐ C ☐ D | 43. ☐ A ☐ B ☐ C ☐ D | 70. ☐ A ☐ B ☐ C ☐ D | 97. ☐ A ☐ B ☐ C ☐ D |
| 17. ☐ A ☐ B ☐ C ☐ D | 44. ☐ A ☐ B ☐ C ☐ D | 71. ☐ A ☐ B ☐ C ☐ D | 98. ☐ A ☐ B ☐ C ☐ D |
| 18. ☐ A ☐ B ☐ C ☐ D | 45. ☐ A ☐ B ☐ C ☐ D | 72. ☐ A ☐ B ☐ C ☐ D | 99. ☐ A ☐ B ☐ C ☐ D |
| 19. ☐ A ☐ B ☐ C ☐ D | 46. ☐ A ☐ B ☐ C ☐ D | 73. ☐ A ☐ B ☐ C ☐ D | 100. ☐ A ☐ B ☐ C ☐ D |
| 20. ☐ A ☐ B ☐ C ☐ D | 47. ☐ A ☐ B ☐ C ☐ D | 74. ☐ A ☐ B ☐ C ☐ D | 101. ☐ A ☐ B ☐ C ☐ D |
| 21. ☐ A ☐ B ☐ C ☐ D | 48. ☐ A ☐ B ☐ C ☐ D | 75. ☐ A ☐ B ☐ C ☐ D | 102. ☐ A ☐ B ☐ C ☐ D |
| 22. ☐ A ☐ B ☐ C ☐ D | 49. ☐ A ☐ B ☐ C ☐ D | 76. ☐ A ☐ B ☐ C ☐ D | 103. ☐ A ☐ B ☐ C ☐ D |
| 23. ☐ A ☐ B ☐ C ☐ D | 50. ☐ A ☐ B ☐ C ☐ D | 77. ☐ A ☐ B ☐ C ☐ D | 104. ☐ A ☐ B ☐ C ☐ D |
| 24. ☐ A ☐ B ☐ C ☐ D | 51. ☐ A ☐ B ☐ C ☐ D | 78. ☐ A ☐ B ☐ C ☐ D | 105. ☐ A ☐ B ☐ C ☐ D |
| 25. ☐ A ☐ B ☐ C ☐ D | 52. ☐ A ☐ B ☐ C ☐ D | 79. ☐ A ☐ B ☐ C ☐ D | 106. ☐ A ☐ B ☐ C ☐ D |
| 26. ☐ A ☐ B ☐ C ☐ D | 53. ☐ A ☐ B ☐ C ☐ D | 80. ☐ A ☐ B ☐ C ☐ D | 107. ☐ A ☐ B ☐ C ☐ D |
| 27. ☐ A ☐ B ☐ C ☐ D | 54. ☐ A ☐ B ☐ C ☐ D | 81. ☐ A ☐ B ☐ C ☐ D | 108. ☐ A ☐ B ☐ C ☐ D |



109. ☐ A ☐ B ☐ C ☐ D
110. ☐ A ☐ B ☐ C ☐ D
111. ☐ A ☐ B ☐ C ☐ D
112. ☐ A ☐ B ☐ C ☐ D
113. ☐ A ☐ B ☐ C ☐ D
114. ☐ A ☐ B ☐ C ☐ D
115. ☐ A ☐ B ☐ C ☐ D
116. ☐ A ☐ B ☐ C ☐ D

117. ☐ A ☐ B ☐ C ☐ D
118. ☐ A ☐ B ☐ C ☐ D
119. ☐ A ☐ B ☐ C ☐ D
120. ☐ A ☐ B ☐ C ☐ D
121. ☐ A ☐ B ☐ C ☐ D
122. ☐ A ☐ B ☐ C ☐ D
123. ☐ A ☐ B ☐ C ☐ D
124. ☐ A ☐ B ☐ C ☐ D
125. ☐ A ☐ B ☐ C ☐ D
126. ☐ A ☐ B ☐ C ☐ D

127. ☐ A ☐ B ☐ C ☐ D
128. ☐ A ☐ B ☐ C ☐ D
129. ☐ A ☐ B ☐ C ☐ D
130. ☐ A ☐ B ☐ C ☐ D
131. ☐ A ☐ B ☐ C ☐ D
132. ☐ A ☐ B ☐ C ☐ D
133. ☐ A ☐ B ☐ C ☐ D
134. ☐ A ☐ B ☐ C ☐ D
135. ☐ A ☐ B ☐ C ☐ D

136. ☐ A ☐ B ☐ C ☐ D
137. ☐ A ☐ B ☐ C ☐ D
138. ☐ A ☐ B ☐ C ☐ D
139. ☐ A ☐ B ☐ C ☐ D
140. ☐ A ☐ B ☐ C ☐ D
141. ☐ A ☐ B ☐ C ☐ D

142. ☐ A ☐ B ☐ C ☐ D
143. ☐ A ☐ B ☐ C ☐ D
144. ☐ A ☐ B ☐ C ☐ D
145. ☐ A ☐ B ☐ C ☐ D

146. ☐ A ☐ B ☐ C ☐ D
147. ☐ A ☐ B ☐ C ☐ D
148. ☐ A ☐ B ☐ C ☐ D
149. ☐ A ☐ B ☐ C ☐ D
150. ☐ A ☐ B ☐ C ☐ D
151. ☐ A ☐ B ☐ C ☐ D
152. ☐ A ☐ B ☐ C ☐ D
153. ☐ A ☐ B ☐ C ☐ D
154. ☐ A ☐ B ☐ C ☐ D

155. ☐ A ☐ B ☐ C ☐ D
156. ☐ A ☐ B ☐ C ☐ D
157. ☐ A ☐ B ☐ C ☐ D
158. ☐ A ☐ B ☐ C ☐ D
159. ☐ A ☐ B ☐ C ☐ D
160. ☐ A ☐ B ☐ C ☐ D
161. ☐ A ☐ B ☐ C ☐ D
162. ☐ A ☐ B ☐ C ☐ D
163. ☐ A ☐ B ☐ C ☐ D
164. ☐ A ☐ B ☐ C ☐ D
165. ☐ A ☐ B ☐ C ☐ D
166. ☐ A ☐ B ☐ C ☐ D

167. ☐ A ☐ B ☐ C ☐ D
168. ☐ A ☐ B ☐ C ☐ D
169. ☐ A ☐ B ☐ C ☐ D
170. ☐ A ☐ B ☐ C ☐ D
171. ☐ A ☐ B ☐ C ☐ D
172. ☐ A ☐ B ☐ C ☐ D
173. ☐ A ☐ B ☐ C ☐ D
174. ☐ A ☐ B ☐ C ☐ D

175. ☐ A ☐ B ☐ C ☐ D
176. ☐ A ☐ B ☐ C ☐ D
177. ☐ A ☐ B ☐ C ☐ D
178. ☐ A ☐ B ☐ C ☐ D
179. ☐ A ☐ B ☐ C ☐ D
180. ☐ A ☐ B ☐ C ☐ D

181. ☐ A ☐ B ☐ C ☐ D
182. ☐ A ☐ B ☐ C ☐ D
183. ☐ A ☐ B ☐ C ☐ D
184. ☐ A ☐ B ☐ C ☐ D
185. ☐ A ☐ B ☐ C ☐ D
186. ☐ A ☐ B ☐ C ☐ D
187. ☐ A ☐ B ☐ C ☐ D
188. ☐ A ☐ B ☐ C ☐ D
189. ☐ A ☐ B ☐ C ☐ D
190. ☐ A ☐ B ☐ C ☐ D

191. ☐ A ☐ B ☐ C ☐ D
192. ☐ A ☐ B ☐ C ☐ D
193. ☐ A ☐ B ☐ C ☐ D
194. ☐ A ☐ B ☐ C ☐ D
195. ☐ A ☐ B ☐ C ☐ D
196. ☐ A ☐ B ☐ C ☐ D
197. ☐ A ☐ B ☐ C ☐ D
198. ☐ A ☐ B ☐ C ☐ D
199. ☐ A ☐ B ☐ C ☐ D
200. ☐ A ☐ B ☐ C ☐ D

201. ☐ A ☐ B ☐ C ☐ D
202. ☐ A ☐ B ☐ C ☐ D
203. ☐ A ☐ B ☐ C ☐ D
204. ☐ A ☐ B ☐ C ☐ D
205. ☐ A ☐ B ☐ C ☐ D
206. ☐ A ☐ B ☐ C ☐ D
207. ☐ A ☐ B ☐ C ☐ D

208. ☐ A ☐ B ☐ C ☐ D
209. ☐ A ☐ B ☐ C ☐ D
210. ☐ A ☐ B ☐ C ☐ D
211. ☐ A ☐ B ☐ C ☐ D
212. ☐ A ☐ B ☐ C ☐ D
213. ☐ A ☐ B ☐ C ☐ D
214. ☐ A ☐ B ☐ C ☐ D
215. ☐ A ☐ B ☐ C ☐ D

216. ☐ A ☐ B ☐ C ☐ D
217. ☐ A ☐ B ☐ C ☐ D
218. ☐ A ☐ B ☐ C ☐ D
219. ☐ A ☐ B ☐ C ☐ D
220. ☐ A ☐ B ☐ C ☐ D
221. ☐ A ☐ B ☐ C ☐ D
222. ☐ A ☐ B ☐ C ☐ D
223. ☐ A ☐ B ☐ C ☐ D
224. ☐ A ☐ B ☐ C ☐ D
225. ☐ A ☐ B ☐ C ☐ D
226. ☐ A ☐ B ☐ C ☐ D
227. ☐ A ☐ B ☐ C ☐ D

228. ☐ A ☐ B ☐ C ☐ D
229. ☐ A ☐ B ☐ C ☐ D
230. ☐ A ☐ B ☐ C ☐ D
231. ☐ A ☐ B ☐ C ☐ D
232. ☐ A ☐ B ☐ C ☐ D
233. ☐ A ☐ B ☐ C ☐ D
234. ☐ A ☐ B ☐ C ☐ D
235. ☐ A ☐ B ☐ C ☐ D
236. ☐ A ☐ B ☐ C ☐ D
237. ☐ A ☐ B ☐ C ☐ D
238. ☐ A ☐ B ☐ C ☐ D
239. ☐ A ☐ B ☐ C ☐ D
240. ☐ A ☐ B ☐ C ☐ D





Wisconsin Contractors Institute

CONTINUING EDUCATION FOR WISCONSIN ELECTRICIANS



2017 NEC CODE CHANGE Part 2 ■ 8 Hours

WISCONSIN CONTRACTORS INSTITUTE

262-409-4282

www.wcittraining.com

DISCLAIMER NOTE: This course is APPROVED by the Wisconsin Department of safety and professional services for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes.

2017 NEC Code Change • Part 2

The following course will summarize many of the important changes to the NEC code.

(Revised) 408.3 (A) (2) Service Panelboards, Switchboards, and Switchgear. Barriers shall be placed in all service panelboards, switchboards, and switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

(Revised) 408.4 (B) Source of Supply. All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be permanently marked to indicate each device or equipment where the power originates. The label shall be permanently affixed, of sufficient durability to withstand the environment involved, and not handwritten.

(Revised) 409.110 Marking. An industrial control panel shall be marked with the following information that is plainly visible after installation:

(1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified.

(2) Supply voltage, number of phases, frequency, and full load current for each incoming supply circuit.

(3) Industrial control panels supplied by more than one electrical source where more than one disconnecting means is required to disconnect all circuits 50-volts or more within the control panel shall be marked to indicate that more than one disconnecting means is required to deenergize the equipment. The location of the means necessary to disconnect all circuits 50-volts or more shall be documented and available.

(4) Short-circuit current rating of the industrial control panel based on one of the following:

- a. Short-circuit current rating of a listed and labeled assembly
- b. Short-circuit current rating established utilizing an approved method

(Revised) 410.62 (C) Electric-Discharge and LED Luminaires. Electric discharge and LED luminaires shall comply with (1), (2), and (3) as applicable.

(1) Cord-Connected Installation. A luminaire or a listed assembly in compliance with any of the conditions in (a) through (c) shall be permitted to be cord connected provided the luminaire is located directly below the outlet or busway, the cord is not subject to strain or physical damage, and the cord is visible over its entire length except at terminations.

(a) A luminaire shall be permitted to be connected with a cord terminating in a grounding-type attachment plug or busway plug.

(b) A luminaire assembly equipped with a strain relief and canopy shall be permitted to use a cord connection between the luminaire assembly and the canopy. The canopy shall be permitted to include a section of raceway not over 150 mm (6 in.) in length and intended to facilitate the connection to an outlet box mounted above a suspended ceiling.

(c) Listed luminaires connected using listed assemblies that incorporate manufactured wiring system connectors in accordance with 604.100(C) shall be permitted to be cord connected.

(Revised) 410.136(B) Informational Note: Combustible low-density cellulose fiberboard includes sheets, panels, and tiles that have a density of 320 kg/m³ (20 lb/ft³) or less and that are formed of bonded plant fiber material but



does not include solid or laminated wood or fiberboard that has a density in excess of 320 kg/m³ (20 lb/ft³) or is a material that has been integrally treated with fire-retarding chemicals to the degree that the flame spread index in any plane of the material will not exceed 25, determined in accordance with tests for surface burning characteristics of building materials. See ANSI/ASTM E84–2015a, Standard Test Method for Surface Burning Characteristics of Building Materials or ANSI/UL 723–2013, Standard for Test for Surface Burning Characteristics of Building Materials.

(Revised) 411.1 Scope. This article covers lighting systems and their associated components operating at no more than 30 volts ac or 60 volts dc. Where wet contact is likely to occur, the limits are 15 volts ac or 30 volts dc.

(NEW) 411.1 Informational Note: Refer to Article 680 for applications involving immersion.

(Revised) 411.3 Low-Voltage Lighting Systems. Low voltage lighting systems shall consist of an isolating power supply, low-voltage luminaires, and associated equipment that are all identified for the use. The output circuits of the power supply shall be rated for 25 amperes maximum under all load conditions.



PART 2 EXAM QUESTIONS

1. What article should be referenced to determine the applications regarding the immersion of low voltage lighting?
 - A. 300
 - B. 700
 - C. 310
 - D. 680
2. How are you NOT allowed to label a panelboard installed in a warehouse that indicates where each device or equipment power originates?
 - A. Placard label
 - B. Typed label
 - C. Hand written label
 - D. Phenolic label
3. What is the maximum length of raceway permitted in a luminaire assembly equipped with a canopy intended to facilitate the connection to an outlet box mounted above a suspended ceiling?
 - A. 6 inches
 - B. 12 inches
 - C. 8 inches
 - D. Only the minimum length is listed
4. What is the maximum current a low voltage power supply can output under all load conditions?
 - A. 20 amps
 - B. 25 amps
 - C. 30 amps
 - D. 2 amps
5. What ANSI is listed to determine the standard test method for surface burning characteristics of building materials?
 - A. ANSI/ASM E84–2015o
 - B. ANSI/ATM E85–2015a
 - C. ANSI/ASTM E84–2015a
 - D. ANSI/ASTM E84–2013b
6. When can an LED Luminaire be cord connected?
 - A. The cord is visible over the entire length
 - B. The cord is not subject to strain
 - C. The cord is not subject to physical damage
 - D. All listed answers
7. What type of power supply is required to be used with low voltage lighting systems?
 - A. Control transformers
 - B. Oscillating power supply
 - C. Isolating power supply
 - D. Air core transformers

8. What is required to be installed to prevent inadvertent contact with uninsulated parts inside switchgear while servicing load terminations?
- A. Guards
 - B. Barriers
 - C. Mesh dividers
 - D. Service lighting

9. What is the maximum DC voltage for a light to be considered low voltage?
- A. 60
 - B. 30
 - C. 15
 - D. 24

10. What article covers the installation and marking of industrial control panels?
- A. 408
 - B. 409
 - C. 406
 - D. 410

(Revised) 411.4 Listing Required. Low-voltage lighting systems shall comply with 411.4(A) or 411.4(B).

(A) Listed System. The luminaires, power supply, and luminaire fittings (including the exposed bare conductors) of an exposed bare conductor lighting system shall be listed for the use as part of the same identified lighting system.

(B) Assembly of Listed Parts. A lighting system assembled from the following listed parts shall be permitted:

- (1) Low-voltage luminaires
- (2) Power supply
- (3) Low-voltage luminaire fittings
- (4) Suitably rated cord, cable, conductors in conduit, or other fixed Chapter 3 wiring method for the secondary circuit

(NEW) 422.5 (A) General. Appliances identified in 422.5(A)(1) through (5) rated 250 volts or less and 60 amperes or less, single- or 3-phase, shall be provided with GFCI protection for personnel. Multiple GFCI protective devices shall be permitted but shall not be required.

- (1) Automotive vacuum machines provided for public use
- (2) Drinking water coolers
- (3) High-pressure spray washing machines — cord-and-plug-connected
- (4) Tire inflation machines provided for public use
- (5) Vending machines

(NEW) 422.5 (B) Type. The GFCI shall be readily accessible, listed, and located in one or more of the following locations:

- (1) Within the branch circuit overcurrent device
- (2) A device or outlet within the supply circuit
- (3) An integral part of the attachment plug
- (4) Within the supply cord not more than 300 mm (12 in.) from the attachment plug
- (5) Factory installed within the appliance



(NEW) 422.6 Listing Required. All appliances operating at 50 volts or more shall be listed.

(Revised) 422.16(B)(2) Built-in Dishwashers and Trash Compactors. Built-in dishwashers and trash compactors shall be permitted to be cord-and-plug-connected with a flexible cord identified as suitable for the purpose in the installation instructions of the appliance manufacturer where all of the following conditions are met:

(1) The flexible cord shall be terminated with a grounding-type attachment plug.

Exception: A listed dishwasher or trash compactor distinctly marked to identify it as protected by a system of double insulation shall not be required to be terminated with a grounding-type attachment plug.

(2) For a trash compactor, the length of the cord shall be 0.9 m to 1.2 m (3 ft to 4 ft) measured from the face of the attachment plug to the plane of the rear of the appliance.

(3) For a built-in dishwasher, the length of the cord shall be 0.9 m to 2.0 m (3 ft to 6.5 ft) measured from the face of the attachment plug to the plane of the rear of the appliance.

(4) Receptacles shall be located to protect against physical damage to the flexible cord.

(5) The receptacle for a trash compactor shall be located in the space occupied by the appliance or adjacent thereto.

(6) The receptacle for a built-in dishwasher shall be located in the space adjacent to the space occupied by the dishwasher.

(7) The receptacle shall be accessible.



(Revised) 422.16 (4) Range Hoods. Range hoods shall be permitted to be cord-and-plug-connected with a flexible cord identified as suitable for use on range hoods in the installation instructions of the appliance manufacturer, where all of the following conditions are met:

(1) The flexible cord is terminated with a grounding-type attachment plug.

Exception: A listed range hood distinctly marked to identify it as protected by a system of double insulation shall not be required to be terminated with a grounding-type attachment plug.

(2) The length of the cord is not less than 450 mm (18 in.) and not over 1.2 m (4 ft).

(3) Receptacles are located to protect against physical damage to the flexible cord.

(4) The receptacle is accessible.

(5) The receptacle is supplied by an individual branch circuit.

PART 2 EXAM QUESTIONS

11. At what voltage do all appliances have to be listed?

- A. 35 volts
- B. 150 volts or less
- C. 50 volts or more
- D. 25 volts

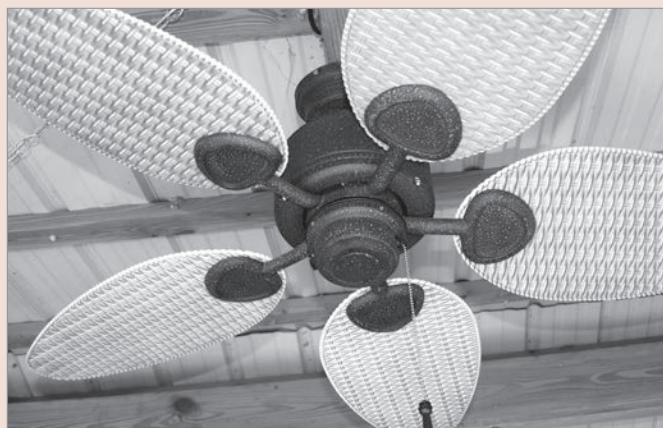
12. What is the current range that an automotive vacuum machine provided for public use is required to be GFCI protected?

- A. 60 to 70 amps
- B. .1 to 60 amps
- C. 20 to 80 amps
- D. .1 to 100 amps

13. What is the minimum listed length that a hood range cord can be?
 - A. 18 inches
 - B. 24 inches
 - C. 12 inches
 - D. 8 inches
14. What is the listed length for a built-in dishwasher cord measured from the face of the attachment plug to the plane of the rear of the appliance?
 - A. There are no length requirements for a built-in dishwasher cord
 - B. 3 to 4 feet
 - C. 1 to 2 feet
 - D. 3 to 6 ft. 6 inches
15. What is the maximum distance a drinking water cooler GFCI inside the supply cord that protects personnel required to be installed from the attachment plug?
 - A. 24 inches
 - B. 12 inches
 - C. 18 inches
 - D. 8 inches
16. What is not considered part of a low voltage lighting system assembly?
 - A. Wall switch
 - B. Low-voltage luminaire fittings
 - C. Power supply
 - D. Low-voltage luminaires
17. What is the listed length for a trash compactor cord measured from the face of the attachment plug to the plane of the rear of the appliance?
 - A. 3 to 6 ft. 6 inches
 - B. 3 to 4 feet
 - C. 1 to 2 feet
 - D. There are no length requirements for a trash compactor cord

(Revised) 422.18 Support of Ceiling-Suspended (Paddle) Fans. Ceiling suspended (paddle) fans shall be supported independently of an outlet box or by one of the following:

- (1) A listed outlet box or listed outlet box system identified for the use and installed in accordance with 314.27(C)
- (2) A listed outlet box system, a listed locking support and mounting receptacle, and a compatible factory installed attachment fitting designed for support, identified for the use and installed in accordance with 314.27(E)



(Revised) 422.21 Covering of Combustible Material at Outlet Boxes. Any combustible ceiling finish that is exposed between the edge of a ceiling-suspended (paddle) fan canopy or pan and an outlet box and that has a surface area of 1160 mm² (180 in.²) or more shall be covered with noncombustible material.

(Revised) 422.30 General. A means shall be provided to simultaneously disconnect each appliance from all ungrounded conductors in accordance with the following sections of Part III. If an appliance is supplied by more than one branch circuit or feeder, these disconnecting means shall be grouped and identified as being the multiple disconnecting means for the appliance. Each disconnecting means shall simultaneously disconnect all ungrounded conductors that it controls.

(Revised) 422.31 (A) Rated at Not over 300 Volt-Amperes or 1/8 Horsepower. For permanently connected appliances rated at not over 300 volt-amperes or 1/8 hp, the branch-circuit overcurrent device shall be permitted

to serve as the disconnecting means where the switch or circuit breaker is within sight from the appliance or is lockable in accordance with 110.25.

(Revised) 422.31 (C) Motor-Operated Appliances Rated over 1/8 Horsepower. The disconnecting means shall comply with 430.109 and 430.110. For permanently connected motor-operated appliances with motors rated over 1/8 hp, the disconnecting means shall be within sight from the appliance or be capable of being locked in the open position in compliance with 110.25.

(Revised) 424.19 Disconnecting Means. Means shall be provided to simultaneously disconnect the heater, motor controller(s), and supplementary overcurrent protective device(s) of all fixed electric space-heating equipment from all ungrounded conductors. Where heating equipment is supplied by more than one source, feeder, or branch circuit, the disconnecting means shall be grouped and identified as having multiple disconnecting means. Each disconnecting means shall simultaneously disconnect all ungrounded conductors that it controls. The disconnecting means specified in 424.19(A) and (B) shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters and shall be lockable in accordance with 110.25.

(Revised) 424.36 Clearances of Wiring in Ceilings.

Wiring located above heated ceilings shall be spaced not less than 50 mm (2 in.) above the heated ceiling. The ampacity of conductors shall be calculated on the basis of an assumed ambient temperature of 50°C (122°F), applying the correction factors shown in the 0–2000-volt ampacity tables of Article 310. If this wiring is located above thermal insulation having a minimum thickness of 50 mm (2 in.), the wiring shall not require correction for temperature.

(Revised) 424.34 Heating Cable Construction. Factory-assembled non-heating leads of heating cables, if any, shall be at least 2.1 m (7 ft) in length.



(Revised) 424.38 (B) Uses Not Permitted. Heating cables shall not be installed as follows:

- (1) In closets, other than as noted in 424.38(C)
- (2) Over the top of walls where the wall intersects the ceiling
- (3) Over partitions that extend to the ceiling, unless they are isolated single runs of embedded cable
- (4) Under or through walls
- (5) Over cabinets whose clearance from the ceiling is less than the minimum horizontal dimension of the cabinet to the nearest cabinet edge that is open to the room or area
- (6) In tub and shower walls
- (7) Under cabinets or similar built-ins having no clearance to the floor

PART 2 EXAM QUESTIONS

18. What is the maximum horsepower that a permanently connected appliance can use its circuit breaker within sight of the appliance as its disconnect?

- A. 1/8 hp
- B. 1/16 hp
- C. 1/4 hp
- D. 3/4 hp

19. Where can heating cables be installed?

- A. As per the manufacturer's instructions
- B. In tub and shower walls
- C. Over the top of walls where the wall intersects the ceiling
- D. Under or through walls

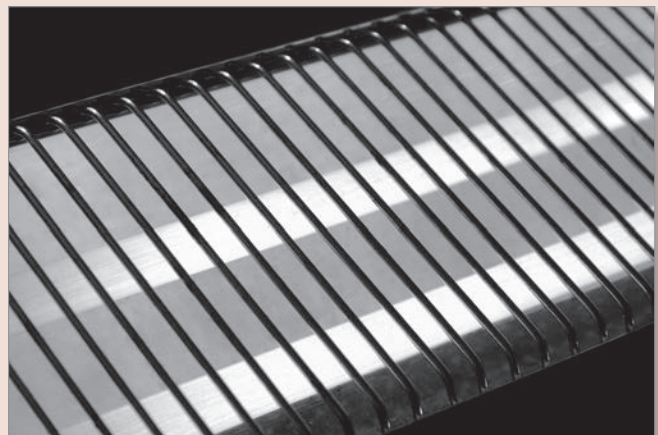
20. What part of Article 422 should be referenced to determine the disconnecting means and requirements for appliances?
- VI
 - II
 - IV
 - III
21. What type of material is a ceiling-suspended (paddle) fan with an outlet box that has a minimum surface area of 180 in.² required to be covered with?
- Insulation material
 - Noncombustible material
 - Noncondensing material
 - Minimum weight inscriptions
22. How many sections does the disconnect for permanently connected motor-operated appliances rated over 1/8 hp required to comply with?
- 3
 - 1
 - 2
 - 6
23. What is the minimum length factory-assembled non-heating leads of heating cables can be?
- 6 ft
 - 7 ft
 - 5 ft
 - 3 ft
24. The disconnecting means specified in 424.19(A) and (B) is required to have a minimum ampere rating of not less than what percent of the total load of the motors and the heaters?
- 135
 - 100
 - 125
 - 150
25. How is a ceiling suspended (paddle) fan required to be supported at the outlet box?
- Tight to the box
 - Securely
 - Rigidly
 - Independently
26. What is the minimum height above a heated ceiling that wiring above the heated ceiling can be installed?
- 3 inches
 - 2 inches
 - 1 inch
 - 4 inches

(Revised) 424.39 Clearance from Other Objects and Openings. Heating elements of cables installed in ceilings shall be separated at least 200 mm (8 in.) from the edge of outlet boxes and junction boxes that are to be used for mounting surface luminaires. A clearance of not less than 50 mm (2 in.) shall be provided from recessed luminaires and their trims, ventilating openings, and other such openings in room surfaces. No heating cable shall be covered by any surface-mounted equipment.

(Revised) 424.40 Splices. The length of heating cable shall only be altered using splices identified in the manufacturer's instructions.

(NEW) 424.45 Installation of Cables Under Floor Coverings.

(A) Identification. Heating cables for installation under floor covering shall be identified as suitable for installation under floor covering.



(B) Expansion Joints. Heating cables shall not be installed where they bridge expansion joints unless provided with expansion and contraction fittings applicable to the manufacture of the cable.

(C) Connection to Conductors. Heating cables shall be connected to branch-circuit and supply wiring by wiring methods described in the installation instructions or as recognized in Chapter 3.

(D) Anchoring. Heating cables shall be positioned or secured in place under the floor covering, per the manufacturer's instructions.

(E) Ground-Fault Circuit-Interrupter Protection. Groundfault circuit-interrupter protection for personnel shall be provided.

(F) Grounding Braid or Sheath. Grounding means, such as copper braid, metal sheath, or other approved means, shall be provided as part of the heated length.

(Revised) 424.70 Scope. The provisions in Part VII of this article shall apply to boilers employing resistance-type heating elements. See Part VIII of this article for electrode-type boilers.

(Revised) 424.95 (B) Interior Walls. The ampacity of any wiring behind heating panels or heating panel sets located in interior walls or partitions shall be calculated on the basis of an assumed ambient temperature of 40°C (104°F), applying correction factors given in the 0–2000 volt ampacity tables of Article 310.

(Revised) 424.97 Nonheating Leads. Excess nonheating leads of heating panels or heating panel sets shall be permitted to be cut to the required length as indicated in the manufacturer's installation instructions. Nonheating leads that are an integral part of a heating panel and a heating panel set, either attached or provided by the manufacturer as part of a terminal junction assembly, shall not be subjected to the ampacity requirements of 424.3(B) for branch circuits.

(NEW) 424.100 Scope. Low-voltage fixed electric space-heating equipment shall consist of an isolating power supply, low voltage heaters, and associated equipment that are all identified for use in dry locations.

(NEW) 424.101 (A) Power Unit. The power unit shall be an isolating type with a rated output not exceeding 25 amperes, 30 volts (42.4 volts peak) ac, or 60 volts dc under all load conditions.

(NEW) 424.101 (B) Alternate Energy Sources. Listed low-voltage fixed electric space-heating equipment shall be permitted to be supplied directly from an alternate energy source such as solar photovoltaic (PV) or wind power. When supplied from such a source, the source and any power conversion equipment between the source and the heating equipment and its supply shall be listed and comply with the applicable section of the NEC for the source used. The output of the source shall meet the limits of 424.101(A).

(NEW) 424.104 (A) Equipment shall be permitted to be supplied from branch circuits rated not over 30 amperes.

(B) The equipment shall be considered a continuous duty load.



PART 2 EXAM QUESTIONS

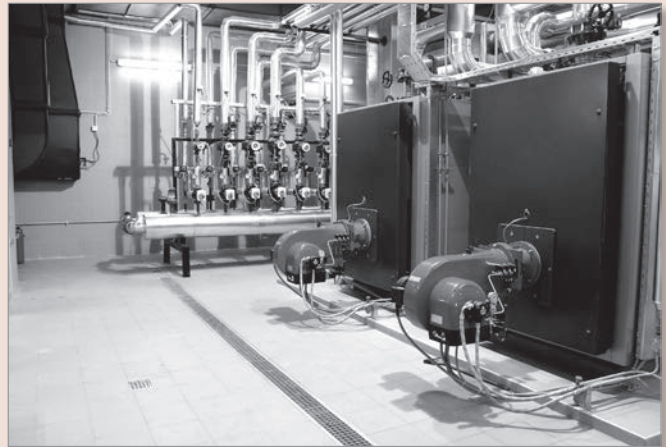
27. What part of Article 424 applies to boilers employing resistance-type heating elements?
- II
 - VII
 - IV
 - VI
28. What is the maximum amperage permitted for power units used with low-voltage fixed electric space-heating equipment?
- 20 amps
 - 25 amps
 - 30 amps
 - 40 amps
29. How is the splicing of heating cable required to be done?
- With a urethane splice kit
 - By note 2 of ANSI/IEEE 2014
 - By the manufacturer's instructions
 - With a polyurethane splice kit
30. What is the largest circuit breaker that listed low-voltage fixed electric space-heating equipment can be installed on?
- 40 amps
 - 20 amps
 - 25 amps
 - 30 amps
31. How is heating cable installed under floor covering required to be protected?
- Kick boards
 - AFCI
 - GFCI
 - Wire channel
32. What is the minimum distance of separation from heating elements of cables installed in ceilings from the edge of outlet boxes and junction boxes that are used for mounting surface luminaires?
- 6 inches
 - 10 inches
 - 8 inches
 - 12 inches
33. How is the ampacity required to be calculated for the assumed ambient temperature of heating panel sets located in interior walls?
- 104°F
 - 40°F
 - 190°F
 - 90°F
34. What section describes the limits of a wind power source that feeds listed low-voltage fixed electric space-heating equipment?
- 424.95 (B)
 - 424.97
 - 424.101(A)
 - 424.100 (A)
35. What type of location is low-voltage fixed electric space-heating equipment required to be installed?
- Listed
 - Dry
 - Identified
 - Engineered
36. Non-heating leads that are an integral part of a heating panel provided by the manufacturer as part of a terminal junction assembly is not subject to the ampacity requirements of what section for branch circuits?
- 424.70
 - 424.95
 - 424.45
 - 424.3(B)

(NEW) 425.1 Scope. This article covers fixed industrial process heating employing electric resistance or electrode heating technology. For the purpose of this article, heating equipment shall include boilers, electrode boilers, duct heaters, strip heaters, immersion heaters, process air heaters, or other approved fixed electric equipment used for industrial process heating. This article shall not apply to heating and room air conditioning for personnel spaces covered by Article 424, fixed heating equipment for pipelines and vessels covered by Article 427, induction and dielectric heating equipment covered by Article 665, and industrial furnaces incorporating silicon carbide, molybdenum, or graphite process heating elements.

(NEW) 425.2 Other Articles. Fixed industrial process heating equipment incorporating a hermetic refrigerant motor-compressor shall also comply with Article 440.

(NEW) 425.8 (C) Above Grade Level, Floor, or Work Platform. Where the enclosure is located above grade, the floor, or a work platform, all of the following shall apply:

- (1) The enclosure shall be accessible.
- (2) The width of the working space shall be the width of the enclosure or a minimum of 762 mm (30 in.), whichever is greater.
- (3) The depth of the workspace shall comply with 110.26(A) or 110.34 based upon the voltage to ground.
- (4) All doors or hinged panels shall open to at least 90 degrees.



(NEW) 425.19 Disconnecting Means. Means shall be provided to simultaneously disconnect the heater, motor controller(s), and supplementary overcurrent protective device(s) of all fixed industrial process heating equipment from all ungrounded conductors. Where heating equipment is supplied by more than one source, feeder, or branch circuit, the disconnecting means shall be grouped and identified as having multiple disconnecting means. Each disconnecting means shall simultaneously disconnect all ungrounded conductors that it controls. The disconnecting means specified in 425.19(A) and (B) shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters and shall be lockable in accordance with 110.25

(NEW) 425.19 (A) Heating Equipment with Supplementary Overcurrent Protection. The disconnecting means for fixed industrial process heating equipment with supplementary overcurrent protection shall be within sight from the supplementary overcurrent protective device(s), on the supply side of these devices, if fuses, and, in addition, shall comply with either 425.19(A)(1) or (A)(2).

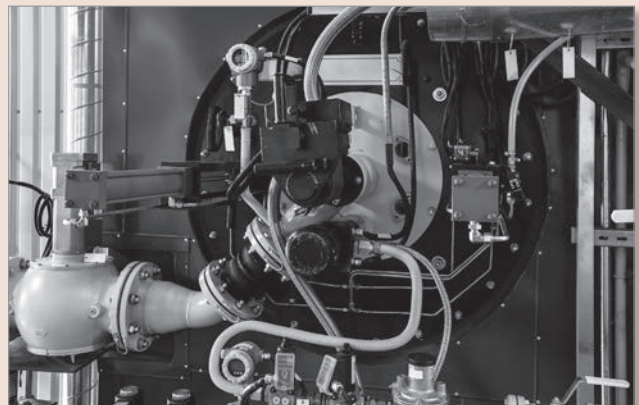
(NEW) 425.19 (A) (1) Heater Containing No Motor Rated over 1/8 Horsepower. The disconnecting means specified in 425.19 or unit switches complying with 425.19(C) shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater under either of the following conditions:

- (1) The disconnecting means provided is also within sight from the motor controller(s) and the heater.
- (2) The disconnecting means is lockable in accordance with 110.25.

(NEW) 425.21 Switch and Circuit Breaker to Be Indicating. Switches and circuit breakers used as disconnecting means shall be of the indicating type.

(NEW) 425.22 (A) Branch-Circuit Devices. Fixed industrial process heating equipment other than such motor-operated equipment as required by Articles 430 and 440 to have additional overcurrent protection shall be permitted to be protected against overcurrent where supplied by one of the branch circuits in Article 210.

(NEW) 425.22 (B) Resistance Elements. Resistance-type heating elements in fixed industrial process heating equipment shall be protected at not more than 60 amperes. Equipment rated more than 48 amperes and employing such elements shall have the heating elements subdivided, and each subdivided load shall not exceed 48 amperes. Where a subdivided load is less than 48 amperes, the rating of the supplementary overcurrent protective device shall comply with 425.3(B). A boiler employing resistance-type immersion heating elements contained in an ASME-rated and stamped vessel shall be permitted to comply with 425.72(A).



PART 2 EXAM QUESTIONS

37. Where is the disconnecting means for fixed industrial process heating equipment with supplementary overcurrent protection required to be installed?
- Within sight from the primary overcurrent protective device(s)
 - Within 50 ft from the supplementary overcurrent protective device(s)
 - Within sight from the supplementary overcurrent protective device(s)
 - Within 50 ft from the primary overcurrent protective device(s)
38. What additional article is fixed industrial process heating equipment incorporating a hermetic refrigerant motor-compressor required to comply with?
- 424
 - 426
 - 450
 - 440
39. What is the disconnect used for fixed industrial process heating employing electric resistance required to simultaneously disconnect?
- Heater
 - Motor controller(s)
 - Supplementary overcurrent protective device(s)
 - All listed answers
40. What new article covers fixed industrial process heating employing electric resistance or electrode heating technology?
- 440
 - 425
 - 424
 - 426
41. A 1/16 th horsepower power motor used with industrial process heating equipment is required to have a lockable disconnect as required by what listed section?
- 110.27
 - 110.18
 - 110.25
 - 425.3
42. How is a hinged door installed above grade used for fixed industrial process heating employing electric resistance required to open?
- 180 degrees
 - Vertically
 - Horizontally
 - 90 degrees
43. If resistance-type heating elements in fixed industrial process heating equipment have a subdivided load of less than 48 amps, what section is the supplementary overcurrent protective device required to comply with?
- 425.72(A)
 - 425.3(B)
 - 425.21
 - 110.25
44. What type of circuit breaker must be used if used as a disconnecting means for fixed industrial process heating equipment?
- Edison breaker
 - Fused
 - Indicating type
 - Solder pot type breaker
45. What is the maximum current that resistance-type heating elements in fixed industrial process heating equipment are required to be protected?
- 100 amps
 - 50 amps
 - 40 amps
 - 60 amps
46. Fixed industrial process heating equipment shall be permitted to be protected against overcurrent where supplied by one of the branch circuits as described in what listed article?
- 240
 - 210
 - 230
 - 220

(NEW) 425.22 (C) Overcurrent Protective Devices.

The supplementary overcurrent protective devices for the subdivided loads specified in 425.22(B) shall be (1) factory installed within or on the heater enclosure or supplied for use with the heater as a separate assembly by the heater manufacturer; (2) accessible, but shall not be required to be readily accessible; and (3) suitable for branch-circuit protection.

(NEW) 425.22 (C) Informational Note No. 3: disconnecting means for cartridge fuses in circuits of any voltage, see 240.40.

(NEW) 425.22 (D) Branch-Circuit Conductors.

The conductors supplying the supplementary overcurrent protective devices shall be considered branch-circuit conductors. Where the heaters are rated 50 kW or more, the conductors supplying the supplementary overcurrent protective devices specified in 425.22(C) shall be permitted to be sized at not less than 100 percent of the nameplate rating of the heater, provided all of the following conditions are met:

- (1) The heater is marked with a minimum conductor size.
- (2) The conductors are not smaller than the marked minimum size.
- (3) A temperature-actuated device controls the cyclic operation of the equipment.

(NEW) 425.22 (E) Conductors for Subdivided Loads. Field-wired conductors between the heater and the supplementary overcurrent protective devices for fixed industrial process heating equipment shall be sized at not less than 125 percent of the load served. The supplementary overcurrent protective devices specified in 425.22(C) shall protect these conductors in accordance with 240.4. Where the heaters are rated 50 kW or more, the ampacity of field-wired conductors between the heater and the supplementary overcurrent protective devices shall be permitted to be not less than 100 percent of the load of their respective subdivided circuits, provided all of the following conditions are met:

- (1) The heater is marked with a minimum conductor size.
- (2) The conductors are not smaller than the marked minimum size.
- (3) A temperature-activated device controls the cyclic operation of the equipment.

(NEW) 425.28 (B) Location. This nameplate shall be located so as to be visible or easily accessible after installation.

(NEW) 425.57 General. Part V shall apply to any heater mounted in the airstream of a forced-air system where the air-moving unit is not provided as an integral part of the equipment.

(NEW) 425.70 The provisions in part VI of this article shall apply to boilers employing resistance-type heating elements. Electrode-type boilers shall not be considered as employing resistance-type heating elements. See Part VII of this article.

(NEW) 425.72 (A) Boiler Employing Resistance-Type Immersion Heating Elements in an ASME-Rated and Stamped Vessel. A boiler employing resistance-type immersion heating elements contained in an ASME-rated and stamped vessel shall have the heating elements protected at not more than 150 amperes. Such a boiler rated more than 120 amperes shall have the heating elements subdivided into loads not exceeding 120 amperes. Where a subdivided load is less than 120 amperes, the rating of the overcurrent protective device shall comply with 425.3(B).

(NEW) 425.72 (B) Boiler Employing Resistance-Type Heating Elements Rated More Than 48 Amperes and Not Contained in an ASME-Rated and Stamped Vessel. A boiler employing resistance-type heating elements not contained in an ASME-rated and stamped vessel shall have the heating elements protected at not more



than 60 amperes. Such a boiler rated more than 48 amperes shall have the heating elements subdivided into loads not exceeding 48 amperes. Where a subdivided load is less than 48 amperes, the rating of the overcurrent protective device shall comply with 425.3(B).

(NEW) 425.72 (E) Conductors Supplying Supplementary Overcurrent Protective Devices. The conductors supplying these supplementary overcurrent protective devices shall be considered branch-circuit conductors. Where the heaters are rated 50 kW or more, the conductors supplying the overcurrent protective device specified in 424.72(C) shall be permitted to be sized at not less than 100 percent of the nameplate rating of the heater, provided all of the following conditions are met:

- (1) The heater is marked with a minimum conductor size.
- (2) The conductors are not smaller than the marked minimum size.
- (3) A temperature- or pressure-actuated device controls the cyclic operation of the equipment.



PART 2 EXAM QUESTIONS

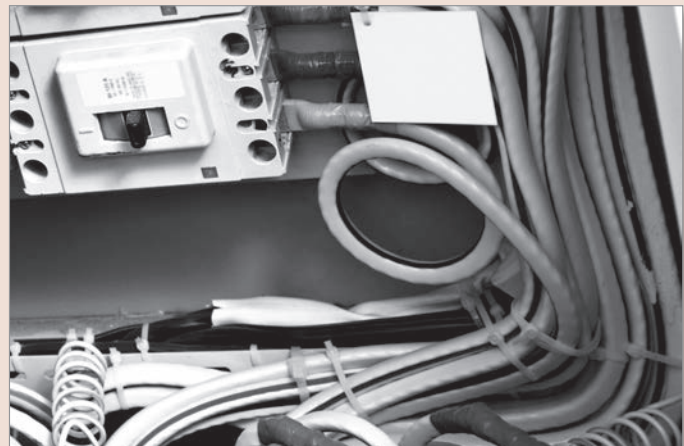
47. What is the maximum allowable current protection for a boiler employing resistance-type immersion heating elements contained in an ASME-rated and stamped vessel?
 - A. 150 amps
 - B. 60 amps
 - C. 125 amps
 - D. 100 amps
48. What are the conductors supplying the supplementary overcurrent protective devices with resistance-type heating elements in fixed industrial process heating equipment considered?
 - A. Branch-circuit conductors
 - B. Feeders
 - C. Service Laterals
 - D. Readily acceptable
49. What are the conductors supplying the supplementary overcurrent protective devices with a boiler employing resistance-type immersion heating elements considered?
 - A. Service Laterals
 - B. Feeders
 - C. Branch-circuit conductors
 - D. Readily acceptable
50. How are field-wired conductors between the heater and the supplementary overcurrent protective devices for fixed industrial process heating equipment required to be sized for the load served?
 - A. 135%
 - B. 100%
 - C. 125%
 - D. 80%
51. What section should be referenced when using cartridge fuses as the disconnect with resistance-type heating elements in fixed industrial process heating equipment?
 - A. 425.3(B)
 - B. 240.40
 - C. 425.21
 - D. 110.25
52. What part of Article 425 applies to boilers employing resistance-type heating elements?
 - A. III
 - B. V
 - C. VII
 - D. VI

53. Fixed industrial process heating equipment mounted in the airstream of a forced-air system where the air-moving unit is not provided as an integral part of the equipment is required to comply with what part of Article 425?
- VII
 - VI
 - V
 - III
54. What is the maximum allowable current protection for a boiler employing resistance-type immersion heating elements not contained in an ASME-rated and stamped vessel?
- 150 amps
 - 60 amps
 - 125 amps
 - 100 amps
55. What part of Article 425 applies to electrode-type boilers that are not considered as employing resistance-type heating elements?
- III
 - V
 - VI
 - VII
56. How many provisions are the supplementary overcurrent protective devices for resistance-type heating elements in fixed industrial process heating equipment with subdivided loads specified in 425.22(B) required to meet?
- 2
 - 3
 - 1
 - There are no special requirements
57. Where is the name plate for fixed industrial process heating equipment required to be installed?
- Readily accessible location
 - Easily accessible location
 - Visible location
 - All listed answers

(NEW) 425.72 (F) Conductors for Subdivided Loads. Field-wired conductors between the heater and the supplementary overcurrent protective devices shall be sized at not less than 125 percent of the load served. The supplementary overcurrent protective devices specified in 425.72(C) shall protect these conductors in accordance with 240.4. Where the heaters are rated 50 kW or more, the ampacity of field-wired conductors between the heater and the supplementary overcurrent protective devices shall be permitted to be not less than 100 percent of the load of their respective subdivided circuits, provided all of the following conditions are met:

- (1) The heater is marked with a minimum conductor size.
- (2) The conductors are not smaller than the marked minimum size.
- (3) A temperature-activated device controls the cyclic operation of the equipment.

(NEW) 425.73 Over temperature Limit Control. Each boiler, designed so that in normal operation there is no change in state of the heat transfer medium, shall be equipped with a temperature sensitive limiting means. It shall be installed to limit maximum liquid temperature and shall directly or indirectly disconnect all ungrounded



conductors to the heating elements. Such means shall be in addition to a temperature-regulating system and other devices protecting the tank against excessive pressure.

(NEW) 425.74 Overpressure Limit Control. Each boiler, designed so that in normal operation there is a change in state of the heat transfer medium from liquid to vapor, shall be equipped with a pressure-sensitive limiting means. It shall be installed to limit maximum pressure and shall directly or indirectly disconnect all ungrounded conductors to the heating elements. Such means shall be in addition to a pressure-regulating system and other devices protecting the tank against excessive pressure.

(NEW) 425.80 Scope. The provisions in Part VII of this article shall apply to boilers for operation at 600 volts, nominal, or less, in which heat is generated by the passage of current between electrodes through the liquid being heated.

(NEW) 425.82 Branch-Circuit Requirements. The size of branch-circuit conductors and overcurrent protective devices shall be calculated on the basis of 125 percent of the total load (motors not included). A contactor, relay, or other device, approved for continuous operation at 100 percent of its rating, shall be permitted to supply its full-rated load. See 210.19(A).

425.86 Markings. All electrode-type boilers shall be marked to show the following:

- (1) The manufacturer's name.
- (2) The normal rating in volts, amperes, and kilowatts.
- (3) The electrical supply required specifying frequency, number of phases, and number of wires.
- (4) The marking "Electrode-Type Process Heating Boiler."
- (5) A warning marking, "All Power Supplies Shall Be Disconnected Before Servicing, Including Servicing the Pressure Vessel." A field-applied warning marking or label shall comply with 110.21(B).

The nameplate shall be located so as to be visible after installation.



(Revised) 426.4 Continuous Load. Fixed outdoor electric deicing and snow-melting equipment shall be considered a continuous load.

(Revised) 426.32 The secondary windings of the isolation transformer connected to the impedance heating elements shall not have an output voltage greater than 30 volts ac.

(Revised) 427.20 Marking. Each factory-assembled heating unit shall be legibly marked within 75 mm (3 in.) of an end of the non-heating leads with the permanent identification symbol, catalog number, and ratings in volts and watts or in volts and amperes.

(Revised) 430.53 (D)(3) Conductors from the point of the tap from the branch circuit to a listed manual motor controller additionally marked "Suitable for Tap Conductor Protection in Group Installations," or to a branch-circuit protective device, shall be permitted to have an ampacity not less than one tenth the rating or setting of the branch-circuit short-circuit and ground-fault protective device. The conductors from the controller to the motor shall have an ampacity in accordance with 430.22. The conductors from the point of the tap to the controller(s) shall (1) be suitably protected from physical damage and enclosed either by an enclosed controller or by a raceway and be not more than 3 m (10 ft) long or (2) have an ampacity not less than that of the branch-circuit conductors.

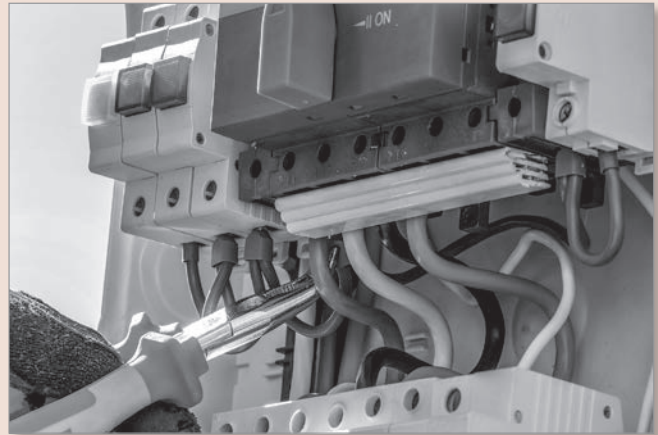
PART 2 EXAM QUESTIONS

58. What is the maximum length permitted for conductors from the point of the tap to a controller?
- 12 ft
 - 10 ft
 - 16 ft
 - 25 ft
59. What is a boiler designed so that in normal operation there is no change in state of the heat transfer medium required to be equipped with?
- Level transmitter
 - Pressure-sensitive limiting means
 - Flow transmitter
 - Temperature sensitive limiting means
60. What is a boiler required to be equipped with that is designed so that in normal operation there is a change in state of the heat transfer medium from liquid to vapor?
- Pressure-sensitive limiting means
 - Temperature sensitive limiting means
 - Flow transmitter
 - Level transmitter
61. How are field-wired conductors between the heater and the supplementary overcurrent protective devices for a boiler employing resistance-type immersion heating elements required to be sized for the load served?
- 135%
 - 100%
 - 125%
 - 80%
62. What is the maximum voltage for boilers covered in part VII of Article 425?
- 480
 - 575
 - 600
 - 1000
63. What type of load is fixed outdoor electric deicing and snow-melting equipment considered?
- Non-continuous load
 - Continuous load
 - Fixed load
 - Stationary load
64. What is the marking on an electrode-type boiler required to say?
- "Electrode-Type Control Process Heating Boiler"
 - "Electrode-Type Process Control Heating Boiler"
 - "Electrode-Type Process Heating Boiler"
 - "Electrode Process Heating Type Boiler"
65. What is the maximum allowable output voltage when secondary windings of an isolation transformer are connected to impedance heating elements?
- 24 volts AC
 - 30 volts AC
 - 60 volts DC
 - 30 volts DC
66. Non-heating leads that are used with factory-assembled heating units are required to be marked within how many inches of the end?
- 2 inches
 - 3 inches
 - 6 inches
 - 4 inches
67. What percentage of the total load are branchcircuit conductors and overcurrent protective devices used with electrode-type boilers required to be calculated?
- 80%
 - 100%
 - 135%
 - 125%

(NEW) 430.53 (D)(4) Conductors from the point of the tap from the branch circuit to a listed manual motor controller additionally marked "Suitable for Tap Conductor Protection in Group Installations," or to a branch-circuit protective device, shall be permitted to have an ampacity not less than one third that of the branch-circuit conductors. The conductors from the controller to the motor shall have an ampacity in accordance with 430.22. The conductors from the point of the tap to the controller(s) shall (1) be suitably protected from physical damage and enclosed either by an enclosed controller or by a raceway and be not more than 7.5 m (25 ft) long or (2) have an ampacity not less than that of the branch-circuit conductors.

(NEW) 430.99 Available Fault Current. The available short circuit current at the motor control center and the date when the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.

(NEW) 430.130 (A)(4) Where an instantaneous trip circuit breaker or semiconductor fuses are permitted in accordance with the drive manufacturer's instructions for use as the branch-circuit short-circuit and ground-fault protective device for listed power conversion equipment, they shall be provided as an integral part of a single listed assembly incorporating both the protective device and power conversion equipment.



(Revised) 440.2 Rated-Load Current. The current of a hermetic refrigerant motor-compressor resulting when it is operated at the rated load, rated voltage, and rated frequency of the equipment it serves.

(NEW) 440.9 Grounding and Bonding. Where multi-motor and combination-load equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use non-threaded fittings.

(Revised) 440.65 Single-phase cord-and-plug-connected room air conditioners shall be provided with one of the following factory-installed devices:

- (1) Leakage-current detector-interruptor (LCDI)
- (2) Arc-fault circuit interrupter (AFCI)
- (3) Heat detecting circuit interrupter (HDCI)

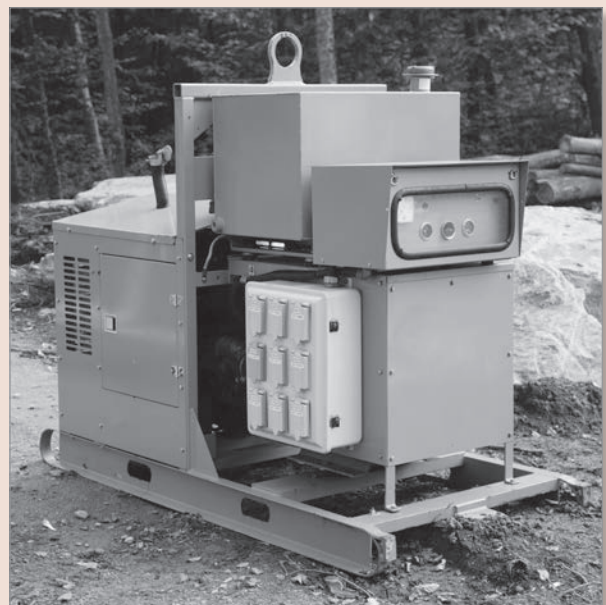
The protection device shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.

(NEW) 445.10 Informational Note: See NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, for information on the location of generator exhaust.

(Revised) 445.11 Marking. Each generator shall be provided with a nameplate giving the manufacturer's name, the rated frequency, the number of phases if ac, the rating in kilowatts or kilovolt-amperes, the power factor, the normal volts and amperes corresponding to the rating, the rated ambient temperature, and the rated temperature rise.

Nameplates or manufacturer's instructions shall provide the following information for all stationary generators and portable generators rated more than 15 kW:

- (1) Subtransient, transient, synchronous, and zero sequence reactances
- (2) Power rating category
- (3) Insulation system class
- (4) Indication if the generator is protected against overload by inherent design, an overcurrent protective relay, circuit breaker, or fuse



(5) Maximum short-circuit current for inverter-based generators, in lieu of the synchronous, subtransient, and transient reactances

Marking shall be provided by the manufacturer to indicate whether or not the generator neutral is bonded to its frame. Where the bonding is modified in the field, additional marking shall be required to indicate whether the neutral is bonded to the frame.

PART 2 EXAM QUESTIONS

68. **AC outdoor multi-motor and combination-load equipment is required to have an equipment grounding conductor of the wire type installed in the outdoor portions of the metallic raceway systems if what occurs?**
 - A. Use non-threaded fittings
 - B. Use threaded fittings
 - C. Use Meyers hubs
 - D. Threaded compression fittings are used
69. **Who is the date when short circuit current calculations were performed at a motor control center required to be made available to?**
 - A. The maintenance crew
 - B. The AHJ
 - C. The Start-up crew
 - D. All listed answers
70. **What best defines the current of a hermetic refrigerant motor-compressor resulting when it is operated at the rated load, rated voltage, and rated frequency of the equipment it serves?**
 - A. Full load-current
 - B. Listed load-current
 - C. Rated load-current
 - D. Locked rotor-current
71. **Where does the 2017 code direct one to find information regarding information on the location of generator exhaust?**
 - A. NFPA 73
 - B. NFPA 37
 - C. IEEE/NFPA 30
 - D. 430.22
72. **Where should the manufacturer of a 50 kW stationary generator indicate the neutral is bonded?**
 - A. At the grounding electrode conductor
 - B. At the frame
 - C. At the equipment grounding conductor
 - D. At the transfer switch
73. **What factory-installed device is a plug-connected room air conditioner required to have installed?**
 - A. Toggle switch
 - B. GFCI
 - C. HDCI
 - D. All listed answers
74. **How many items should be listed in a 20 kW portable generator manufacturer's instructions?**
 - A. 3
 - B. 4
 - C. 7
 - D. 5
75. **Conductors "Suitable for Tap Conductor Protection in Group Installations," or to a branch-circuit protective device, are permitted to have an ampacity not less than what of the branch-circuit conductors?**
 - A. One sixth
 - B. One third
 - C. One tenth
 - D. One sixteenth
76. **What section allows semiconductor fuses serving as a ground-fault protective device for listed power conversion equipment designed so it is an integral part of a single listed assembly incorporating both the protective device and power conversion equipment?**
 - A. 430.53 (D)(3)
 - B. 430.99
 - C. 430.130 (A)(4)
 - D. 430.53 (D)(4)
77. **What is the maximum distance that a plug-connected room air conditioner protection device is required to be installed from the end of an attachment plug?**
 - A. 18 inches
 - B. 3 inches
 - C. 6 inches
 - D. 12 inches

(NEW) 445.13 (B) Overcurrent Protection Provided.

Where the generator set is equipped with a listed overcurrent protective device or a combination of a current transformer and overcurrent relay, conductors shall be permitted to be tapped from the load side of the protected terminals in accordance with 240.21(B). Tapped conductors shall not be permitted for portable generators rated 15 kW or less where field wiring connection terminals are not accessible.

(Revised) 445.14 Protection of Live Parts. Live parts of generators operating at more than 50 volts ac or 60 volts dc to ground shall not be exposed to accidental contact where accessible to unqualified persons.



(NEW) 445.18 (A) Disconnecting Means. Generators other than cord-and-plug-connected portable shall have one or more disconnecting means. Each disconnecting means shall simultaneously open all associated ungrounded conductors. Each disconnecting means shall be lockable in the open position in accordance with 110.25.

(NEW) 445.18 (B) Shutdown of Prime Mover. Generators shall have provisions to shut down the prime mover. The means of shutdown shall comply with all of the following:

- (1) Be equipped with provisions to disable all prime mover start control circuits to render the prime mover incapable of starting
- (2) Initiate a shutdown mechanism that requires a mechanical reset

The provisions to shut down the prime mover shall be permitted to satisfy the requirements of 445.18(A) where it is capable of being locked in the open position in accordance with 110.25.

Generators with greater than 15 kW rating shall be provided with an additional requirement to shut down the prime mover. This additional shutdown means shall be located outside the equipment room or generator enclosure and shall also meet the requirements of 445.18(B)(1) and (B)(2).

(NEW) 445.18 (C) Generators Installed in Parallel. Where a generator is installed in parallel with other generators, the provisions of 445.18(A) shall be capable of isolating the generator output terminals from the paralleling equipment. The disconnecting means shall not be required to be located at the generator.

(Revised) 445.20 Ground-Fault Circuit-Interrupter Protection for Receptacles on 15-kW or Smaller Portable Generators. Receptacle outlets that are a part of a 15-kW or smaller portable generator shall have listed ground-fault circuit-interrupter protection (GFCI) for personnel integral to the generator or receptacle as indicated in either (A) or (B):

(NEW) (A) Unbonded (Floating Neutral) Generators. Unbonded generators with both 125-volt and 125/250-volt receptacle outlets shall have listed GFCI protection for personnel integral to the generator or receptacle on all 125-volt, 15- and 20-ampere receptacle outlets. Exception: GFCI protection shall not be required where the 125-volt receptacle outlet(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use.

(NEW) (B) Bonded Neutral Generators. Bonded generators shall be provided with GFCI protection on all 125-volt, 15- and 20-ampere receptacle outlets.

(NEW) Exception: GFCI protection shall not be required where the 125-volt receptacle outlet(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use.

(NEW) 445.20 (B) Bonded Neutral Generators. Bonded generators shall be provided with GFCI protection on all 125-volt, 15- and 20-ampere receptacle outlets.

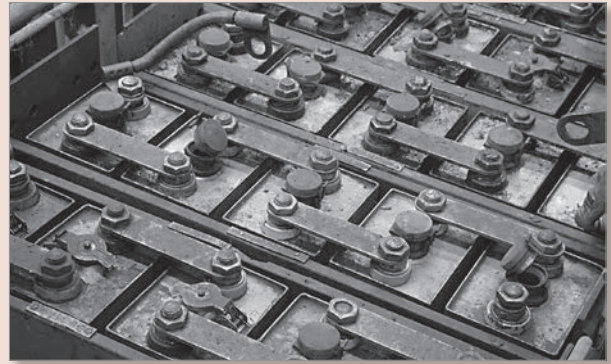
(NEW) Informational Note: Refer to 590.6(A)(3) for GFCI requirements for 15-kW or smaller portable generators used for temporary electric power and lighting.

(NEW) 445.20 (A) Unbonded (Floating Neutral) Generators. Unbonded generators with both 125-volt and 125/250-volt receptacle outlets shall have listed GFCI protection for personnel integral to the generator or receptacle on all 125-volt, 15- and 20-ampere receptacle outlets.

(Revised) 450.43 (C) Locks. Doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to qualified persons. Personnel doors shall open in the direction of egress and be equipped with listed panic hardware.

(NEW) 480.3 Equipment. Storage batteries and battery management equipment shall be listed. This requirement shall not apply to lead-acid batteries.

(Revised) 480.6 Overcurrent Protection for Prime Movers. Overcurrent protection shall not be required for conductors from a battery with a voltage of 60 volts dc or less if the battery provides power for starting, ignition, or control of prime movers. Section 300.3 shall not apply to these conductors.



PART 2 EXAM QUESTIONS

78. A generator disconnect is required to be lockable in what position?
 - A. Tripped position
 - B. Closed position
 - C. Open position
 - D. Overload position
79. What are storage batteries and battery management equipment required to be?
 - A. Listed
 - B. Rated
 - C. Readily accessible
 - D. Guarded
80. What is not permitted for portable generators rated 15 kW or less where field wiring connection terminals are not accessible?
 - A. Operating under natural gas solely
 - B. Back feeding a branch circuit
 - C. Operating under gas solely
 - D. Using tapped conductors
81. What additional requirement is a 25 kW generator required to have?
 - A. A switched neutral
 - B. An eddy current meter
 - C. Current transformers
 - D. Additional means to shut down the prime mover
82. At how many dc volts to ground are the live parts of generators required to be protected against accidental contact where accessible to unqualified persons?
 - A. 50
 - B. 60
 - C. 32
 - D. 24
83. What section pertains directly to floating neutral generators?
 - A. 445.18(B)(1)
 - B. 445.18(A)
 - C. 445.20 (A)
 - D. 590.6(A)(3)
84. If a generator is installed in parallel with other generators, what section pertains to isolating the generator output terminal from the paralleling equipment?
 - A. 445.20 (A)
 - B. 445.18(B)(1)
 - C. 445.18(A)
 - D. 590.6(A)(3)
85. Where does the 2017 code direct you to look for the GFCI requirements for 15-kW or smaller portable generators used for temporary electric power and lighting?
 - A. 445.20 (A)
 - B. 445.18(A)
 - C. 445.20 (B)
 - D. 590.6(A)(3)

86. What is the receptacle on a 10 kW generator required to be listed as?

- A. LCDI
- B. GFCI
- C. AFCI
- D. HDCI

87. What is the personnel door in a transformer vault required to be equipped with?

- A. Usage alarm
- B. Listed panic hardware
- C. Egress sign
- D. Quick latch feature

88. What is the maximum dc voltage where overcurrent protection is not required for conductors from a battery to a generator starter?

- A. 12
- B. 100
- C. 24
- D. 60

(Revised) 480.7 (A) Disconnecting Means. A disconnecting means shall be provided for all ungrounded conductors derived from a stationary battery system with a voltage over 60 volts dc. A disconnecting means shall be readily accessible and located within sight of the battery system.

(Revised) 480.8 Insulation of Batteries. Batteries constructed of an electrically conductive container shall have insulating support if a voltage is present between the container and ground.

(NEW) 480.9 Battery Support Systems. For battery chemistries with corrosive electrolyte, the structure that supports the battery shall be resistant to deteriorating action by the electrolyte. Metallic structures shall be provided with nonconducting support members for the cells, or shall be constructed with a continuous insulating material. Paint alone shall not be considered as an insulating material.



(Revised) 480.11 (A) Vented Cells. Each vented cell shall be equipped with a flame arrester.

Informational Note: A flame arrester prevents destruction of the cell due to ignition of gases within the cell by an external spark or flame.

(Revised) 480.11 (B) Sealed Cells. Where the battery is constructed such that an excessive accumulation of pressure could occur within the cell during operation, a pressure-release vent shall be provided.

(Revised) 500.5(A) General. Locations shall be classified depending on the properties of the flammable gas, flammable liquid-produced vapor, combustible liquid-produced vapors, combustible dusts, or fibers/flyings that could be present, and the likelihood that a flammable or combustible concentration or quantity is present. Each room, section, or area shall be considered individually in determining its classification. Where pyrophoric materials are the only materials used or handled, these locations are outside the scope of this article. Refrigerant machinery rooms that contain ammonia refrigeration systems and are equipped with adequate mechanical ventilation that operates continuously or is initiated by a detection system at a concentration not exceeding 150 ppm shall be permitted to be classified as “unclassified” locations.

(NEW) 490.3 (B) Enclosures in Damp or Wet Locations. Enclosures in damp or wet locations shall meet the requirements of 312.2.

500.6 (4) Informational Note No. 2: For classification of areas involving ammonia atmospheres, see ANSI/ASHRAE 15-2013, Safety Standard for Refrigeration Systems.

(Revised) 500.8 (E)(2) Equipment Provided with Threaded Entries for Metric- Threaded Fittings. For equipment with metric-threaded entries, listed conduit fittings or listed cable fittings shall be used. Such entries shall be identified as being metric, or listed adapters to permit connection to conduit or NPT-threaded fittings shall be provided with the equipment and shall be used for connection to conduit or NPT-threaded fittings. Metric-threaded fittings installed into explosion-proof equipment shall have a class of fit of at least 6g/6H and shall be made up with at least five threads fully engaged.

(Revised) 501.15(A)(1)(2) The entry is metric designator 53 (trade size 2) or larger, and the enclosure contains terminals, splices, or taps. An enclosure, identified for the location, and marked "Leads Factory Sealed," or "Factory Sealed," or "Seal not Required," or equivalent shall not be considered to serve as a seal for another adjacent enclosure that is required to have a conduit seal. Conduit seals shall be installed within 450 mm (18 in.) from the enclosure or as required by the enclosure marking. Only explosion-proof unions, couplings, reducers, elbows, and capped elbows that are not larger than the trade size of the conduit shall be permitted between the sealing fitting and the explosion-proof enclosure.

(Revised) 501.15 (D) (1) At Terminations. Cables shall be sealed with sealing fittings that comply with 501.15(C) at all terminations. Type MC-HL cables with a gas/vapor tight continuous corrugated metallic sheath and an overall jacket of suitable polymeric material shall be sealed with a listed fitting after the jacket and any other covering have been removed so that the sealing compound can surround each individual insulated conductor in such a manner as to minimize the passage of gases and vapors. Seals for cables entering enclosures shall be installed within 450 mm (18 in.) of the enclosure or as required by the enclosure marking. Only explosion-proof unions, couplings, reducers, elbows, and capped elbows that are not larger than the trade size of the enclosure entry shall be permitted between the sealing fitting and the enclosure.



PART 2 EXAM QUESTIONS

- | | |
|---|--|
| <p>89. How close do cable seals need to be installed from an enclosure when required?</p> <ul style="list-style-type: none"> A. 18 inches B. 24 inches C. 10 ft D. 36 inches | <p>91. What section should be referenced for enclosures in damp or wet locations operating at over 1000 volts?</p> <ul style="list-style-type: none"> A. 314.2 B. 312.2 C. 310.4 D. 315(B)(2) |
| <p>90. What alone is not an insulating material with regards to a support system for batteries?</p> <ul style="list-style-type: none"> A. Paint B. Rubber C. Plastic D. Porcelain | <p>92. What are vented cells required to be equipped with regarding battery systems?</p> <ul style="list-style-type: none"> A. Restrictor plate B. Flame arrester C. Pressure-release vent D. Blow off valve |

93. How many threads must be fully engaged when using metric-threaded fittings installed into explosion-proof equipment?
- 3
 - 4
 - 6
 - 5
94. What is required to be installed when a battery is constructed such that an excessive accumulation of pressure could occur within the cell during operation?
- Flame arrester
 - Restrictor plate
 - Pressure-release vent
 - Blow off valve
95. Refrigerant machinery rooms that contain ammonia refrigeration systems are considered "unclassified" locations if the concentration does not exceed how many ppm?
- 150
 - 200
 - 100
 - 75
96. How close do conduit seals need to be installed from an enclosure when required?
- 24 inches
 - 18 inches
 - 10 ft
 - 36 inches
97. What are batteries constructed of an electrically conductive container required to have if a voltage is present between the container and ground?
- Terminal covers
 - Bleed off conductors
 - Insulating support
 - Battery terminal insulators
98. At what voltage is a disconnecting means required for all ungrounded conductors derived from a stationary battery system?
- 50 volts dc
 - 60 volts dc
 - 60 volts ac
 - 24 volts dc
99. What ANSI covers areas involving ammonia atmospheres?
- ANSI/ISA-60079-28 (12.21.02)-2013
 - ANSI/IEEE 14-2013
 - ANSI/ASHRAE 13-2015
 - ANSI/ASHRAE 15-2013

501.105 (A) Class I, Division 1. In Class I, Division 1 locations, meters, instruments, and relays, including kilowatt-hour meters, instrument transformers, resistors, rectifiers, and thermionic tubes, shall be provided with enclosures identified for Class I, Division 1 locations. Enclosures for Class I, Division 1 locations include explosion-proof enclosures and purged and pressurized enclosures.

(Revised) 501.105 (B) Class I, Division 2. In Class I, Division 2 locations, meters, instruments, and relays shall comply with 501.105(B)(2) through (B)(6).

(1) General-Purpose Assemblies. Where an assembly is made up of components for which general-purpose enclosures are acceptable as provided in 501.105(B)(1), (B)(2), and (B)(3), a single general-purpose enclosure shall be acceptable for the assembly. Where such an assembly includes any of the equipment described in 501.105(B)(1), 501.105(B)(2),



and 501.105(B)(3), the maximum obtainable surface temperature of any component of the assembly that exceeds 100°C shall be clearly and permanently indicated on the outside of the enclosure. Alternatively, equipment shall be permitted to be marked to indicate the temperature class for which it is suitable, using the temperature class (T Code) of Table 500.8(C).

(Revised) 501.105 (6) Connections. To facilitate replacements, process control instruments shall be permitted to be connected through flexible cord by means of attachment plug and receptacle, provided that all of the following conditions apply:

(1) The attachment plug and receptacle are listed for use in Class I, Division 2 locations and for use with flexible cords and shall be of the locking and grounding type.

Exception: A Class I, Division 2 listing shall not be required if the circuit is nonincendive field wiring.

(2) Unless the attachment plug and receptacle are interlocked mechanically or electrically, or otherwise designed so that they cannot be separated when the contacts are energized and the contacts cannot be energized when the plug and socket outlet are separated, a switch complying with 501.105(B)(2) is provided so that the attachment plug or receptacle is not depended on to interrupt current.

Exception: The switch shall not be required if the circuit is nonincendive field wiring.

(3) The flexible cord does not exceed 900 mm (3 ft) and is of a type listed for extra-hard usage or for hard usage if protected by location, if applicable.

(4) Only necessary receptacles are provided.

(5) The circuit has a maximum current of 3 amps.

(NEW) 501.125(B)(5) Informational Note No. 5: For details of the evaluation process to determine incandivity, refer to Annex A and Figure A1 of UL 1836–2014, Outline of Investigation for Electric Motors and Generators for Use in Class I, Division 2, Class I, Zone 2, Class II, Division 2 and Zone 22 Hazardous (Classified) Locations.

(NEW) 502.10(A)(1)(5) In industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation, listed Type ITC-HL cable with a gas/vapor tight continuous corrugated metallic sheath and an overall jacket of suitable polymeric material, and terminated with fittings listed for the application, and installed in accordance with the provisions of Article 727.

(Revised) 504.1 Scope. This article covers the installation of intrinsically safe (I.S.) apparatus, wiring, and systems for Articles 500 through 516.

(NEW) 505.4 (B) Informational Note No. 8: Portable or transportable equipment having self-contained power supplies, such as battery-operated equipment, could potentially become an ignition source in hazardous (classified) locations. See ANSI/ISA-12.12.03-2011, Standard for Portable Electronic Products Suitable for Use in Class I and II, Division 2, Class I Zone 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations.

(NEW) 505.4 (B) Informational Note No. 9: For additional information concerning the installation of equipment utilizing optical emissions technology (such as laser equipment) that could potentially become an ignition source in hazardous (classified) locations, see ANSI/ISA-60079-28 (12.21.02)-2013, Explosive Atmospheres — Part 28: Protection of equipment and transmission systems using optical radiation.



PART 2 EXAM QUESTIONS

- 100. What annex is listed for details regarding the evaluation process to determine incendivity?**
- A. D
 - B. B
 - C. A
 - D. F
- 101. What publication is listed for additional information concerning the installation of equipment utilizing optical emissions technology (such as laser equipment) that could potentially become an ignition source in hazardous (classified) locations?**
- A. ANSI/ASHRAE 15-2013
 - B. ANSI/ISA-60079-28 (12.21.02)-2013
 - C. ANSI/ISA-12.12.03-2011
 - D. IEEE/ASHRAE 15-2014
- 102. What is the maximum allowable current for a process control instrument to be connected by a flexible cord?**
- A. 2.5 amps
 - B. 2 amps
 - C. .1 to 1 amp
 - D. 3 amps
- 103. If an assembly is made up of components for which general-purpose enclosures are acceptable as provided in 501.105(B)(1), (B)(2), and (B)(3), what is the minimum allowable general-purpose enclosure(s) acceptable for this assembly?**
- A. One
 - B. Two
 - C. Three
 - D. There are no minimum requirements for this installation
- 104. What is the maximum flexible cord length that a process control instrument can have connected?**
- A. 5 ft
 - B. 4 ft
 - C. 3 ft
 - D. 2 ft
- 105. What publication is listed regarding the standard for portable electronic products suitable for use in Class I and II, Division 2, Class I Zone 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations?**
- A. ANSI/ASHRAE 15-2013
 - B. ANSI/ISA-12.12.03-2011
 - C. ANSI/ISA-60079-28 (12.21.02)-2013
 - D. IEEE/ASHRAE 15-2014
- 106. What article must type ITC-HL cable comply with when installed in industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation?**
- A. 501.10
 - B. 700
 - C. 800
 - D. 727
- 107. A kilowatt-hour meter is required to be installed in what type of enclosure?**
- A. Class III, Division 1I
 - B. Class I, Division 1
 - C. Class I, Division 1I
 - D. Class II, Division 1
- 108. What article covers the installation of intrinsically safe systems?**
- A. 501
 - B. 500
 - C. 502
 - D. 504

(Revised) 505.6 (A) Group IIC. Atmospheres containing acetylene, hydrogen, or flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value less than or equal to 0.50 mm or minimum igniting current (MIC) ratio less than or equal to 0.45.

(Revised) 505.6 Group (C) IIA. Atmospheres containing acetone, ammonia, ethyl alcohol, gasoline, methane, propane, or flammable gas, flammable liquid–produced vapor, or combustible liquid–produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value greater than 0.90 mm or minimum igniting current (MIC) ratio greater than 0.80.

(Revised) 505.7(F) Available Short-Circuit Current for Type of Protection “e”. Unless listed and marked for connection to circuits with higher available short-circuit current, the available short-circuit current for electrical equipment using type of protection “e” for the field wiring connections in Zone 1 locations shall be limited to 10,000 rms symmetrical amperes to reduce the likelihood of ignition of a flammable atmosphere by an arc during a short-circuit event.



(Revised) 505.9(E)(1) Equipment Provided with Threaded Entries for NPT Threaded Conduit or Fittings. For equipment provided with threaded entries for NPT threaded conduit or fittings, listed conduit, listed conduit fittings, or listed cable fittings shall be used. All NPT threaded conduit and fittings shall be threaded with a National (American) Standard Pipe Taper (NPT) thread. NPT threaded entries into explosion proof or flameproof equipment shall be made up with at least five threads fully engaged.

(NEW) 505.17 (B) Instrumentation Connections for Zone 2. To facilitate replacements, process control instruments shall be permitted to be connected through flexible cords, attachment plugs, and receptacles, provided that all of the following conditions apply:

- (1) A switch listed for Zone 2 is provided so that the attachment plug is not depended on to interrupt current, unless the circuit is type “ia,” “ib,” or “ic” protection, in which case the switch is not required.
- (2) The current does not exceed 3 amperes at 120 volts, nominal.
- (3) The power-supply cord does not exceed 900 mm (3 ft), is of a type listed for extra-hard usage or for hard usage if protected by location, and is supplied through an attachment plug and receptacle of the locking and grounding type.
- (4) Only necessary receptacles are provided.
- (5) The receptacle carries a label warning against unplugging under load.

(Revised) 506.5 (1) Zone 20. A Zone 20 location is a location in which either of the following occur:

- (1) Ignitable concentrations of combustible dust or ignitable fibers/flyings are present continuously.
- (2) Ignitable concentrations of combustible dust or ignitable fibers/flyings are present for long periods of time.

(Revised) 506.5 (2) Zone 21. A Zone 21 location is a location where one of the following apply:

- (1) Ignitable concentrations of combustible dust or ignitable fibers/flyings are likely to exist occasionally under normal operating conditions.
- (2) Ignitable concentrations of combustible dust or ignitable fibers/flyings may exist frequently because of repair or maintenance operations or because of leakage.
- (3) Equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of combustible dust or ignitable fibers/flyings

and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition.

(4) The location is adjacent to a Zone 20 location from which ignitable concentrations of dust or ignitable fibers/flyings could be communicated.

(Revised) 506.5 (3) Zone 22. A Zone 22 location is a location where one of the following apply:

(1) Ignitable concentrations of combustible dust or ignitable fibers/flyings are not likely to occur in normal operation and, if they do occur, will only persist for a short period.

(2) Combustible dust or fibers/flyings are handled, processed, or used but in which the dust or fibers/flyings are normally confined within closed containers or closed systems from which they can escape only as a result of the abnormal operation of the equipment with which the dust or fibers/flyings are handled, processed, or used.

(3) The location is adjacent to a Zone 21 location, from which ignitable concentrations of dust or fibers/flyings could be communicated.



PART 2 EXAM QUESTIONS

109. What zone exhibits ignitable concentrations of combustible dust or ignitable fibers/flyings that may exist frequently because of repair or maintenance operations or because of leakage?

- A. 2
- B. 20
- C. 22
- D. 21

110. What is the minimum igniting current ratio for combustible liquid-produced vapor mixed with air that may burn or explode having either a maximum experimental safe gap (MESG) value less than or equal to 0.50?

- A. 0.50
- B. 0.45
- C. 0.40
- D. 0.54

111. What is the available short-circuit current for electrical equipment using type "e" protection for the field wiring connections in Zone 1 locations?

- A. 15,000 rms symmetrical amperes
- B. 20,000 rms symmetrical amperes
- C. 10,000 rms symmetrical amperes
- D. 100,000 rms symmetrical amperes

112. A group IIA atmosphere should have a maximum experimental safe gap value greater than what?

- A. 0.90 mm
- B. 0.60 mm
- C. 0.45 mm
- D. 0.50 mm

113. What type of taper is used for threaded conduit and fittings?

- A. Pipe Taper thread (NPT)
- B. Standard Pipe Taper (NPT) thread
- C. National (American) Standard Pipe Taper (NPT) thread
- D. Iron pipe size (IPS)

114. What zone would best describe ignitable concentrations of combustible dust or ignitable fibers/flyings that are present continuously?

- A. 2
- B. 21
- C. 22
- D. 20

115. What zone has combustible dust or fibers/flyings that are handled, processed, or used, but in which the dust or fibers/flyings are normally confined within closed containers of closed systems from which they can escape only as a result of the abnormal operation of the equipment with which the dust or fibers/flyings are handled, processed, or used?

- A. 21
- B. 20
- C. 22
- D. 2

116. How many items must be met to use flexible cords to connect process control instruments in a Zone 2 location?

- A. 2
- B. 4
- C. 6
- D. 5

(Revised) 506.6 Material Groups. For the purposes of testing, approval, and area classification, various air mixtures (not oxygen enriched) shall be grouped as required in 506.6(A), (B), and (C).

(A) Group IIIC. Combustible metal dust. Group IIIC shall be considered to be equivalent to Class II, Group E.

(B) Group IIIB. Combustible dust other than combustible metal dust. Group IIIB shall be considered to be equivalent to Class II, Groups F and G.

(C) Group IIIA. Solid particles, including fibers, greater than 500 µm in nominal size, which could be suspended in air and could settle out of the atmosphere under their own weight. Group IIIA shall be considered to be equivalent to Class III.



(Revised) 511.3 (C) Repair Garages, Major and Minor. Where vehicles using Class I liquids or heavier-than-air gaseous fuels (such as LPG) are repaired, hazardous area classification guidance is found in Table 511.3(C).

Informational Note: For additional information, see NFPA 30A-2015, Code for Motor Fuel Dispensing Facilities and Repair Garages, Table 8.3.2.

(Revised) 511.3 (D) Repair Garages, Major. Where vehicles using lighter-than-air gaseous fuels (such as hydrogen and natural gas) are repaired or stored, hazardous area classification guidance is found in Table 511.3(D).

Informational Note: For additional information see NFPA 30A-2015, Code for Motor Fuel Dispensing Facilities and Repair Garages, Table 8.3.2.

(NEW) 511.8 Underground Wiring. Underground wiring shall be installed in threaded rigid metal conduit or intermediate metal conduit.

(Revised) 514.3(B) (2) Compressed Natural Gas, Liquefied Natural Gas, and Liquefied Petroleum Gas Areas. Table 514.3(B)(2) shall be used to delineate and classify areas where CNG, LNG, compressed or liquefied hydrogen, LP-Gas, or combinations of these, are dispensed as motor vehicle fuels along with Class I or Class II liquids that are also dispensed as motor vehicle fuels.

Where CNG or LNG dispensers are installed beneath a canopy or enclosure, either the canopy or enclosure shall be designed to prevent accumulation or entrapment of ignitable vapors or all electrical equipment installed beneath the canopy or enclosure shall be suitable for Class I, Division 2 hazardous (classified) locations.

Dispensing devices for LP-Gas shall be located as follows:

- (1) At least 3 m (10 ft) from any dispensing device for Class I liquids
- (2) At least 1.5 m (5 ft) from any dispensing device for Class I liquids where the following conditions exist:
 - a. The LP-Gas deliver nozzle and filler valve release no more than 4 cm³ (0.1 oz) of liquid upon disconnection.
 - b. The fixed maximum liquid level gauge remains closed during the entire refueling process.

(NEW) 514.3(B)(3)(a) Aboveground tanks storing CNG or LNG shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property.

Informational Note: The relevant distances are given in Section 8.4 of NFPA 52-2013, Vehicular Gaseous Fuel Systems Code.

(NEW) 514.3(B)(b) Aboveground tanks storing hydrogen shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property.

Informational Note: The relevant distances given in NFPA-2011, Hydrogen Technologies Code.

(NEW) 514.3(B)(c) Aboveground tanks storing LP-Gas shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property.

Informational Note: The relevant distances are given in Section 6.3 of NFPA 58-2014, Liquefied Petroleum Gas Code.



PART 2 EXAM QUESTIONS

117. What is group IIIB now equivalent to?

- A. Class III
- B. Class II, Group E
- C. Class II, Group H
- D. Class II, Groups F and G

118. What section of the Liquefied Petroleum Gas Code would you find the relevant distances for the aboveground storage of LP-Gas?

- A. Section 5.5
- B. Section 4.3
- C. Section 6.7
- D. Section 6.3

119. What are above ground storage tanks that store LNG required to be separated from?

- A. Storage buildings
- B. Adjacent property line
- C. In-ground storage tanks
- D. All listed answers

120. What table should be used to determine hazardous area classification guidance where vehicles using heavier-than-air gaseous fuels are repaired?

- A. 506.6(A)
- B. 511.3(D)
- C. 511.3(C)
- D. 506.5 (3)

121. What is group IIIA now equivalent to?

- A. Class II, Groups F and G
- B. Class II, Group E
- C. Class II, Group H
- D. Class III

122. If you only have 22 inches of cover, what type of raceway is required to be used for underground wiring in a commercial garage?

- A. HDPE
- B. PVC
- C. Threaded rigid metal
- D. RTRC

123. What table should be used to determine hazardous area classification guidance where vehicles using lighter-than-air gaseous fuels are stored?

- A. 511.3(C)
- B. 511.3(D)
- C. 506.6(A)
- D. 506.5 (3)

124. What is the minimum distance from a Class I liquid being dispensed as motor vehicle fuel is a LP-Gas dispenser required to be?

- A. 12 ft
- B. 3 ft
- C. 6 ft
- D. 10 ft

125. Where would you find the relevant distances when storing hydrogen?

- A. NFPA 58-2014
- B. NFPA 52-2013
- C. NFPA-2011
- D. 514.3(B)(2)

126. What is group IIIC now equivalent to?

- A. Class III
- B. Class II, Groups F and G
- C. Class II, Group H
- D. Class II, Group E

(NEW) 514.3(B)(d) Aboveground tanks storing CNG, LNG, or LP-Gas shall be separated from each other by at least 6 m (20 ft) and from dispensing devices that dispense liquid or gaseous motor vehicle fuels by at least 6 m (20 ft).

Exception No. 1: The required separation shall not apply to tanks or dispensers storing or handling fuels of the same chemical composition.

Exception No. 2: The required separation shall not apply when both the gaseous fuel storage and dispensing equipment are at least 15 m (50 ft) from any other aboveground motor fuel storage or dispensing equipment.

Informational Note: For further information, see NFPA 52-2013, Vehicular Gaseous Fuel Systems Code, or NFPA 58-2014, Liquefied Petroleum Gas Code, as applicable.

(NEW) 514.3(B)(e) Dispenser Installations Beneath Canopies. Where CNG or LNG dispensers are installed beneath a canopy or enclosure, either the canopy or enclosure shall be designed to prevent accumulation or entrapment of ignitable vapors or all electrical equipment installed beneath the canopy or enclosure shall be suitable for Class I, Division 2 hazardous (classified) locations.

(NEW) 514.3(B)(f) Specific Requirements for LP-Gas Dispensing Devices. Dispensing devices for LP-Gas shall be located as follows:

- (1) At least 3 m (10 ft) from any dispensing device for Class I liquids
- (2) At least 1.5 m (5 ft) from any dispensing device for Class I liquids where the following conditions exist:
 - a. The LP-Gas deliver nozzle and filler valve release no more than 4 cm³ (0.1 oz) of liquid upon disconnection.
 - b. The fixed maximum liquid level gauge remains closed during the entire refueling process.

Table 514.3(B)(2) shall be used to delineate and classify areas for the purpose of installation of electrical wiring and electrical utilization equipment.



(Revised) 514.11 (A) Emergency Electrical Disconnects. Fuel dispensing systems shall be provided with one or more clearly identified emergency shutoff devices or electrical disconnects. Such devices or disconnects shall be installed in approved locations but not less than 6 m (20 ft) or more than 30 m (100 ft) from the fuel dispensing devices that they serve. Emergency shutoff devices or electrical disconnects shall disconnect power to all dispensing devices; to all remote pumps serving the dispensing devices; to all associated power, control, and signal circuits; and to all other electrical equipment in the hazardous (classified) locations surrounding the fuel dispensing devices. When more than one emergency shutoff device or electrical disconnect is provided, all devices shall be interconnected. Resetting from an emergency shutoff condition shall require manual intervention and the manner of resetting shall be approved by the authority having jurisdiction.

(NEW) 517.2 Governing Body. The person or persons who have the overall legal responsibility for the operation of a health care facility.

(NEW) 517.2 Support (Category 4) Space. Space in which failure of equipment or a system is not likely to have a physical impact on patient care.

(Revised) 517.19 (1) Minimum Number and Supply. Each operating room shall be provided with a minimum of 36 receptacles divided between at least two branch circuits. At least 12 receptacles, but no more than 24, shall be connected to either of the following:

- (1) The normal system branch circuit required in 517.19(A)
- (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same location

(Revised) 517.19 (F) Additional Protective Techniques in Critical Care (Category 1) Spaces (Optional). Isolated power systems shall be permitted to be used for critical care (Category 1) spaces, and, if used, the isolated power system equipment shall be listed as isolated power equipment. The isolated power system shall be designed and installed in accordance with 517.160.



PART 2 EXAM QUESTIONS

127. What type of location is an LNG dispenser installed beneath a canopy required to be suitable for?
 - A. Class III, Division
 - B. Class II, Division 2
 - C. Class I, Division 2
 - D. Class II, Division 1
128. What is the minimum number of receptacles required for an operating room?
 - A. 24
 - B. 36
 - C. 12
 - D. 30
129. An aboveground storage tank that has LP-Gas must be separated by what distance from CNG aboveground motor fuel storage or dispensing equipment?
 - A. 20ft
 - B. 100 ft
 - C. 50 ft
 - D. 10 ft
130. Who has the overall legal responsibility for the operation of a health care facility?
 - A. Governing Body
 - B. Administrator
 - C. Board of directors
 - D. Quality of care committee

131. What is the minimum distance from fuel dispensing systems that an emergency shutoff device must be installed?

- A. 10 ft
- B. 100 ft
- C. 50 ft
- D. 20ft

132. In general, how far from a Class I liquid are dispensing devices for LP-Gas required to be installed?

- A. 100 ft
- B. 10ft
- C. 50 ft
- D. 20 ft

133. What type of category is a critical care space?

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

134. What is the maximum distance from fuel dispensing systems that an emergency shutoff device can be installed?

- A. 10 ft
- B. 20 ft
- C. 50 ft
- D. 100ft

135. The type of space in which the failure of equipment or a system is not likely to have a physical impact on patient care is best defined as?

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

(NEW) 517.29 (B) Critical care (Category 1) spaces shall be served only by a Type 1 essential electrical system.

(NEW) 517.40 Informational Note:

Nursing homes and other limited care facilities can be classified as critical care (Category 1) or general care (Category 2) patient care space depending on the design and type of care administered in the facility. For small, less complex facilities, only minimal alternate lighting and alarm service may be required. At

nursing homes and other limited care facilities where patients are not sustained by electrical life support equipment or inpatient hospital care the requirements of 517.40 through 517.41 apply. If the level of care is comparable to that provided in a hospital, see the essential electrical system requirements of 517.29 through 517.30.



(Revised) 517.43(E) Dining and Recreation Areas. Sufficient lighting in dining and recreation areas to provide illumination to exit ways at a minimum of 5 ft-candles.

(NEW) 520.2 Adapter. A device used to adapt a circuit from one configuration of an attachment plug or receptacle to another configuration with the same current rating.

(NEW) 520.2 Stage Switchboard, Portable. A portable rack or pack containing dimmers or relays with associated overcurrent protective devices, or overcurrent protective devices alone that are used to feed stage equipment.

(Revised) 520.53 Construction. Portable stage switchboards shall be listed and shall comply with 520.53(A) through (E). (A) Pilot Light. A pilot light shall be provided for each ungrounded conductor feeding the switchboard. The pilot light(s) shall be connected to the incoming feeder so that operation of the main overcurrent protective device or master switch shall not affect the operation of the pilot light(s).

(NEW) 520.54 (B) Conductor Sizing. The power supply conductors for portable stage switchboards utilizing solid-state phase control dimmers shall be sized considering the neutral conductor as a current-carrying conductor for ampacity adjustment purposes. The power supply conductors for portable stage switchboards utilizing only solid-state sine wave dimmers shall be sized considering the neutral conductor as a non-current carrying conductor for ampacity adjustment purposes.

(Revised) 520.54 (J) Supply Neutral Conductor. Supply neutral conductors shall comply with (1) and (2) below:

(1) Marking. Grounded neutral conductors shall be permitted to be identified by marking at least the first 150 mm (6 in.) from both ends of each length of conductor with white or gray.

(2) Conductor Sizing. Where single-conductor feeder cables not installed in raceways are used on multiphase circuits feeding portable stage switchboards containing solid-state phasecontrol dimmers, the grounded neutral conductor shall have an ampacity of at least 130 percent of the ungrounded circuit conductors feeding the portable stage switchboard. Where such feeders are supplying only solid-state sine wave dimmers, the grounded neutral conductor shall have an ampacity of at least 100 percent of the ungrounded circuit conductors feeding the portable stage switchboard.

(NEW) 520.62 (F) Single-Conductor Feeders. Portable power distribution equipment fed by single-conductor feeder systems shall comply with 520.53(C) and (D) and 520.54.

(Revised) 550.2 Manufactured Home. A structure, transportable in one or more sections, which in the traveling mode is 2.4 m (8 ft) or more in width or 12.2 m (40 ft) or more in length, or when erected on site is 29.77 m² (320 ft²) or more is built on a permanent chassis and is designed to be used as a dwelling with or without a permanent foundation, whether or not connected to the utilities, and includes plumbing, heating, air conditioning, and electrical systems contained therein. The term manufactured home includes any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency. Calculations used to determine the number of square meters (square feet) in a structure are based on the structure's exterior dimensions and include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows. For the purpose of this Code and unless otherwise indicated, the term mobile home includes manufactured homes and excludes park trailers defined in Article 552.4.



PART 2 EXAM QUESTIONS

136. What is a device used to adapt a circuit from one configuration of an attachment plug or receptacle to another configuration with the same current rating?

- A. Adapter
- B. Splitter
- C. Spearman rank order correlation coefficient
- D. Extension cord

137. What type of category is a general care space?

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

138. What is the minimum length when transported that a structure could be considered a manufactured home?
- A. 32 ft
 - B. 30 ft
 - C. 40 ft
 - D. 8 ft
139. What is the minimum required illumination from dining rooms to exit ways with regards to health care facilities?
- A. 7 ft-candles
 - B. 2 ft-candles
 - C. 10 ft-candles
 - D. 5 ft-candles
140. How many sections are single-conductor feeder systems that power portable power distribution equipment required to comply with?
- A. 3
 - B. 4
 - C. 2
 - D. 5
141. What is a portable rack containing relays with their associated overcurrent protective devices used to feed stage equipment?
- A. Switchboard Stage, Portable
 - B. Stage Switchboard, Portable
 - C. Stage switch system, System portable
 - D. Switchboard stage, Portable system
142. What type of electrical system is required for a critical care area?
- A. Type 3 Life safety electrical system
 - B. Type 2 isolated electrical system
 - C. Type 1 critical electrical system
 - D. Type 1 essential electrical system
143. What is each ungrounded conductor feeding a portable stage switchboard required to be equipped with?
- A. A rheostat
 - B. A pilot light
 - C. A quick disconnect
 - D. A current transformer
144. How should the supply neutral conductors for portable stage switchboards be identified?
- A. With 3 white or gray stripes at each end
 - B. With a pilot light
 - C. With 6 inches of white or gray phase tape at each end
 - D. All listed answers
145. What conductor is required to be used for ampacity adjustment purposes regarding the branch circuit feeding a portable stage switchboard utilizing only solid-state sine wave dimmers?
- A. The power supply conductors and neutral
 - B. The power supply conductors
 - C. The neutral conductor only
 - D. There are no ampacity adjustments required for portable stage switchboards

(Revised) 550.25 (B) Mobile Homes and Manufactured Homes. All 120-volt branch circuits that supply 15- and 20-ampere outlets shall comply with 210.12.

(Revised) 551.71 (C) 50-Ampere. A minimum of 20 percent of existing and 40 percent of all new recreational vehicle sites, with electrical supply, shall each be equipped with a 50-ampere, 125/250-volt receptacle conforming to the configuration as identified in Figure 551.46(C)(1). Every recreational vehicle site equipped with a 50-ampere receptacle shall also be equipped with a 30-ampere, 125-volt receptacle conforming to Figure 551.46(C)(1). These electrical supplies shall be permitted to include additional receptacles that have configurations in accordance with 551.81.

(NEW) 551.72 (A) Systems. Distribution systems shall provide the voltage and have a capacity for the receptacles provided in the recreational vehicle (RV) site supply equipment as calculated according to 551.73 and shall have an ampacity not less than 30 amperes. Systems permitted include 120 volts, 1-phase; 120/240 volts, 1-phase; and 120/208 volts, 1-phase.



(NEW) 552.5 Park trailer Labels. Labels required by Article 552 shall be made of etched, metal-stamped, or embossed brass or stainless steel; plastic laminates not less than 0.13 mm (0.005 in.) thick; or anodized or al clad aluminum not less than 0.5 mm (0.020 in.) thick or the equivalent.

(Revised) 552.44(D) Labeling at Electrical Entrance. Each park trailer shall have a safety label with the signal word WARNING in minimum 6 mm (1/4 in.) high letters and body text in minimum 3 mm (1/8 in.) high letters on a contrasting background. The safety label shall be affixed to the exterior skin, at or near the point of entrance of the power-supply assembly and shall read, as appropriate:

THIS CONNECTION IS FOR 110–125-VOLT AC, 60 HZ, 30 AMPERE SUPPLY
or

THIS CONNECTION IS FOR 208Y/120-VOLT OR 120/240- VOLT AC, 3-POLE, 4-WIRE, 60 HZ, _____ AMPERE SUPPLY.
followed by

DO NOT EXCEED THE CIRCUIT RATING. EXCEEDING THE CIRCUIT RATING MAY CAUSE A FIRE AND RESULT IN DEATH OR SERIOUS INJURY.

(Revised) 555.3 Ground-Fault Protection. The overcurrent protective devices that supply the marina, boatyards, and commercial and noncommercial docking facilities shall have ground-fault protection not exceeding 30 mA.

(NEW) 555.24 Signage. Permanent safety signs shall be installed to give notice of electrical shock hazard risks to persons using or swimming near a boat dock or marina and shall comply with all of the following:

- (1) The signage shall comply with 110.21(B)(1) and be of sufficient durability to withstand the environment.
- (2) The signs shall be clearly visible from all approaches to a marina or boatyard facility.
- (3) The signs shall state “WARNING — POTENTIAL SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER.”

(Revised) 600.1 Scope. This article covers the installation of conductors, equipment, and field wiring for electric signs, retrofit kits, and outline lighting, regardless of voltage. All installations and equipment using neon tubing, such as signs, decorative elements, skeleton tubing, or art forms, are covered by this article.

(NEW) 600.2 Photovoltaic (PV) Powered Sign. A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system.



PART 2 EXAM QUESTIONS

146. If an RV park has a 50-ampere receptacle at each recreational vehicle site, what other receptacle, if any, should be installed?

- A. 40 amp
- B. 15 amp
- C. 20 amp
- D. 30 amp

147. What section are the branch circuits that supply 15- and 20-ampere outlets in manufactured homes required to comply with?

- A. 215.12
- B. 220.10
- C. 210.12
- D. 210.15

148. A plastic laminate park trailer label is required to have what minimum thickness?
- 0.020 in.
 - 0.005 in.
 - .5 in.
 - 0.050 in.
149. Recreational vehicle site supply equipment distribution systems are calculated as per what listed section?
- 551.77
 - 551.72 (B)
 - 551.71 (C)
 - 551.73
150. What is the maximum current of ground fault protection allowed that supply the overcurrent protective devices in a marina?
- 10 mA
 - 20 mA
 - 30 mA
 - 40 mA
151. At what height are the letters on each park trailer safety label with the signal word WARNING required to be?
- 3/8 in.
 - 1/4 in.
 - 1/8 in.
 - 3/4 in.
152. What listed term best defines a complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system?
- Induction (IP) Powered Sign
 - Turbine (TB) Powered Sign
 - Battery (BP) Powered Sign
 - Photovoltaic (PV) Powered Sign
153. What article should be referenced for the installation of skeleton tubing and equipment?
- 724
 - 604
 - 555
 - 600
154. What is the permanent safety sign that gives notice of an electrical shock hazard risk to persons using or swimming near a boat marina?
- "WARNING — SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER."
 - "WARNING — POTENTIAL SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER."
 - "WARNING — POTENTIAL HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER."
 - "WARNING — POTENTIAL SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT."

(NEW) 600.4 (B) Signs with a Retrofitted Illumination System.

- The retrofitted sign shall be marked that the illumination system has been replaced.
- The marking shall include the kit provider's and installer's name, logo, or unique identifier.
- Signs equipped with tubular light-emitting diode lamps powered by the existing sign sockets shall include a label alerting the service personnel that the sign has been modified. The label shall meet the requirements of 110.21(B). The label shall also include a warning not to install fluorescent lamps and shall also be visible during re-lamping.

(Revised) 600.24 (B) Grounding. Metal parts of Class 2 power supplies and power sources shall be grounded by connecting to the equipment grounding conductor.

(NEW) 604.6 Listing Requirements. Manufactured wiring systems and associated components shall be listed.



(Revised) 605.9 (C) Receptacle, Maximum. An individual office furnishing or groups of interconnected individual office furnishings shall not contain more than 13 15-ampere, 125-volt receptacles. For purposes of this requirement, a receptacle is considered (1) up to two (simplex) receptacles provided within a single enclosure and that are within 0.3 m (1 ft) of each other or (2) one duplex receptacle.

(Revised) 620.11 (A) Hoistway Door Interlock Wiring. The conductors to the hoistway door interlocks from the hoistway riser shall be one of the following:

- (1) Flame retardant and suitable for a temperature of not less than 200°C (392°F). Conductors shall be Type SF or equivalent.
- (2) Physically protected using an approved method, such that the conductor assembly is flame retardant and suitable for a temperature of not less than 200°C (392°F).

(Revised) 620.23 (A) Separate Branch Circuits. The branch circuit(s) supplying the lighting for machine rooms, control rooms, machinery spaces, or control spaces shall be separate from the branch circuit(s) supplying the receptacle(s) in those places. These circuits shall supply no other loads.

(NEW) 620.51(D)(2) Available Short-Circuit Current Field Marking. Where an elevator control panel is used, it shall be legibly marked in the field with the maximum available short-circuit current at its line terminals. The field marking(s) shall include the date the short-circuit current calculation was performed and be of sufficient durability to withstand the environment involved. When modifications to the electrical installation occur that affect the maximum available short-circuit current at the elevator control panel, the maximum available short-circuit current shall be verified or recalculated as necessary to ensure the elevator control panel's short-circuit current rating is sufficient for the maximum available short-circuit current at the line terminals of the equipment. The required field marking(s) shall be adjusted to reflect the new level of maximum available short-circuit current.

(NEW) 620.51(E) Surge Protection. Where any of the disconnecting means in 620.51 has been designated as supplying an emergency system load, surge protection shall be provided.

(Revised) 625.1 Scope. This article covers the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive, inductive, or wireless power transfer (contactless inductive charging) means, and the installation of equipment and devices related to electric vehicle charging.

(Revised) 625.2 Cable Management System. An apparatus designed to control and organize the output cable to the electric vehicle or to the primary pad.

(NEW) 625.2 Charger Power Converter. The device used to convert energy from the power grid to a high-frequency output for wireless power transfer.

(NEW) 625.2 Fastened in Place. Mounting means of an EVSE in which the fastening means are specifically designed to permit periodic removal for relocation, interchangeability, maintenance, or repair without the use of a tool.



PART 2 EXAM QUESTIONS

- 155. What listed term is the mounting means of an EVSE in which the fastening means are specifically designed to permit periodic removal for relocation, interchangeability, maintenance, or repair without the use of a tool?**
- A. Charger Power Converter
 - B. Fixed in Place
 - C. Cable Management System
 - D. Fastened in Place
- 156. What is the disconnect that supplies an emergency system load as designated in 620.51 required to be provided with?**
- A. Cartridge fuses
 - B. Edison fuses
 - C. Surge protection
 - D. Thermal overloads
- 157. What are manufactured wiring systems and associated components required to be?**
- A. Guarded
 - B. Listed
 - C. Readily accessible
 - D. Accessible
- 158. What type of branch circuit is required to power the lighting for a machine room?**
- A. 20 amp
 - B. Dedicated
 - C. 15 amp
 - D. 277 volt
- 159. What is the minimum temperature protection for conductors to a hoistway door interlock from a hoistway riser required to be?**
- A. 100°C
 - B. 392°C
 - C. 200°C
 - D. 200°F
- 160. Where is the maximum available short-circuit current required to be marked when using an elevator control panel?**
- A. At the fire alarm control panel (FACP)
 - B. On the elevator equipment room door
 - C. At the service disconnect
 - D. At its line terminals
- 161. What device is used to convert energy from the power grid to a high-frequency output for wireless power transfer?**
- A. Cable Management System
 - B. Fixed in Place
 - C. Charger Power Converter
 - D. Fastened in Place
- 162. What article applies to electric vehicle charging?**
- A. 625
 - B. 620
 - C. 680
 - D. 630
- 163. What is the maximum number of 15 amp receptacles allowed to be installed in interconnected individual office furnishings?**
- A. 5
 - B. 10
 - C. 13
 - D. There are no limits
- 164. What listed term describes an apparatus designed to control and organize the output cable to the electric vehicle or to the primary pad?**
- A. Fixed in Place
 - B. Cable Management System
 - C. Charger Power Converter
 - D. Fastened in Place
- 165. Where are the metal parts of Class 2 power supplies used in electric signs required to be connected?**
- A. Equipment grounding conductor
 - B. Grounded conductor
 - C. Grounding electrode conductor
 - D. Building steel
- 166. The label affixed to a retrofitted sign is required to meet the requirements of what listed section?**
- A. 110.25
 - B. 210.12
 - C. 555.3
 - D. 110.21(B)

(NEW) 625.2 Fixed in Place. Mounting means of an EVSE attached to a wall or surface with fasteners that require a tool to be removed.

(NEW) 625.2 Output Cable to the Primary Pad. A multi-conductor, shielded cable assembly consisting of conductors to carry the high-frequency energy and any status signals between the charger power converter and the primary pad.

(NEW) 625.2 Portable (as applied to EVSE). A device intended for indoor or outdoor use that can be carried from charging location to charging location and is designed to be transported in the vehicle when not in use.

(NEW) 625.2 Primary Pad. A device external to the EV that provides power via the contactless coupling and may include the charger power converter.

(NEW) 625.2 Wireless Power Transfer (WPT). The transfer of electrical energy from a power source to an electrical load via electric and magnetic fields or waves by a contactless inductive means between a primary and a secondary device.

(NEW) 625.2 Wireless Power Transfer Equipment (WPTE). Equipment consisting of a charger power converter and a primary pad. The two devices are either separate units or contained within one enclosure.

(Revised) 625.50 Location. The electric vehicle supply equipment shall be located for direct electrical coupling of the EV connector (conductive or inductive) to the electric vehicle. Unless specifically listed and marked for the location, the coupling means of the electric vehicle supply equipment shall be stored or located at a height of not less than 450 mm (18 in.) above the floor level for indoor locations or 600 mm (24 in.) above the grade level for outdoor locations. This requirement does not apply to portable electric vehicle supply equipment constructed in accordance with 625.44(A).

(Revised) 630.31 Ampacity of Supply Conductors. The ampacity of the supply conductors for resistance welders shall be in accordance with 630.31(A) and (B).

(Revised) 640.3 (B) Ducts, Plenums, and Other Air-Handling Spaces. Section 300.22(B) shall apply to circuits and equipment installed in ducts specifically fabricated for environmental air. Section 300.22(C) shall apply to circuits and equipment installed in other spaces used for environmental air (plenums).

(NEW) 640.21(C) Informational Note: See 770.3 for the classification of composite optical fiber cables.

(Revised) 640.42 (C) Between Equipment and/or Between Equipment Racks. Installation of flexible cords and cables used for the distribution of audio signals between equipment shall comply with Parts I and II of Article 400 and Parts I, II, and III of Article 725, respectively. Cords and cables listed for portable use, either hard or extra-hard service as defined by Article 400, shall also be permitted. Other listed cable types and assemblies, including optional hybrid communications, signal, and composite optical fiber cables, shall be permitted.

645.3 (E) Fire Alarm Cables and Equipment. Parts I, II, and III of Article 760 shall apply to fire alarm



systems cables and equipment installed in an information technology equipment room. Only fire alarm cables listed in accordance with Part IV of Article 760 and listed fire alarm equipment shall be permitted to be installed in an information technology equipment room.

(NEW) 645.3 (H) Optical Fiber Cables. Only optical fiber cables listed in accordance with 770.179 shall be permitted to be installed in an information technology equipment room.

PART 2 EXAM QUESTIONS

167. How many provisions are required to be followed when determining the ampacity of supply conductors for resistance welders?
- A. 2
 - B. 3
 - C. 4
 - D. 1
168. What is a device external to the EV that provides power via the contactless coupling and may include the charger power converter?
- A. Portable (as applied to EVSE)
 - B. Output Cable to the Primary Pad
 - C. Primary Pad
 - D. Wireless Power Transfer (WPT)
169. What is a multi-conductor, shielded cable assembly consisting of conductors to carry the high-frequency energy and any status signals between the charger power converter and the primary pad?
- A. Wireless Power Transfer (WPT)
 - B. Portable (as applied to EVSE)
 - C. Primary Pad
 - D. Output Cable to the Primary Pad
170. What term embodies the transfer of electrical energy from a power source to an electrical load via electric and magnetic fields or waves by a contactless inductive means between a primary and a secondary device?
- A. Output Cable to the Primary Pad
 - B. Wireless Power Transfer (WPT)
 - C. Portable (as applied to EVSE)
 - D. Wireless Power Transfer Equipment (WPTE)
171. The mounting means of an EVSE attached to a surface with fasteners that require a tool to be removed best describes what term?
- A. Fixed in Place
 - B. Fastened in Place
 - C. Cable Management System
 - D. Charger Power Converter
172. What is the minimum outdoor height above finish grade that the coupling means of electric vehicle supply equipment is required to be installed?
- A. 36 inches
 - B. 18 inches
 - C. 30 inches
 - D. 24 inches
173. What part(s) of Article 400 is the installation of flexible cords and cables used for the distribution of audio signals between equipment required to comply with?
- A. IV
 - B. I, II, and III
 - C. I and II
 - D. V and VI
174. What section applies to circuits and equipment installed in ducts specifically fabricated for environmental air?
- A. 300.22(C)
 - B. 300.22(B)
 - C. 310.15(C)
 - D. 310.15(B)
175. What part of Article 760 applies to fire alarm systems cables and equipment installed in an information technology equipment room?
- A. V and VI
 - B. I and II
 - C. IV
 - D. I, II, and III
176. What section applies to circuits and equipment installed in other spaces used for environmental air (plenums)?
- A. 300.22(C)
 - B. 300.22(B)
 - C. 310.15(C)
 - D. 310.15(B)

177. What section must be referenced to determine if specific optical fiber cables can be installed in an information technology equipment room?

- A. 770.3
- B. 770.179
- C. 300.22(B)
- D. 800.32

178. What section should be referenced to determine the classification of composite optical fiber cables?

- A. 300.22(B)
- B. 770.179
- C. 770.3
- D. 800.32

179. What term matches equipment consisting of a charger power converter and a primary pad where the two devices are in either separate units or contained within one enclosure?

- A. Wireless Power Transfer (WPT)
- B. Output Cable to the Primary Pad
- C. Portable (as applied to EVSE)
- D. Wireless Power Transfer Equipment (WPTE)

180. The description of a device intended for indoor or outdoor use that can be carried from charging location to charging location and is designed to be transported in the vehicle when not in use matches what listed term?

- A. Primary Pad
- B. Output Cable to the Primary Pad
- C. Portable (as applied to EVSE)
- D. Wireless Power Transfer (WPT)

(NEW) 645.5 (E)(2) Installation Requirements for Electrical Supply Cords, Data Cables, Interconnecting Cables, and Grounding Conductors Under a Raised Floor. The following cords, cables, and conductors shall be permitted to be installed under a raised floor:

- (1) Supply cords of listed information technology equipment in accordance with 645.5(B).
- (2) Interconnecting cables enclosed in a raceway.
- (3) Equipment grounding conductors.
- (4) In addition to wiring installed in compliance with 725.135(C), Types CL2R, CL3R, CL2, and CL3 and substitute cables including CMP, CMR, CM, and CMG installed in accordance with 725.154(A), shall be permitted under raised floors.

Informational Note: Figure 725.154(A) illustrates the cable substitution hierarchy for Class 2 and Class 3 cables.

- (5) Listed Type DP cable having adequate fire-resistant characteristics suitable for use under raised floors of an information technology equipment room.

(NEW) 645.5 (E)(3) Installation Requirements for Optical Fiber Cables Under a Raised Floor. In addition to optical fiber cables installed in accordance with 770.113(C), Types OFNR, OFCR, OFN, and OFC shall be permitted under raised floors.

- (F) Securing in Place. Power cables; communications cables, connecting cables, interconnecting cables, and associated boxes, connectors, plugs, and receptacles that are listed as part of, or for, information technology equipment shall not be required to be secured in place where installed under raised floors.

Informational Note: Securement requirements for raceways and cables not listed as part of, or for, information technology equipment are found in 300.11.



(Revised) 646.3 (E) Fire Alarm Equipment. Parts I, II, and III of Article 760 shall apply to fire alarm systems, cables, and equipment installed in an MDC, where provided. Only fire alarm cables listed in accordance with Part IV of Article 760 and listed fire alarm equipment shall be permitted to be installed in an MDC.

(Revised) 646.3 (F) Cable Routing Assemblies and Communications Wires, Cables, Raceways, and Equipment. Parts I, II, III, IV, and V of Article 800 shall apply to cable routing assemblies, communications wires, cables, raceways, and equipment installed in an MDC. Only communications wires and cables listed in accordance with 800.179, cable routing assemblies and communications raceways listed in accordance with 800.182, and communications equipment listed in accordance with 800.170 shall be permitted to be installed in an MDC.

(Revised) 646.3(G) Community Antenna Television and Radio Distribution Systems Cables and Equipment. Parts I, II, III, IV, and V of Article 820 shall apply to community antenna television and radio distribution systems equipment installed in an MDC. Only community antenna television and radio distribution cables listed in accordance with 820.179 and listed CATV equipment shall be permitted to be installed in an MDC.

(Revised) 650.1 Scope. This article covers those electrical circuits and parts of electrically operated pipe organs that are employed for the control of the keyboards and of the sounding apparatus, typically organ pipes.

(NEW) 650.2 Electronic Organ. A musical instrument that imitates the sound of a pipe organ by producing sound electronically.

(Revised) 668.11 (B) Metal Enclosures Grounded. All metal enclosures of power-supply apparatus for the direct-current cell line process operating with a power supply over 50 volts shall be grounded by either of the following means:

- (1) Through protective relaying equipment
- (2) By a minimum 2/0 AWG copper grounding conductor or a conductor of equal or greater conductance



(Revised) 670.5(1) Industrial machinery shall not be installed where the available short-circuit current exceeds its short-circuit current rating as marked in accordance with 670.3(A)(4).

(NEW) 670.5 (2) Industrial machinery shall be legibly marked in the field with the maximum available short-circuit current. The field marking(s) shall include the date the short-circuit current calculation was performed and be of sufficient durability to withstand the environment involved.

PART 2 EXAM QUESTIONS

181. How close to a box under a raised floor does communication cable need to be secured?

- A. Within 15 inches
- B. Communication cable installed under a raised floor does not need to be secured
- C. 12 inches
- D. No less than 24 inches

182. What figure in the 2017 code illustrates the cable substitution hierarchy for Class 2 and Class 3 cables?

- A. 725.135(C)
- B. 725.154(A)
- C. 770.179
- D. 300.22(C)

183. What part of Article 760 is required to be referenced for the only type of fire alarm cable permitted in a Modular Data Center (MDC)?
- I
 - III
 - II
 - IV
184. What is required to be listed on the field marking regarding industrial machinery and its short-circuit current calculation?
- The person who did the calculation
 - The time of the calculation
 - The date of the calculation
 - All listed answers
185. What article applies to a radio distribution systems equipment installed in an MDC?
- 800
 - 720
 - 760
 - 820
186. What article applies to 3/4 inch EMT installed in a modular data center (MDC) with communications wires inside the raceway?
- 720
 - 800
 - 760
 - 820
187. What article should be referenced if performing work on a pipe organ?
- 645
 - 820
 - 650
 - 646
188. What size copper grounding conductor needs to ground all metal enclosures that deal with direct-current cell line process power-supply conductors or equipment operating at 60 volts dc?
- 1/0 AWG
 - 2/0 AWG
 - 3/0 AWG
 - 4/0 AWG
189. What is a musical instrument that imitates the sound of a pipe organ by producing sound electronically?
- Synthesizing array, Electronic
 - Electric forced air organ
 - Steam powered organ
 - Electronic organ
190. What must be done if a newly arrived piece of industrial equipment's short-circuit current exceeds its short-circuit current rating?
- Use adjustable electronic heaters and adjust the ratings to match
 - Install an inline disconnect that matches the short-circuit current rating
 - Do not install the equipment
 - All listed answers

(NEW) 670.6 Surge Protection. Industrial machinery with safety interlock circuits shall have surge protection installed.

(NEW) 680.2 Electrically Powered Pool Lift. An electrically powered lift that provides accessibility to and from a pool or spa for people with disabilities.

(Revised) 680.2 Storable Swimming, Wading, or Immersion Pools; or Storable/

Portable Spas and Hot Tubs. Swimming, wading, or immersion pools that are intended to be stored when not in use, constructed on or above the ground and are capable of holding water to a maximum depth of 1.0 m (42 in.), or a pool, spa,



or hot tub constructed on or above the ground, with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension.

(NEW) 680.7 Grounding and Bonding Terminals. Grounding and bonding terminals shall be identified for use in wet and corrosive environments. Field-installed grounding and bonding connections in a damp, wet, or corrosive environment shall be composed of copper, copper alloy, or stainless steel. They shall be listed for direct burial use.

(NEW) 680.14 (A) General. Areas where pool sanitation chemicals are stored, as well as areas with circulation pumps, automatic chlorinators, filters, open areas under decks adjacent to or abutting the pool structure, and similar locations shall be considered to be a corrosive environment. The air in such areas shall be considered to be laden with acid, chlorine, and bromine vapors, or any combination of acid, chlorine, or bromine vapors, and any liquids or condensation in those areas shall be considered to be laden with acids, chlorine, and bromine vapors, or any combination of acid, chlorine, or bromine vapors.

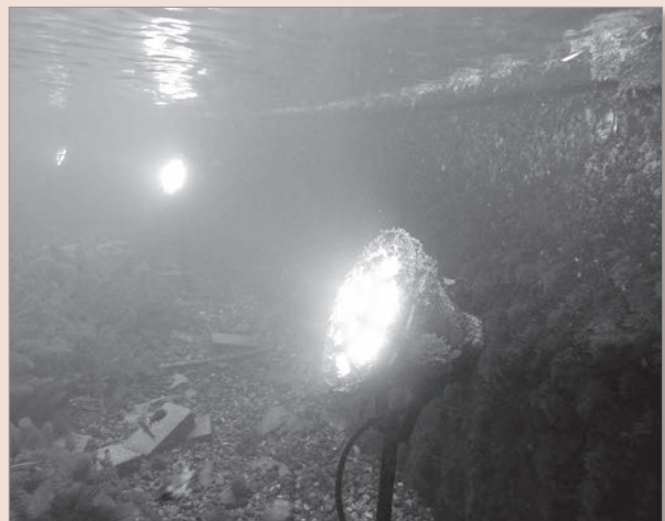
(Revised) 680.22 (2) Circulation and Sanitation System, Location. Receptacles that provide power for water-pump motors or for other loads directly related to the circulation and sanitation system shall be located at least 1.83 m (6 ft) from the inside walls of the pool. These receptacles shall have GFCI protection and be of the grounding type.

(NEW) 680.22 (B)(7) Low-Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits, and Similar Equipment. Listed low-voltage gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment using low-voltage ignitors that do not require grounding, and are supplied by listed transformers or power supplies that comply with 680.23(A)(2) with outputs that do not exceed the low-voltage contact limit shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of the pool. Metallic equipment shall be bonded in accordance with the requirements in 680.26(B). Transformers or power supplies supplying this type of equipment shall be installed in accordance with the requirements in 680.24. Metallic gas piping shall be bonded in accordance with the requirements in 250.104(B) and 680.26(B)(7).

(Revised) 680.23 (F)(1) Wiring Methods. Where branch-circuit wiring on the supply side of enclosures and junction boxes connected to conduits run to underwater luminaires are installed in corrosive environments as described in 680.14, the wiring method of that portion of the branch circuit shall be as required in 680.14(B) or shall be liquid-tight flexible nonmetallic conduit. Wiring methods installed in corrosive environments as described in 680.14 shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122, but not smaller than 12 AWG. Where installed in noncorrosive environments, branch circuits shall comply with the general requirements in Chapter 3.

(Revised) 680.25(A) Feeders. Where feeders are installed in corrosive environments as described in 680.14, the wiring method of that portion of the feeder shall be as required in 680.14(B) or shall be liquidtight flexible nonmetallic conduit. Wiring methods installed in corrosive environments as described in 680.14 shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122, but not smaller than 12 AWG. Where installed in noncorrosive environments, feeders shall comply with the general requirements in Chapter 3.

(NEW) 680.28 Gas-Fired Water Heater. Circuits serving gas-fired swimming pool and spa water heaters operating at voltages above the low-voltage contact limit shall be provided with ground-fault circuit-interrupter protection for personnel.



PART 2 EXAM QUESTIONS

- 191. What term best describes an electrically powered lift that provides accessibility to and from a pool or spa for people with disabilities?**
- Powered Pool Lift, Electronic
 - Electronically Powered Pool Lift
 - Powered Pool Lift, Electric
 - Electrically Powered Pool Lift
- 192. What is industrial machinery with safety interlock circuits required to have installed?**
- Surge protection
 - Resistor banks for load breaking
 - In line capacitors
 - An induction array
- 193. What is a grounding terminal installed in the wet and corrosive environment around a pool required to be listed for?**
- Direct burial
 - Hard usage
 - Moisture resistance
 - All listed answers
- 194. What maximum depth is listed for a nonmetallic pool to still be considered storable?**
- 48 inches
 - 46 inches
 - 42 inches
 - 40 inches
- 195. How far from the inside wall of a pool are receptacles that power water-pump motors for the sanitation system required to be?**
- 4 ft
 - 6 ft
 - 5 ft
 - 10 ft
- 196. What type of environment is the storage of pool chemicals considered?**
- Particulate hazard
 - Class 1 division 1
 - Combustible
 - Corrosive
- 197. What is the smallest insulated copper equipment grounding conductor that can be installed to comply with 680.14?**
- 12 AWG
 - 10 AWG
 - 14 AWG
 - 8 AWG
- 198. How far from the inside wall of a pool can a fire pit using low-voltage ignitors not requiring grounding supplied by a listed power supply be installed?**
- 4 ft
 - 5 ft
 - 6 ft
 - 10 ft
- 199. What are circuits serving gas-fired spa water heaters operating at voltages above the low-voltage contact limit required to be provided with?**
- Ground-fault circuit-interrupter
 - Arc-fault circuit-interrupter
 - Fused disconnects
 - Bi-metal overloads
- 200. What table is required to be used to size equipment grounding conductors?**
- 250.103(A)
 - 250.66
 - 250.102(D)
 - 250.122

(Revised) 682.15 Ground-Fault Circuit-Interrupter (GFCI) Protection. Fifteen- and 20-ampere single-phase, 125-volt through 250-volt receptacles installed outdoors and in or on floating buildings or structures within the electrical datum plane area shall be provided with GFCI protection for personnel. The GFCI protection device shall be located not less than 300 mm (12 in.) above the established electrical datum plane.

(Revised) 690.2 Array. A mechanically integrated assembly of module(s) or panel(s) with a support structure and foundation, tracker, and other components, as required, to form a dc or ac power producing unit.

(Revised) 690.2 Bipolar Photovoltaic Array. A dc PV array that has two outputs, each having opposite polarity to a common reference point or center tap.

(NEW) 690.2 DC-to-DC Converter Output Circuit. Circuit conductors between the dc-to-dc converter source circuit(s) and the inverter or dc utilization equipment.

(NEW) 690.2 DC-to-DC Converter Source Circuit. Circuits between dc-to-dc converters and from dc-to-dc converters to the common connection point(s) of the dc system.

(NEW) 690.2 Generating Capacity. The sum of parallel-connected inverter maximum continuous output power at 40°C in kilowatts.

(NEW) 690.2 Interactive Inverter Output Circuit. The conductors between the interactive inverter and the service equipment or another electrical power production and distribution network.

(Revised) 690.2 Inverter Input Circuit. Conductors connected to the dc input of an inverter.

(Revised) 690.2 Inverter Output Circuit. Conductors connected to the ac output of an inverter.

690.7 Maximum Voltage. The maximum voltage of PV system dc circuits shall be the highest voltage between any two circuit conductors or any conductor and ground. PV system dc circuits on or in one- and two-family dwellings shall be permitted to have a maximum voltage of 600 volts or less. PV system dc circuits on or in other types of buildings shall be permitted to have a maximum voltage of 1000 volts or less. Where not located on or in buildings, listed dc PV equipment, rated at a maximum voltage of 1500 volts or less, shall not be required to comply with Parts II and III of Article 490.

(NEW) 691.10 Arc-Fault Mitigation. PV systems that do not comply with the requirements of 690.11 shall include details of fire mitigation plans to address dc arc-faults in the documentation required in 691.6.

(NEW) 691.1 Scope. This article covers the installation of large-scale PV electric power production facilities with a generating capacity of no less than 5000 kW, and not under exclusive utility control.

(NEW) 691.11 Fence Grounding. Fence grounding requirements and details shall be included in the documentation required in 691.6.

(Revised) 692.1 Scope. This article applies to the installation of fuel cell systems.

(NEW) 700.5 (E) Documentation. The short-circuit current rating of the transfer equipment, based on the specific overcurrent protective device type and settings protecting the transfer equipment, shall be field marked on the exterior of the transfer equipment.



PART 2 EXAM QUESTIONS

- 201. The circuit conductors between the dc-to-dc converter source circuit(s) and the inverter or dc utilization equipment best describes what listed term?**
- A. DC-to-DC Converter Output Circuit
 - B. Array
 - C. Bipolar Photovoltaic Array
 - D. DC-to-DC Converter Source Circuit
- 202. Where is the short-circuit current rating of transfer equipment required to be field marked?**
- A. Inside the equipment disconnect
 - B. On the interior
 - C. On the exterior
 - D. On the equipment disconnect
- 203. What is the minimum distance above the electrical datum plane area is the GFCI protection for a 20-ampere single-phase, 125-volt receptacle required to be installed on a floating building?**
- A. 24 inches
 - B. 18 inches
 - C. 12 inches
 - D. 30 inches
- 204. What term best defines a dc PV array that has two outputs, each having opposite polarity to a common reference point or center tap?**
- A. Bipolar Photovoltaic Array
 - B. Array
 - C. DC-to-DC Converter Output Circuit
 - D. DC-to-DC Converter Source Circuit
- 205. What are the conductors between an interactive inverter and the service equipment or another electrical power production and distribution network known as?**
- A. Inverter Output Circuit
 - B. Generating Capacity
 - C. Inverter Input Circuit
 - D. Interactive Inverter Output Circuit
- 206. What is the maximum PV system dc circuit voltage permitted for a two-family dwelling?**
- A. 1000
 - B. 600
 - C. 240
 - D. 300
- 207. What is the sum of parallel-connected inverter maximum continuous output power at 40°C in kilowatts?**
- A. Inverter Output Circuit
 - B. Interactive Inverter Output Circuit
 - C. Inverter Input Circuit
 - D. Generating Capacity
- 208. What term best defines the conductors connected to the dc input of an inverter?**
- A. Generating Capacity
 - B. Inverter Input Circuit
 - C. Interactive Inverter Output Circuit
 - D. Inverter Output Circuit
- 209. What article applies to the installation of fuel cell systems?**
- A. 691.6
 - B. 690.10
 - C. 690.7
 - D. 692
- 210. What are conductors connected to the ac output of an inverter known as?**
- A. Interactive Inverter Output Circuit
 - B. Generating Capacity
 - C. Inverter Output Circuit
 - D. Inverter Input Circuit
- 211. What section requires fence grounding requirements and details to be included in the documentation with regards to large-scale PV electric power production facilities?**
- A. 692
 - B. 690.10
 - C. 690.7
 - D. 691.6
- 212. At what power output is a PV electric power production facility considered a large-scale PV electric power production facility?**
- A. 2000 kW
 - B. 5000 kW
 - C. 15000 kW
 - D. 25000 kW

213. How are circuits between dc-to-dc converters and from dc-to-dc converters to the common connection point(s) of the dc system defined in the 2017 code?

- A. Bipolar Photovoltaic Array
- B. Array
- C. DC-to-DC Converter Source Circuit
- D. DC-to-DC Converter Output Circuit

214. What section does a PV system, if not in compliance, require the inclusion of details of fire mitigation plans to address dc arc-faults in the documentation?

- A. 691.6
- B. 690.10
- C. 690.7
- D. 690.11

215. What is a mechanically integrated assembly of module(s) or panel(s) with a support structure and foundation, tracker, and other components, as required, to form a dc or ac power producing unit?

- A. Array
- B. Bipolar Photovoltaic Array
- C. DC-to-DC Converter Output Circuit
- D. DC-to-DC Converter Source Circuit

(Revised) 700.10 (A) Identification.

Emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system by the following methods:

(1) All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked as a component of an emergency circuit or system.

(2) Where boxes or enclosures are not encountered, exposed cable or raceway systems shall be permanently marked to be identified as a component of an emergency circuit or system, at intervals not to exceed 7.6 m (25 ft). Receptacles supplied from the emergency system shall have a distinctive color or marking on the receptacle cover plates or the receptacles.



(Revised) 700.12 (A) Storage Battery. Storage batteries shall be of suitable rating and capacity to supply and maintain the total load for a minimum period of 1 1/2 hours, without the voltage applied to the load falling below 87 1/2 percent of normal. Automotive-type batteries shall not be used.

702.12 (C) Power Inlets Rated at 100 Amperes or Greater, for Portable Generators. Equipment containing power inlets for the connection of a generator source shall be listed for the intended use. Systems with power inlets shall be equipped with an interlocked disconnecting means.

(Revised) 705.2 Interactive Inverter Output Circuit. The conductors between the interactive inverter and the service equipment or another electric power production source, such as a utility, for electrical production and distribution network.

(Revised) 705.2 Microgrid Interconnect Device (MID). A device that allows a microgrid system to separate from and reconnect to a primary power source.

(Revised) 705.2 Microgrid System. A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

(Revised) 705.2 Multimode Inverter. Equipment having the capabilities of both the interactive inverter and the stand-alone inverter.

(NEW) 705.23 Interactive System Disconnecting Means. A readily accessible means shall be provided to disconnect the interactive system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.

(NEW) 706.1 Scope. This article applies to all permanently installed energy storage systems (ESS) operating at over 50 volts ac or 60 volts dc that may be stand-alone or interactive with other electric power production sources.

(NEW) 706.34 (C) Gas Piping. Gas piping shall not be permitted in dedicated battery rooms.

(Revised) 710.1 Scope. This article covers electric power production sources operating in stand-alone mode.

(NEW) 712.1 Scope. This article applies to direct current microgrids.



PART 2 EXAM QUESTIONS

216. How often is a cable tray that has emergency circuits required to be labeled as a component of an emergency circuit or system?
- A. 30 ft
 - B. 10 ft
 - C. 25 ft
 - D. 15 ft
217. What type of storage battery cannot be used for emergency systems?
- A. Sealed cell
 - B. Automotive-type batteries
 - C. Lead acid
 - D. Nickle-cadmium
218. What are portable generators with power inlets rated at 100 amps or more required to be equipped with?
- A. Resistor bank
 - B. Fused disconnect
 - C. Current transformers
 - D. Interlocked disconnecting means
219. What term best describes the conductors between the interactive inverter and the service equipment or another electric power production source, such as a utility, for electrical production and distribution networks?
- A. Microgrid System
 - B. Microgrid Interconnect Device (MID)
 - C. Interactive Inverter Output Circuit
 - D. Multimode Inverter
220. What is a device that allows a microgrid system to separate from and reconnect to a primary power source?
- A. Interactive Inverter Output Circuit
 - B. Microgrid Interconnect Device (MID)
 - C. Microgrid System
 - D. Multimode Inverter
221. A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source best describes what listed term?
- A. Microgrid Interconnect Device (MID)
 - B. Interactive Inverter Output Circuit
 - C. Microgrid system
 - D. Multimode Inverter

222. What does the 2017 Code define as equipment having the capabilities of both an interactive inverter and a stand-alone inverter?

- A. Interactive Inverter Output Circuit
- B. Multimode Inverter
- C. Microgrid Interconnect Device (MID)
- D. Microgrid system

223. Where does the disconnect of an interactive system need to be installed?

- A. Within 36 inches of the source
- B. An accessible location
- C. Within 12 inches on the system source
- D. A readily accessible location

224. At what dc voltage are permanently installed energy storage systems that may be stand-alone or interactive with other electric power production sources considered complying with Article 706?

- A. Over 50 dc volts
- B. Over 60 dc volts
- C. 24 dc volts
- D. 36 dc volts and over

225. What type of piping is not allowed in dedicated battery rooms?

- A. Gas piping
- B. Sprinkler piping
- C. Aluminum piping
- D. Galvanized EMT

226. What article applies to electric power production sources operating in stand-alone mode?

- A. 708
- B. 710
- C. 712
- D. 705

227. What new article applies to microgrids in the 2017 code?

- A. 705
- B. 708
- C. 710
- D. 712

(NEW) 712.52 (A) General. Direct-current microgrids shall be grounded in accordance with 250.162

(Revised) 725.179(G) Class 2 and Class 3 Cable Voltage Ratings. Class 2 cables shall have a voltage rating of not less than 150 volts. Class 3 cables shall have a voltage rating of not less than 300 volts. Class 2 and Class 3 cables shall have a temperature rating of not less than 60°C (140°F).

(Revised) 760.176 Listing and Marking of NPLFA Cables. Non-powerlimited fire alarm cables installed as wiring within buildings shall be listed in accordance with 760.176(A) and (B) and as being resistant to the spread of fire in accordance with 760.176(C) through (F), and shall be marked in accordance with 760.176(G). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath. Non-power-limited fire alarm cables shall have a temperature rating of not less than 60°C (140°F).

(Revised) 770.1 Scope. This article covers the installation of optical fiber cables. This article does not cover the construction of optical fiber cables.

(NEW) 800.3(H) Temperature Limitation of Conductors. Section 310.15(A)(3) shall apply.

(Revised) 800.44 (B) Exception No. 1: Communications wires and cables shall not be required to have a vertical clearance of not less than 2.5 m (8 ft) above auxiliary buildings, such as garages and the like.



(Revised) 800.179 (I) Hybrid Power and Communications Cables. Listed hybrid power and communications cables shall be permitted where the power cable is a listed Type NM or NM-B, conforming to Part III of Article 334, and the communications cable is a listed Type CM, the jackets on the listed NM or NM-B, and listed CM cables are rated for 600 volts minimum, and the hybrid cable is listed as being resistant to the spread of fire.

(Revised) 800.182 Cable Routing Assemblies and Communications Raceways. Cable routing assemblies and communications raceways shall be listed in accordance with 800.182(A) through (C). Cable routing assemblies shall be marked in accordance with Table 800.182(a). Communications raceways shall be marked in accordance with Table 800.182(B).

(NEW) 820.110(A)(3) Innerduct for Coaxial Cables. Listed plenum communications raceways, listed riser communications raceways, and listed general-purpose communications raceways selected in accordance with Table 800.154(b) shall be permitted to be installed as innerduct in any type of listed raceway permitted in Chapter 3.

(Revised) 830.44 (C) Clearance from Ground. Overhead (aerial) spans of network-powered broadband communications cables shall conform to not less than the following:

- (1) 2.9 m (9 1/2 ft) — above finished grade, sidewalks, or from any platform or projection from which they might be reached and accessible to pedestrians only
- (2) 3.5 m (11 1/2 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic
- (3) 4.7 m (15 1/2 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles such as cultivated, grazing, forest, and orchard

(NEW) 840.3 (F) Other Communications Systems. As appropriate for the system involved, traditional communications systems shall comply with the requirements of the following:

- (1) Communications Circuits — Article 800
- (2) Radio and Television Equipment — Article 810
- (3) Community Antenna Television and Radio Distribution Systems — Article 820
- (4) Network-Powered Broadband Communications Systems — Article 830

(NEW) 840.47 (B) Communications Wires and Cables. Installations of communications wires and multi-pair communications cables shall comply with 800.47.



PART 2 EXAM QUESTIONS

228. What table is required to be referenced to determine how communication raceways are to be marked?

- A. 800.182(A)
- B. 800.182(B)
- C. 800.179 (I)
- D. 800.154(b)

229. How far above a residential driveway are an overhead (aerial) span of network-powered broadband communications cables required to be installed?

- A. 20 ft
- B. 9 1/2 ft
- C. 15 1/2 ft
- D. 11 1/2 ft

- 230. What section is required to be referenced to determine the grounding for direct-current microgrids?**
- A. 250.66
 - B. 250.122
 - C. 250.162
 - D. 250.102(C)
- 231. What section are multi-pair communications cables required to comply with?**
- A. 800.47
 - B. 830.44 (C)
 - C. 800.154(b)
 - D. 800.182(B)
- 232. What is the minimum temperature rating for non-power-limited fire alarm cables?**
- A. 120°F
 - B. 60°F
 - C. 140°F
 - D. 50°F
- 233. Above what type of structure do communication cables not have to maintain their minimum vertical clearance?**
- A. Above roofs
 - B. Grain silo
 - C. Industrial crane
 - D. Garages
- 234. What does Article 770 not cover?**
- A. The installation of optical fiber cables
 - B. The construction of optical fiber cables
 - C. Overhead spans of optical fiber cables
 - D. Installation of optical fiber cables above roofs
- 235. What is a hybrid cable required to be listed as being resistant to?**
- A. Harmonics
 - B. Induction
 - C. Temperature
 - D. The spread of fire
- 236. What table allows listed general-purpose communications raceways to be installed as innerduct in any type of listed raceway permitted in Chapter 3?**
- A. 800.179 (I)
 - B. 800.182(A)
 - C. 800.154(b).
 - D. 800.182(B)
- 237. What article is radio and television equipment required to comply with?**
- A. 830
 - B. 810
 - C. 820
 - D. 800
- 238. How far above a sidewalk are an overhead (aerial) span of network-powered broadband communications cables required to be installed?**
- A. 20 ft
 - B. 11 1/2 ft
 - C. 15 1/2 ft
 - D. 9 1/2 ft
- 239. What is the minimum voltage rating for Class 2 cables?**
- A. 150 volts
 - B. 300 volts
 - C. 600 volts
 - D. 1000 volts
- 240. What section must be referenced to determine the temperature limitation of conductors used with communication circuits?**
- A. 310.15(A)(3)
 - B. 315.15(A)(3)
 - C. 315.10(A)(2)
 - D. 310.15(B)(2)

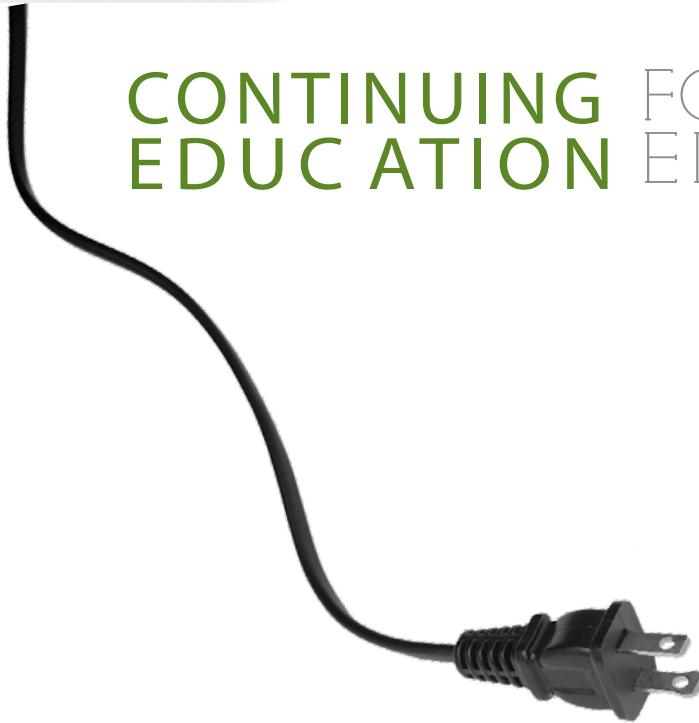


Wisconsin Contractors Institute

**CONTINUING
EDUCATION** FOR WISCONSIN
ELECTRICIANS

2017 NEC Article 250

2 Hours



WISCONSIN CONTRACTORS INSTITUTE

262-409-4282

www.wcittraining.com

DISCLAIMER NOTE: This course is APPROVED by the Wisconsin Department of safety and professional services for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes.

ARTICLE 250

Article 250.1 Scope.

Article 250 is organized into 10 different parts that deal with specific requirements with regards to bonding and grounding. The specific parts are as follows:

- (I) General
- (II) System Grounding AC Systems 50v to 1000v
- (III) Grounding Electro System and Grounding Electro Conductor
- (IV) Enclosure, raceway, and service Cable Grounding
- (V) Bonding
- (VI) Equipment grounding and Equipment grounding Conductors
- (VII) Methods of Equipment Grounding
- (VIII) Direct Current Systems
- (IX) Instruments, Meters, Relays
- (X) Grounding of Systems 1KV and Over (High Voltage)

Article 250.2 Bonding Jumper, Supply Side. A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.

250.3 Application of Other Articles. For other articles applying to particular cases of installation of conductors and equipment, grounding and bonding requirements are identified in Table 250.3 that are in addition to, or modifications of, those of this article.

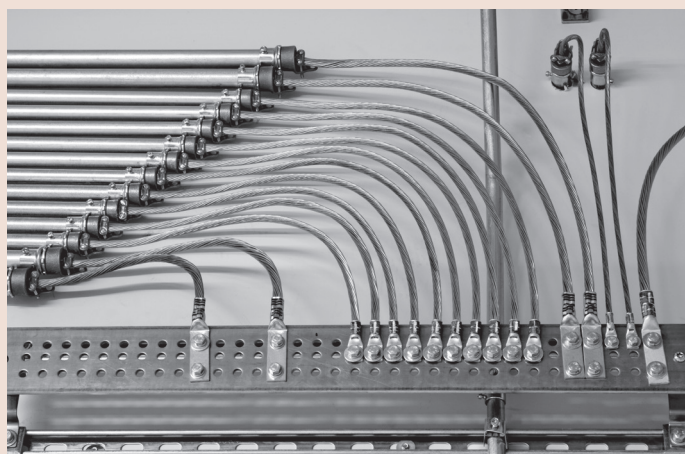
250.4 (A)(1) Electrical System Grounding. Electrical systems that are grounded are required to be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation.

(NEW) 250.4(A)(1) Informational Note No. 2: See NFPA 780-2014, Standard for the Installation of Lightning Protection Systems, for information on installation of grounding and bonding for lightning protection systems.

250.4(A)(4) Bonding of Electrically Conductive Materials and other Equipment. Normally non-current-carrying electrically conductive materials that are likely to become energized shall be connected together and to the electrical supply source in a manner that establishes an effective ground fault current path.

250.6 (A) Arrangement to Prevent Objectionable Current. The grounding of electrical systems, circuit conductors, surge arresters, surge-protective devices, and conductive normally non-current-carrying metal parts of equipment shall be installed and arranged in a manner that will prevent objectionable current.

250.6 (C) Temporary Currents Not Classified as Objectionable Currents. Temporary currents resulting from abnormal conditions, such as ground faults, shall not be classified as objectionable current for the purposes specified in 250.6(A) and (B).



EXAM QUESTIONS

1. What is connecting the normally non-current-carrying electrically conductive materials that are likely to become energized together trying to establish?
 - A. An Open System
 - B. Zero potential
 - C. An effective ground fault current path
 - D. An isolating grounded system
2. What part of Article 250 deals with the grounding of high voltage equipment?
 - A. V
 - B. IV
 - C. IX
 - D. X
3. What does Article 250 NOT classify ground faults as?
 - A. Impaired currents
 - B. Objectionable currents
 - C. Temporary currents
 - D. Stray currents
4. What part of Article 250 should be used to determine methods of equipment grounding?
 - A. IX
 - B. I
 - C. VII
 - D. II
5. General information with regards to Article 250 can be found in what part?
 - A. I
 - B. II
 - C. III
 - D. IV
6. What does the supply side bonding jumper ensure between metal parts?
 - A. Power Factor corrections
 - B. Voltage Gradients
 - C. Current flow
 - D. Conductivity
7. How are the non-current metal parts of equipment required to be installed?
 - A. To eliminate Heat
 - B. To Prevent objectionable current
 - C. To control dust build up
 - D. To Eliminate voltage spikes
8. What part of Article 250 covers equipment grounding conductors?
 - A. X
 - B. IV
 - C. VI
 - D. IX
9. What table in the National Electrical Code would you find specific bonding requirements?
 - A. Article 670
 - B. Article 250.3
 - C. Article 230
 - D. No Listed Answer
10. What part of Article 250 covers information regarding Instruments, Meters, and Relays?
 - A. IX
 - B. X
 - C. VII
 - D. IV

250.6 (E) Isolation of Objectionable Direct-Current Ground Currents. Where isolation of objectionable dc ground currents from cathodic protection systems is required, a listed ac coupling/dc isolating device shall be permitted in the equipment grounding conductor path to provide an effective return path for ac ground-fault current while blocking dc current.

250.8 (B) Methods Not Permitted. Connection devices or fittings that depend solely on solder shall not be used.

250.10 Protection of Ground Clamps and Fittings. Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.

250.12 Clean Surfaces. Nonconductive coatings (such as paint, lacquer, and enamel) on equipment to be grounded shall be removed from threads and other contact surfaces to ensure good electrical continuity or be connected by means of fittings designed so as to make such removal unnecessary.

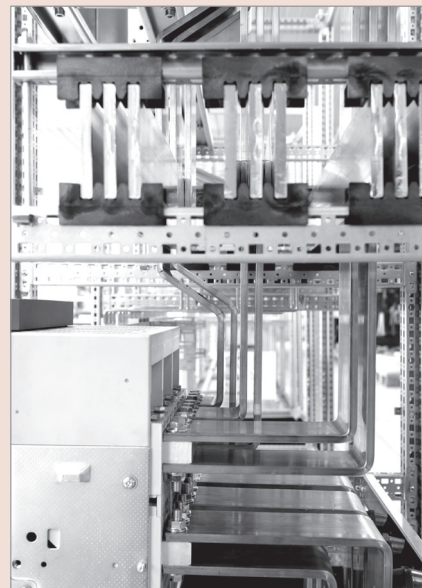
250.20 (A) Alternating-Current Systems of Less Than 50 Volts. Alternating-current systems of less than 50 volts shall be grounded under any of the following conditions:

- (1) Where supplied by transformers, if the transformer supply system exceeds 150 volts to ground
- (2) Where supplied by transformers, if the transformer supply system is ungrounded
- (3) Where installed outside as overhead conductors

250.20 (C) Alternating-Current Systems of 1 kV and Over. Alternating-current systems supplying mobile or portable equipment shall be grounded as specified in 250.188. Where supplying other than mobile or portable equipment, such systems shall be permitted to be grounded.

250.20 (D) Impedance Grounded Neutral Systems. Impedance grounded neutral systems shall be grounded in accordance with 250.36 or 250.187.

250.21 (C) Marking. Ungrounded systems shall be legibly marked "Caution: Ungrounded System Operating — _____ Volts Between Conductors" at the source or first disconnecting means of the system. The marking shall be of sufficient durability to withstand the environment involved.



250.22 Circuits Not to Be Grounded. The following circuits shall not be grounded:

- (1) Circuits for electric cranes operating over combustible fibers in Class III locations, as provided in 503.155
- (2) Circuits in health care facilities as provided in 517.61 and 517.160
- (3) Circuits for equipment within electrolytic cell line working zones as provided in Article 668
- (4) Secondary circuits of lighting systems as provided in 411.6(A)
- (5) Secondary circuits of lighting systems as provided in 680.23(A)(2)
- (6) Class 2 load side circuits for suspended ceiling low-voltage power grid distribution systems as provided in 393.60(B)

250.24 (A)(5) Load-Side Grounding Connections. A grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, to equipment grounding conductor(s), or be reconnected to ground on the load side of the service disconnecting means except as otherwise permitted in this article.

Informational Note: See 250.30 for separately derived systems, 250.32 for connections at separate buildings or structures, and 250.142 for use of the grounded circuit conductor for grounding equipment.

250.24(C)(2) Parallel Conductors in Two or More Raceways or Cables. If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or cables, the grounded conductor shall also be installed in parallel. The size of the grounded conductor in each raceway or cable shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or cable, as indicated in 250.24(C)(1), but not smaller than 1/0 AWG.

(Revised) 250.30(A)(6)(C) Connections. All tap connections to the common grounding electrode conductor shall be made at an accessible location by one of the following methods:

- (1) A connector listed as grounding and bonding equipment.
- (2) Listed connections to aluminum or copper busbars not smaller than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate the number of terminations necessary for the installation. If aluminum busbars are used, the installation shall also comply with 250.64(A).
- (3) The exothermic welding process.

EXAM QUESTIONS

11. An AC system that operates at 50 volts or less must be grounded if _____.
 - A. Installed outside as overhead conductors
 - B. Supplied by transformers, if the transformer supply system is ungrounded
 - C. Supplied by transformers, if the transformer supply system exceeds 150 volts to ground
 - D. All listed answers
12. What type of fitting that connects a grounding system cannot be used?
 - A. A listed Connector
 - B. One that depends solely on solder
 - C. A rated connector designed for the purpose
 - D. Listed split bolt
13. What is the smallest size conductor that can be used for the grounded conductor when it is run in parallel?
 - A. # 3
 - B. # 2
 - C. 1/0
 - D. #1
14. Equipment that is being grounded is required to have _____ coatings removed at the point of connection.
 - A. Lacquer
 - B. Paint
 - C. Enamel
 - D. All listed answers
15. What are circuits installed in accordance with 680.23(A) (2)not required to be?
 - A. Listed
 - B. Grounded
 - C. Rated
 - D. Identified
16. An AC system that operates at 1200 volts and supplies portable equipment is required to be grounded in accordance with _____.
 - A. 250.52(A)
 - B. 250.66
 - C. 250.122
 - D. 250.188
17. How do you determine the size of a parallel grounded conductor in a raceway?
 - A. It shall be based on the total circular mil area of a single ungrounded conductor in the raceway
 - B. It shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway
 - C. 250.122
 - D. 250.102(C)
18. How many options are listed for grounding an impedance grounded neutral system?
 - A. 2
 - B. 3
 - C. 4
 - D. 1
19. How is an ungrounded system required to be labeled?
 - A. "Caution Look out System Operating — ____Volts Between Conductors"
 - B. "Caution: Do not touch System Operating — ____Volts Between Conductors"
 - C. "Caution: Ungrounded System Operating — ____Volts Between Conductors"
 - D. "Caution Open system Operating — ____Volts Between Conductors"
20. If isolation of objectionable DC current is required, where should the dc isolating device be installed?
 - A. In the grounded conductor path
 - B. In the grounding conductor path
 - C. In the equipment grounding conductor path
 - D. In the bonding jumper path
21. Where are ungrounded systems required to be marked?
 - A. First disconnecting means
 - B. At the listed disconnect
 - C. At the marked disconnect
 - D. At the last disconnect

250.30 Grounding Separately Derived Alternating Current Systems.

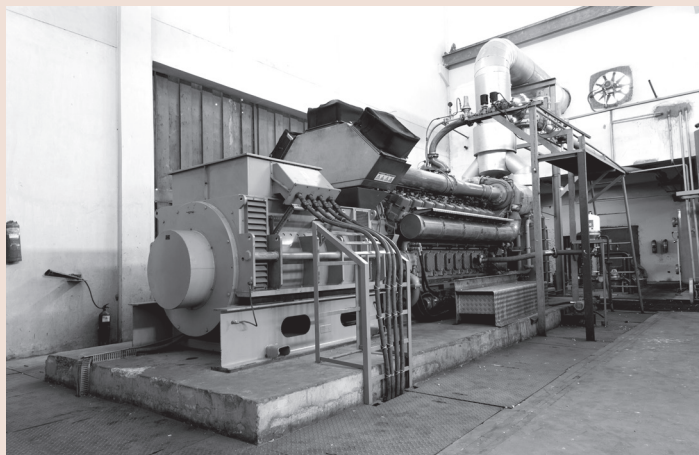
Informational Note No. 1: An alternate ac power source, such as an on-site generator, is not a separately derived system if the grounded conductor is solidly interconnected to a service supplied system grounded conductor. An example of such a situation is where alternate source transfer equipment does not include a switching action in the grounded conductor and allows it to remain solidly connected to the service-supplied grounded conductor when the alternate source is operational and supplying the load served.

(Revised) 250.30(A)(4) The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C).

Exception: If a separately derived system originates in equipment that is listed and identified as suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

Article 250.30(C) Grounding Separately Derived Alternating Current Systems. Outdoor Source.

If the source of the separately derived system is located outside the building or structure supplied, a grounding electrode connection shall be made at the source location to one or more grounding electrodes in compliance with 250.50. In addition, the installation shall comply with 250.30(A) for grounded systems or with 250.30(B) for ungrounded systems.



Article 250.32 (A) Grounding Electrode. Building(s) or structure(s) supplied by feeder(s) or branch circuit(s) shall have a grounding electrode or grounding electrode system installed in accordance with Part III of Article 250. The grounding electrode conductor(s) shall be connected in accordance with 250.32(B) or (C). Where there is no existing grounding electrode, the grounding electrode(s) required in 250.50 shall be installed.

Article 250.32 (E) Grounding Electrode Conductor. The size of the grounding electrode conductor to the grounding electrode(s) shall not be smaller than given in 250.66, based on the largest ungrounded supply conductor. The installation shall comply with Part III of this article.

Article 250.32(B)(1) Supplied by a Feeder or Branch Circuit. An equipment grounding conductor, as described in 250.118, shall be run with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The equipment grounding conductor shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. The equipment grounding conductor shall be sized in accordance with 250.122. Any installed grounded conductor shall not be connected to the equipment grounding conductor or to the grounding electrode(s).

Article 250.52(A)(1) Grounding Electrodes. Electrodes permitted for Grounding. Metal Underground Water Pipe. A metal water pipe is considered a grounding electrode if it is in contact with the earth for a minimum of 10ft. Additionally, the grounding electrode conductor is still required to connect to the metal water pipe within 5 ft of where it enters the building. The 5 ft connection rule has been moved to 250.68(C) since the 5 ft of water pipe extending out of the building is considered more of a grounding electrode conductor since it is no longer in direct contact with the earth and that portion is not considered a grounding electrode. Only the actual buried water pipe in direct connection with the earth is considered the grounding electrode.

EXAM QUESTIONS

22. In general, if a new transformer is being added to an existing system, how do you establish the grounding electrode for the new transformer?
- Tie into the building's existing grounding electrode system
 - Use one ground rod installed within 6ft of the new transformer
 - Install a ground grid with a minimum of 4 contact points
 - Use two ground rods installed within 6ft of the new transformer
23. What section does a grounding electrode connection for ungrounded systems required to comply with?
- 250.66
 - 250.32(A)
 - 250.30(B)
 - 250.118
24. At what location do outdoor grounding electrode connections need to be made?
- Property line
 - Last Connection point
 - The Source
 - Utility pole
25. If a detached garage has its branch circuit installed from the house panel, the grounding electrode system for the detached garage needs to comply with what part of Article 250?
- V
 - II
 - IV
 - III
26. What table is required to be used to size an equipment grounding conductor?
- 250.122
 - 250.66
 - 310.15a
 - 310.16
27. How many feet does a metal water pipe need to be in direct contact with the earth to be considered a grounding electrode?
- 7
 - 10
 - 8
 - 5
28. What Table is used to size the grounding electrode conductor to the grounding electrode(s)?
- 250.102(C)
 - 250.122
 - 250.118
 - 250.66
29. Within how many feet of entering a structure does a grounding electrode conductor need to connect to a buried metal water pipe barring the use of any exceptions?
- 5
 - 6
 - 8
 - 10
30. What conductor in a transfer switch needs to break to make a generator considered a separately derived system?
- Bonded
 - Grounding
 - Grounded
 - Phase

(New) 250.52 (A)(2) Metal In-ground Support Structure(s). One or more metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or a structure, it shall be permissible to bond only one into the grounding electrode system.

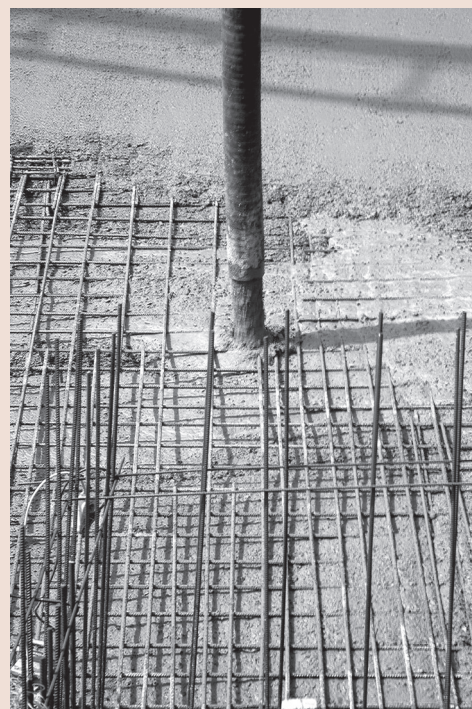
Informational note: Metal in-ground support structures include, but are not limited to pilings, casings, and other structural metal.

Article 250.52(A)(3) Concrete-Encased Electrode. A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either (1) or (2):

(1) One or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods of not less than 13 mm (1/2 in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces connected together by the usual steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length; or

(2) Bare copper conductor not smaller than 4 AWG Metallic components shall be encased by at least 50 mm (2 in.) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.

Informational Note: Concrete installed with insulation, vapor barriers, films or similar items separating the concrete from the earth is not considered to be in "direct contact" with the earth.



Article 250.53(A) (2) Supplemental Electrode Required. A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). The supplemental electrode shall be permitted to be bonded to one of the following:

- (1) Rod, pipe, or plate electrode
- (2) Grounding electrode conductor
- (3) Grounded service-entrance conductor
- (4) Nonflexible grounded service raceway
- (5) Any grounded service enclosure

Exception: If using a single electrode and the resistance is 25 ohms or less, then a supplemental electrode will not be required.

Article 250.53(A)(3) Supplemental Electrode. If multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall not be less than 1.8 m (6 ft) apart.

Informational Note: The paralleling efficiency of rods is increased by spacing them twice the length of the longest rod.

(Revised) 250.52 (A)(7) Plate Electrodes. Each plate electrode shall expose not less than 0.186 m² (2 ft²) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (1/4 in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

250.53 (D) (1) Continuity. Continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters or filtering devices and similar equipment.

(Revised) 250.53(F) Ground Ring. The ground ring shall be installed not less than 750 mm (30 in.) below the surface of the earth.

250.53 (H) Plate Electrode. Plate electrodes to be installed not less than 750 mm (30 in.) below the surface of the earth.

EXAM QUESTIONS

31. What is the minimum required length that a concrete encased electrode can be?
 - A. 20 feet
 - B. 17 feet
 - C. 18 feet
 - D. 16 feet
32. What is the minimum diameter where a piece of rebar can be used as a concrete encased electrode?
 - A. 3/8 inch
 - B. 1/2 inch
 - C. 1/4 inch
 - D. 3/16 inch
33. What is the minimum depth that a ground ring is required to be installed below finish grade?
 - A. 36 inch
 - B. 18 inch
 - C. 24 inch
 - D. 30 inch
34. If multiple metal in-ground support structures are present at a building or a structure, how many are required to bond into the grounding electrode system?
 - A. Minimum of 1/2
 - B. 1/3
 - C. 1
 - D. All are required to bond into the grounding electrode system
35. What shall the continuity of the grounding path or bonding connection to interior piping not rely on?
 - A. Water softeners
 - B. Water meters
 - C. Filtering devices and similar equipment
 - D. All listed answers
36. What is the minimum thickness required for a plate electrode?
 - A. 1/8 in
 - B. 1/2 in
 - C. 3/4 in
 - D. 1/4 in
37. How many feet does a structure's steel need to be in direct contact with the earth to be used as a grounding electrode?
 - A. 6
 - B. 8
 - C. 9 1/2
 - D. 10
38. At what minimum resistance value is a supplemental electrode not required to be installed?
 - A. 25 Ohms
 - B. 27 Ohms
 - C. 30 Ohms
 - D. 43 Ohms
39. What is the minimum acceptable size that a bare copper conductor could be used as a concrete encased electrode provided it was encased in the minimum amount of concrete?
 - A. 8
 - B. 6
 - C. 4
 - D. 10
40. What is the minimum distance below finish grade that a plate electrode can be installed?
 - A. 36 inches
 - B. 30 inches
 - C. 48 inches
 - D. 24 inches
41. How much concrete needs to cover a continuous piece of bare copper conductor used as a concrete encased electrode?
 - A. 1 1/4 inches
 - B. 1 inches
 - C. 2 inches
 - D. 1/2 inches
42. How do you increase the paralleling efficiency of ground rods?
 - A. Decrease the spacing by 1/2 of the longest ground rod
 - B. Space them twice the length of the longest rod
 - C. Space them 3 times the length of the shortest rod
 - D. No listed answer

43. What is the minimum distance that supplemental electrodes are required to be spaced from each other?
- 6 ft.
 - 4 ft.
 - 5 ft.
 - 2 ft.
44. Where do you find what is considered an acceptable supplemental electrode?
- 250.53(A)(3) through (A)(9)
 - 210.42(A)(2) through (A)(8)
 - 250.52(A)(2) through (A)(8)
 - No listed answer
45. Hold down bolts used to secure a building column can be used as a grounding electrode if the bolts are connected to the _____.
- Concrete encased electrode
 - Concrete
 - A PVC pipe
 - Earth

250.64(B) Securing and Protection Against Physical Damage. Where exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members.

(Revised) 250.64 (B)(1) Not Exposed to Physical Damage. A 6 AWG or larger copper or aluminum grounding electrode conductor not exposed to physical damage shall be permitted to be run along the surface of the building construction without metal covering or protection.

(Revised) 250.64 (B)(2) Exposed to Physical Damage. A 6 AWG or larger copper or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit Type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

(Revised) 250.64 (B)(3) Smaller Than 6 AWG. Grounding electrode conductors smaller than 6 AWG shall be protected in RMC, IMC, PVC, RTRC-XW, EMT, or cable armor.

Article 250.64(D)(1) Common Grounding Electrode Conductor and taps. A service that has multiple grounding electrode taps due to multiple disconnects shall connect to a common grounding electrode conductor that is connected to a common busbar for these connections. The busbar shall be at least 1/4 in. thick x 2 in. wide aluminum or copper and shall be securely fastened in an accessible location. If aluminum busbars are used, the installation shall also comply with 250.64(A). The connections to this busbar shall be made by a listed connector or by exothermic welding.



(Revised) 250.66 (A) Connections to a Rod, Pipe, or Plate Electrode(s). If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

250.68(C) Grounding Electrode Conductor Connections. Grounding Electrode Conductor Connections. Grounding electrode conductors and bonding jumpers shall be permitted to be connected at the following locations and used to extend the connection to an electrode(s):

(1) Interior metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 1.52 m (5 ft) from the point of entrance to the building shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52 m (5 ft) from the point of

entrance to the building shall not be used as a conductor to interconnect electrodes of the grounding electrode system. The buried metal water pipe that is in contact with the earth can only be considered an electrode if it is in direct contact with the earth for a minimum of 10 ft.

250.92(B) Method of Bonding at the service. Bonding jumpers meeting the requirements of this article shall be used around impaired connections, such as reducing washers or oversized, concentric, or eccentric knockouts. Standard locknuts or bushings shall not be the only means for the bonding required by this section but shall be permitted to be installed to make a mechanical connection of the raceway(s).

(New) 250.94 (B) Other Means. Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate at least three terminations for communication systems in addition to other connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 250.64(A).

250.98 Bonding Loosely Jointed Metal Raceways. Expansion fittings and telescoping sections of metal raceways to be made electrically continuous by equipment bonding jumpers or other means.

(Revised) 250.102 Grounded Conductor, Bonding Conductors, and Jumpers. (A) Material. Bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

(Moved) 250.102 (C)(2) Informational Note No. 2: See Chapter 9, Table 8, for the circular mil area of conductors 18 AWG through 4/0 AWG.

EXAM QUESTIONS

46. What type of connector is required to be used when connecting grounding electrode taps to a common busbar where the grounding electrode conductor is also connected?
 - A. Copper
 - B. Flanged
 - C. Listed
 - D. CO/AL
47. If using an expansion joint on a 2" aluminum conduit, what does the code require to be installed around the expansion joint?
 - A. Grounding jumper
 - B. Equipment grounding conductor
 - C. Equipment bonding jumper
 - D. All listed answers
48. What is the minimum size a grounding electrode conductor not exposed to physical damage can be run along the surface of a building without metal covering or protection?
 - A. 1/0
 - B. 4 AWG
 - C. 2 AWG
 - D. 6 AWG
49. If a bonding jumper to a plate electrode does not extend on to other types of electrodes that require a larger size conductor, what is the maximum size aluminum grounding electrode conductor required to be run?
 - A. 6 AWG
 - B. 4 AWG
 - C. 2 AWG
 - D. 1/0
50. What table shows the circular mil area for conductors 18 AWG through 4/0 AWG?
 - A. 250.122
 - B. Table 250.102(C)(1)
 - C. Table 5
 - D. Table 8
51. If using an aluminum busbar for the tap connections to a common grounding electrode conductor, what section is required to be referenced for this installation?
 - A. 250.64(A)
 - B. 250.24(C)(2)
 - C. 250.30(A)(4)
 - D. 240.67

52. Within how many feet is a buried metal water pipe entering a building allowed to tie directly to building steel as to provide a path to the grounding electrode?
- 7 ft.
 - 6 ft.
 - 5 ft.
 - 10 ft.
53. If a service has multiple disconnecting enclosures, where do all the grounding electrode taps need to connect to?
- A common grounded conductor
 - A common grounding electrode conductor
 - A common equipment grounding conductor
 - Any phase conductor
54. Where are communications system bonding terminations required to be installed if using a busbar?
- At each server rack for testing and maintenance
 - In the communications room
 - In the main electrical service room next to the service concrete encased electrode
 - In an accessible location
55. What is the minimum size busbar required when multiple electrode taps connect to a common busbar where the grounding electrode conductor is also connected?
- 1/2 in. x 2 in.
 - 1/4 in. x 2 in.
 - 1 in. x 3 in.
 - 2 in. x 2 in.
56. What is the minimum size grounding electrode conductor that must be protected from physical damage by RMC, IMC, PVC, RTRC-XW, EMT, or cable armor?
- 8
 - 6
 - 4
 - No Special requirement

250.102 (E) Installation. Bonding jumpers or conductors and equipment bonding jumpers shall be permitted to be installed inside or outside of a raceway or an enclosure.

250.102 (E)(1) Inside a Raceway or an Enclosure. If installed inside a raceway, equipment bonding jumpers and bonding jumpers or conductors must comply with the requirements of 250.119 and 250.148.

250.102 (E)(2) Outside a Raceway or an Enclosure. If installed on the outside, the length of the bonding jumper or conductor or equipment bonding jumper shall not exceed 1.8 m (6 ft) and shall be routed with the raceway or enclosure.



(Revised) 250.104 Bonding of Piping Systems and Exposed Structural Metal. (A) Metal Water Piping. The metal water piping system shall be bonded as required in (A)(1), (A)(2), or (A)(3) of this section.

(1) General. Metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

- Service equipment enclosure
- Grounded conductor at the service
- Grounding electrode conductor if of sufficient size
- One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size.

The bonding jumper(s) shall be installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The points of attachment of the bonding jumper(s) shall be accessible. The bonding jumper(s) shall be sized in accordance with Table 250.102(C)(1) except as permitted in 250.104(A)(2) and 250.104(A)(3).

(Revised) 250.104 (A)(3) Multiple Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s). The metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

- (1) Building or structure disconnecting means enclosure where located at the building or structure
- (2) Equipment grounding conductor run with the supply conductors
- (3) One or more grounding electrodes used.

The bonding jumper(s) shall be sized in accordance with Table 250.102(C)(1), based on the size of the feeder or branch circuit conductors that supply the building or structure. The bonding jumper shall not be required to be larger than the largest ungrounded feeder or branch-circuit conductor supplying the building or structure.

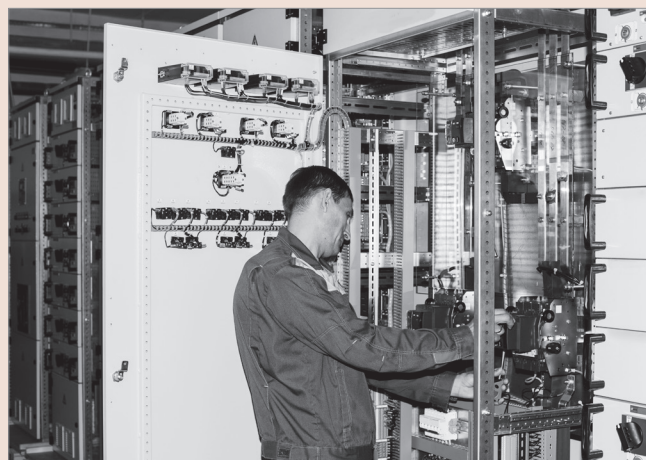
(Revised) 250.104 (B) Other Metal Piping. If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

- (1) Equipment grounding conductor for the circuit that is likely to energize the piping system
- (2) Service equipment enclosure
- (3) Grounded conductor at the service
- (4) Grounding electrode conductor, if of sufficient size
- (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.122, and equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

(Revised) 250.104 (C) Structural Metal. Exposed structural metal that is interconnected to form a metal building frame and is not intentionally grounded or bonded and is likely to become energized shall be bonded to any of the following:

- (1) Service equipment enclosure
 - (2) Grounded conductor at the service
 - (3) Disconnecting means for buildings or structures supplied by a feeder or branch circuit
 - (4) Grounding electrode conductor, if of sufficient size
 - (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size
- The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.102(C)(1) and installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 250.68(A) Exception No. 2.



(Revised) 250.104 (D)(2) Separately Derived Systems. Structural Metal. If exposed structural metal that is interconnected to form the building frame exists in the area served by the separately derived system, it shall be bonded to the grounded conductor of each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 250.102(C)(1) based on the largest ungrounded conductor of the separately derived system.

250.106 Lightning Protection Systems. The lightning protection system ground terminals to be bonded to the building or structure grounding electrode system.

EXAM QUESTIONS

57. **Where is the lightning protection system of an office building required to be connected?**
- A. Meter can
 - B. Service enclosure
 - C. Grounding electrode system
 - D. All listed answers
58. **What is the maximum allowable length for an equipment bonding jumper installed outside of a raceway?**
- A. 5 ft
 - B. 6 ft
 - C. 4 ft
 - D. 3 ft
59. **What is the bonding jumper connection that is connected to exposed structural metal that is interconnected to form a metal building required to be?**
- A. Exothermic welded
 - B. Readily accessible
 - C. Secured
 - D. Accessible
60. **What table should be used to size bonding jumpers for metal water piping systems?**
- A. 250.102(C)(1)
 - B. 250.122
 - C. 250.104(A)(2)
 - D. 250.64(A)

WCI Wisconsin Contractors Institute

CONTINUING
EDUCATION | FOR WISCONSIN
ELECTRICIANS

2017 NEC Article 517
3 Hours



WISCONSIN CONTRACTORS INSTITUTE

262-409-4282

www.wcittraining.com

DISCLAIMER NOTE: This course is APPROVED by the Wisconsin Department of safety and professional services for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes.

ARTICLE 517 HEALTH CARE FACILITIES

Article 517 is organized into 7 different parts that deal with specific requirements with regards to Health Care Facilities. The specific parts are as follows:

- I. General
- II. Wiring and Protection
- III. Essential Electrical Systems
- IV. Inhalation Anesthetizing Locations
- V. X-Ray Installations
- VI. Communications, Signaling Systems, Data Systems, Fire Alarm Systems, and systems less than 120 volts, Nominal
- VII. Isolated Power Systems



Parts I and II are the most general of the article. Part I gives a general scope and the definitions portion of the entire article. Part II is the Wiring and Protection section for all patient care areas of health care facilities. The other five (5) parts are dedicated to specific locations and/or systems throughout Health Care Facilities.

Article 517.1: The provisions of this article shall apply to electrical construction and installation criteria in health care facilities that provide services to humans. The requirements in part II and III not only apply to single function buildings but also intended to be individually used to their respective forms of occupancy with in a multifunction building. (E.g. a doctor's examining room located within a limited care facility would be required to meet the provisions of 517.10).

Article 517.2 Definitions:

(Revised) Ambulatory Health Care Occupancy. An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following:

- (1) Treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without assistance of others.
- (2) Anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others.
- (3) Emergency or urgent care for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others.

Electrical Life-Support Equipment. Electrically powered equipment whose continuous operation is necessary to maintain a patient's life.

Article 517.2 Definitions:

Equipment Branch. A system of feeders and branch circuits arranged for delayed, automatic, or manual connection to the alternate power source and that serves primarily 3-phase power equipment.

Battery Powered Lighting Units: Individual unit equipment for back up lighting consisting of the following.

- 1) Rechargeable battery
- 2) Battery-charging means
- 3) Provisions for one or more lamps mounted on the equipment, or with terminals for remote lamps or both.
- 4) Relaying device arranged to energize the lamps automatically upon failure of the power to the unit or equipment.

(NEW) Governing Body. The person or persons who have the overall legal responsibility for the operation of a health care facility.

(Revised) Patient Bed Location: The area of a patients' sleeping bed or the bed or procedure table of a critical care space.

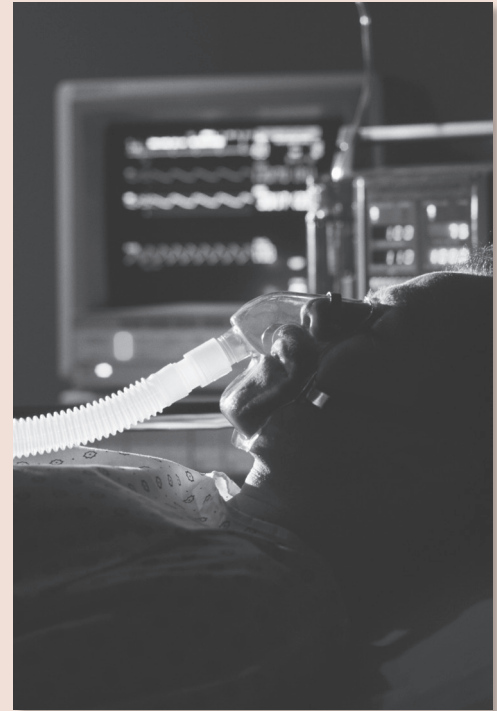
Patient Equipment Grounding Point: A jack or terminal that serves as the collection point for redundant grounding of electrical appliances for patient care vicinity or for grounding other items in order to eliminate electromagnetic interference problems.

Patient Care Vicinity: A space, within a location intended for the examination and treatment of patients, extending 1.8 m (6 ft) beyond the normal location of the patient bed, chair, table, treadmill, or other device that supports the patient during examination and treatment and extending vertically to 2.3 m (7 ft 6 in.) above the floor.

(Revised) Selected Receptacles: A minimum number of receptacles selected by the governing body of a facility as necessary to provide essential patient care and facility services during loss of normal power.

(NEW) Support (Category 4) Space. Space in which failure of equipment or a system is not likely to have a physical impact on patient care.

Task Illumination: provisions for the minimum lighting required to carry out necessary tasks in certain areas, including but not limited to safe access to supplies and equipment, and access to exits.



EXAM QUESTIONS

1. What part of Article 517 would you find the definitions portion?
 - A. VII. Isolated Power Systems
 - B. II. Wiring and Protection
 - C. I. General
 - D. V. X-Ray Installations
2. How many parts are there to Article 517?
 - A. 7
 - B. 5
 - C. 9
 - D. 8
3. Which part of Article 517 would you find the Wiring and Protection section?
 - A. I
 - B. VI
 - C. VII
 - D. II
4. Systems less than 120 volts nominal would be covered in what part of Article 517?
 - A. I
 - B. VI
 - C. VII
 - D. II
5. What best defines electrically powered equipment of which continuous operation is necessary to maintain a patient's life?
 - A. Ambulatory Health Care equipment
 - B. Electrical Life-Support system
 - C. Nursing home equipment
 - D. Electrical Life-Support Equipment
6. What best defines a system of circuits and equipment set up for automatic, delayed, or a manual connection to an alternate power source and that serves primarily 3-phase power equipment?
 - A. Essential electrical system
 - B. Equipment Branch
 - C. Isolated power system
 - D. Life safety branch

7. **Battery powered lighting units are individual equipment for back up illumination consisting of all but one of the following:**
 - A. Battery charging means
 - B. Rechargeable battery
 - C. Manual or automatic means of switching
 - D. Provisions for one or more lamp to be mounted on the equipment
8. **Who has the overall legal responsibility for the operation of a health care facility?**
 - A. Governing Body
 - B. Administrator
 - C. Board of directors
 - D. Quality of care committee
9. **What best defines the space in which the failure of equipment or a system is not likely to have a physical impact on patient care?**
 - A. Category 4
 - B. Category 2
 - C. Category 3
 - D. Category 1
10. **A jack or terminal that serves as the collection point for redundant grounding of electrical appliances for patient care vicinity or for grounding other items in order to eliminate electromagnetic interference problems is known as?**
 - A. Reference grounding point
 - B. Patient equipment grounding point
 - C. Selected receptacles
 - D. Equipment branch
11. **How far does the space within a location intended for the examination and treatment of patients need to extend beyond the normal location of the patient bed to be considered a patient care vicinity?**
 - A. 6 ft 6 inches
 - B. 7 ft 6 inches
 - C. 3 ft
 - D. 6 ft
12. **How high does the vertical space within a location intended for the examination and treatment of patients need to extend to be considered a patient care vicinity?**
 - A. 6 ft 6 inches
 - B. 7 ft 6 inches
 - C. 3 ft
 - D. 6 ft
13. **What best defines the minimum lighting required to carry out necessary tasks in the described areas, including safe access to supplies and equipment, and access to exits with regards to health care facilities?**
 - A. Task Illumination
 - B. Critical Branch
 - C. Emergency Lighting
 - D. Support lighting

517.10 (A) Applicability. Part II shall apply to patient care space of all health care facilities.

517.10 (B) Not Covered. Part II shall not apply to the following:

- (1) Business offices, corridors, waiting rooms, and the like in clinics, medical and dental offices, and outpatient facilities
- (2) Areas of nursing homes and limited care facilities wired in accordance with Chapters 1 through 4 of this Code where these areas are used exclusively as patient sleeping rooms.

517.13 Grounding of Receptacles and Fixed Electrical Equipment in Patient Care Spaces. Wiring in patient care areas shall comply with 517.13(A) and (B).



(A) Wiring Methods. All branch circuits serving patient care spaces shall be provided with an effective ground-fault current path by installation in a metal raceway system, or a cable having a metallic armor or sheath assembly. The metal raceway system, or metallic cable armor, or sheath assembly shall itself qualify as an equipment grounding conductor in accordance with 250.118.

517.14 Panel Board Bonding. The equipment grounding terminal buses of the normal and essential branch-circuit panel boards serving the same individual patient care vicinity shall be connected together with an insulated continuous copper conductor not smaller than 10 AWG. Where two or more panel boards serving the same individual patient care vicinity are served from separate transfer switches on the essential electrical system, the equipment grounding bus of those panels shall be connected together with an insulated continuous copper conductor no smaller than a 10 AWG. This conductor shall be permitted to be broken in order to terminate on the equipment grounding terminal bus in each panel board.

(Revised) 517.16 (A) Inside of a Patient Care Vicinity. An isolated grounding receptacle shall not be installed within a patient care vicinity.

517.18 General Care (Category 2) Spaces. (A) Patient Bed Location. Each patient bed location shall be supplied by at least two branch circuits, one from the critical branch and one from the normal system. All branch circuits from the normal system shall originate in the same panelboard. The electrical receptacles or the cover plate for the electrical receptacles supplied from the critical branch shall have a distinctive color or marking so as to be readily identifiable and shall also indicate the panelboard and branch-circuit number supplying them. Branch circuits serving patient bed locations shall not be part of a multiwire branch circuit.

Exception NO 1: Branch circuits serving only special purpose outlets or receptacles, such as portable X-ray outlets, shall not be required to be served from the same panel board or distribution panel.

Exception NO 2: Requirements of 517.18(A) shall not apply to patient bed locations in clinics, medical and dental offices, and outpatient facilities; psychiatric, substance abuse, and rehabilitation hospitals; sleeping rooms of nursing homes and limited care facilities meeting the requirements of 517.10(B)(2)

Exception NO 3: A general care (Category 2) patient bed location served from two separate transfer switches on the emergency system shall not be required to have circuits from the normal system.

517.19 Critical Care (Category 1) Spaces. (A) Patient Bed Location Branch Circuits. Each patient bed location shall be supplied by at least two branch circuits, one or more from the critical branch and one or more circuits from the normal system. At least one branch circuit from the critical branch shall supply an outlet(s) only at that bed location.

517.19 Critical Care (Category 1) Spaces (B) Patient bed location receptacles. (1) Minimum Number and Supply. Each patient bed location shall be provided with a minimum of 14 receptacles, at least one of which shall be connected to either of the following:

- (1) The normal system branch circuit required in 517.19(A)
- (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same patient bed location



(Revised) 517.19 Critical Care (Category 1) Spaces (C) Operating Room Receptacles. (1) Minimum Number and Supply. Each operating room shall be provided with a minimum of 36 receptacles divided between at least two branch circuits. At least 12 receptacles, but no more than 24, shall be connected to either of the following:

- (1) The normal system branch circuit required in 517.19(A)
- (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same location.

(Revised) 517.19 Critical Care (Category 1) Spaces (C) Operating Room Receptacles. (2) Receptacle Requirements. The receptacles shall be permitted to be of the locking or nonlocking type, single, duplex, or quadruplex types or any combination of the three. All nonlocking-type receptacles shall be listed hospital grade and so identified. The grounding terminal of each receptacle shall be connected to the reference grounding point by means of an insulated copper equipment grounding conductor.

EXAM QUESTIONS

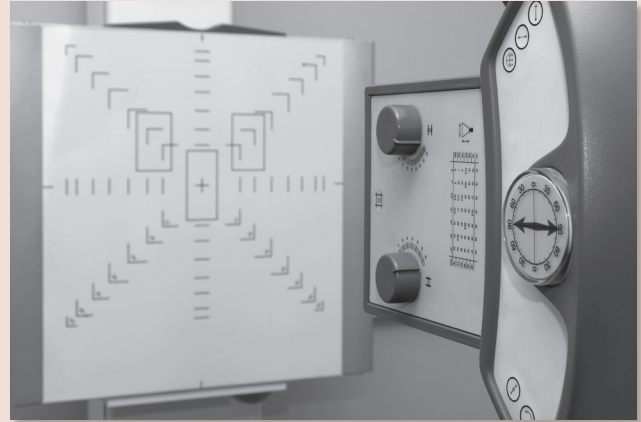
- | | |
|---|--|
| <p>14. What part of Article 517 would NOT apply directly to a dental office installation?</p> <ul style="list-style-type: none"> A. III B. II C. IV D. VI <p>15. What is the minimum size equipment grounding conductor that can be used to tie together the terminal buses of the normal and essential branch-circuit panel boards that serve the same individual patient care vicinity?</p> <ul style="list-style-type: none"> A. 8 AWG B. 6 AWG C. 4 AWG D. 10 AWG <p>16. What are all branch circuits serving patient care areas required to be provided with?</p> <ul style="list-style-type: none"> A. Labels B. Effective ground-fault current path C. Identified terminals D. All listed answers <p>17. What type of receptacles are NOT permitted within a patient care vicinity?</p> <ul style="list-style-type: none"> A. Any receptacle Orange in color B. 15 amp C. Commercial grade D. Isolated ground receptacles <p>18. How are electrical receptacles or cover plates supplied from the critical branch required to be identified?</p> <ul style="list-style-type: none"> A. Markings B. A distinctive color C. Labels D. All listed answers | <p>19. A general care patient bed location served from two separate transfer switches on the critical branch is not required to have an additional circuit from what listed system?</p> <ul style="list-style-type: none"> A. Normal system B. Critical system C. Standby system D. General care patient bed locations cannot be served by a transfer switch <p>20. How many circuits are required at each patient bed location?</p> <ul style="list-style-type: none"> A. One B. Two C. Six D. Three <p>21. How many receptacles are required at each patient bed location?</p> <ul style="list-style-type: none"> A. Twelve B. Ten C. Eight D. Fourteen <p>22. How many receptacles are required in an operating room?</p> <ul style="list-style-type: none"> A. 12 B. 36 C. 24 D. 18 <p>23. What is the minimum number of receptacles that are required to be connected to the normal or critical branch in an operating room?</p> <ul style="list-style-type: none"> A. 12 B. 36 C. 24 D. 18 |
|---|--|

24. What are operating room nonlocking-type receptacles required to be listed as?

- A. 20 amp
- B. Hospital Grade
- C. Continuous duty
- D. All listed answers

517.19 Critical Care (Category 1) Spaces (G) Isolated power system equipment grounding. Where an isolated ungrounded power source is used and limits the first fault current to a low magnitude, the equipment grounding conductor associated with the secondary circuit shall be permitted to run outside of the enclosure of the power conductors in the same circuit.

517.19 Critical Care (Category 1) Spaces (H) Special Purpose Receptacle Grounding. The equipment grounding conductor for special purpose outlets, such as operation of mobile x-ray equipment, shall be extended to the reference grounding points of branch circuits for all locations likely to be served from each outlet. Where such a circuit is served from an isolated ungrounded system, the grounding conductor shall not be required to be run with the power conductors; however the equipment grounding terminal of the special purpose outlet shall be connected to the reference grounding point.



517.20 Wet Procedure Locations (A) Receptacles and fixed equipment. Wet procedure locations shall be provided with special protection against electric shock by one of the following:

- (1) Power distribution system that inherently limits the possible ground fault current due to the first fault to a low value, without interrupting the power supply.
- (2) Power distribution system in which the power supply is interrupted if the ground fault current does, in fact, exceed a value of 6 mA.

517.20 Wet Procedure Locations (B) Isolated Power Systems. Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment, and the isolated power system shall be designed and installed according to 517.160.

517.21 Ground Fault Circuit Interrupter Protection for Personnel. Ground fault circuit interrupter for protection of personnel shall not be required for receptacles installed in those critical care (Category 1) spaces where the toilet and basin are installed within the patient room.

517.25 Essential Electrical System Scope. The essential electrical system for these facilities shall comprise a system capable of supplying a limited amount of lighting and power service, which is considered essential for life safety and orderly cessation of procedures during the time normal electrical service, is interrupted for any reason. This includes clinics, medical and dental offices, outpatient facilities, nursing homes, limited care facilities, hospitals and other health care facilities serving patients.

517.31 Requirements for the Essential Electrical System. (A) Separate Branches. Essential electrical systems for hospitals shall be comprised of three separate branches capable of supplying a limited amount of lighting and power service that is considered essential for life safety and effective hospital operation during the time the normal electrical service is interrupted for any reason. The three branches are life safety, critical, and equipment.

The division between the branches shall occur at transfer switches where more than one transfer switch is required.

517.31 Requirements for the Essential Electrical System. (B) Transfer Switches. The number of transfer switches to be used shall be based on reliability and design. Each branch of the essential electrical system shall have one or more transfer switches. One transfer switch and downstream distribution system shall be permitted to serve one or more branches in a facility with a maximum demand on the essential electrical system of 150 kVA.

517.31 Requirements for the Essential Electrical System. (B)(1) Optional Loads. Loads served by the generating equipment not specifically named in Article 517 shall be served by their own transfer switches such that the following conditions apply:

- (1) These loads shall not be transferred if the transfer will overload the generating equipment.
- (2) These loads shall be automatically shed upon generating equipment overloading.

517.31 Requirements for the Essential Electrical System. (C) Wiring Requirements. (1) Separation from Other Circuits. The life safety branch and critical branch of the essential electrical system shall be kept entirely independent of all other wiring and equipment and shall not enter the same raceways, boxes, or cabinets with each other or other wiring.

Where general care locations are served from two separate transfer switches on the essential electrical system in accordance with 517.18(A), Exception No. 3, the general care circuits from the two separate systems shall be kept independent of each other.

Where critical care locations are served from two separate transfer switches on the essential electrical system in accordance with 517.19(A), Exception No. 2, the critical care circuits from the two separate systems shall be kept independent of each other.



EXAM QUESTIONS

25. If an isolated ungrounded power source is used to limit the first fault current to a low magnitude, what secondary conductor is allowed to be run outside of the enclosure?
 - A. Grounded conductor
 - B. Equipment grounding conductor
 - C. Phase line side conductor
 - D. Primary load side conductor
26. Where is the equipment grounding conductor for mobile x-ray equipment required to be extended?
 - A. The line side conductors used for the outlet
 - B. The grounded conductor points of branch circuits for all locations
 - C. The Service
 - D. The grounding points of branch circuits for all locations likely to be served
27. Wet procedure location patient care areas are required to be provided with special protection against what?
 - A. Harmonics
 - B. Electric shock
 - C. Eddy currents
 - D. All listed answers
28. What is isolated power equipment required to be listed as?
 - A. Hospital Grade
 - B. Commercial Grade
 - C. Isolated power equipment
 - D. Nema 3R
29. Ground fault circuit interrupter for protection of personnel where the toilet and basin are installed within the patient room is not required in what area?
 - A. Critical care areas
 - B. Out Patient areas
 - C. Waiting room areas
 - D. Nursing stations

30. The Essential Electrical Systems are required to do what in all health care facilities?
- Supply a limited amount of lighting and power service
 - Supply only equipment power
 - Supply emergency power to only hospitals
 - Supply emergency lighting to dental offices
31. How many separate branches make up the Essential Electrical System?
- 4
 - 1
 - 2
 - 3
32. What are the names of the branches that make up the Essential Electrical System?
- Life safety
 - Critical
 - Equipment
 - All listed answers
33. What determines the number of transfer switches required for the Essential Electrical System?
- Load considerations
 - Design and Reliability
 - Output rating
 - All listed answers
34. What branches of the essential electrical system are required to be installed independent of all other wiring and equipment?
- Equipment branch and critical branch
 - Life safety branch and emergency branch
 - Transfer switch and emergency branch
 - Life safety branch and the critical branch

517.31 Wiring Requirements (C)(1) Separation from Other Circuits.

Wiring of the life safety branch and the critical branch shall be permitted to occupy the same raceways, boxes, or cabinets of other circuits not part of the branch where such wiring complies with one of the following:

- Is in transfer equipment enclosures
- Is in exit or emergency luminaires supplied from two sources
- Is in a common junction box attached to exit or emergency luminaires supplied from two sources
- Is for two or more circuits supplied from the same branch and same transfer switch

The wiring of the equipment branch shall be permitted to occupy the same raceways, boxes, or cabinets of other circuits that are not part of the essential electrical system.

517.31 Wiring Requirements (C)(2) Isolated Power Systems. Where isolated power systems are installed in any of the areas in 517.34(A)(1) and (A)(2), each system shall be supplied by an individual circuit serving no other load.

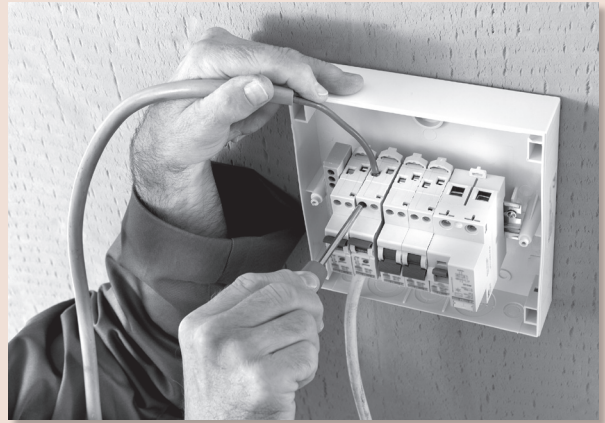
(Revised) 517.31 Wiring Requirements (C)(3) Mechanical Protection of the Essential Electrical System. The wiring of the life safety and critical branches shall be mechanically protected. Where installed as branch circuits in patient care spaces, the installation shall comply with the requirements of 517.13(A) and (B). Only the following wiring methods shall be permitted:

- Nonflexible metal raceways, Type MI cable, Type RTRC marked with the suffix -XW, or Schedule 80 PVC conduit. Nonmetallic raceways shall not be used for branch circuits that supply patient care areas.
- Where encased in not less than 50mm (2in) of concrete, Schedule 40 PVC conduit, flexible nonmetallic or



jacketed metallic raceways, or jacketed metallic cable assemblies listed for installation in concrete. Nonmetallic raceways shall not be used for branch circuits that supply patient care areas.

- (3) Listed flexible metal raceways and listed metal sheathed cable assemblies in any of the following:
- Where used in listed prefabricated medical head walls.
 - In listed office furnishings.
 - Where fished into existing walls or ceilings, not otherwise accessible and not subject to physical damage.
 - Where necessary for flexible connection to equipment.
 - For equipment that requires a flexible connection due to movement, vibration, or operation
 - Luminaires installed in rigid ceiling structures where there is no access above the ceiling space after the luminaire is installed
- (4) Flexible power cords of appliances or other utilization equipment connected to the emergency system.
- (5) Cables for class 2 or class 3 systems permitted by Part VI of this article, with or without raceways.



EXAM QUESTIONS

35. According to Article 517, when would it be permissible for the life safety branch and the critical branch of the essential electrical system to share a common J-box with conductors of different systems?
- If only one circuit is in the box and is dedicated to the common panel
 - If no other enclosure penetrates the electrical panel
 - If two or more circuits supplied from the same branch and same transfer switch
 - There are no exceptions to this rule
36. What type of circuit is required to comply 517.34(A)(1) and (A)(2)?
- Dedicated
 - Variable voltage
 - Frequency driven
 - One that is identified with distinctive marking(s)
37. How is the wiring of the life safety and critical branches required to be protected?
- Isolation switching
 - Mechanically
 - Through interlocking means
 - With Edison fuses
38. What is the minimum amount of concrete required to cover schedule 40 PVC so it can be used in a patient care area?
- 3 inches
 - 2 inches
 - 4 inches
 - 1 inches
39. Flexible metal raceways and listed metal sheathed cable assemblies for a patient care area are allowed only in which of the following.
- Where fished into existing walls or ceilings, not otherwise accessible and not subject to physical damage.
 - Mechanical rooms
 - Between the emergency and normal power systems
 - Coming out of concrete
40. What class of Cables for systems permitted by Part VI of Article 517 can be installed with or without raceways?
- Class 3 or class 4
 - Class 1 or class 3
 - Class 2 or class 4
 - Class 2 or class 3

517.31 Hospitals (D) Capacity of Systems. The essential electrical system shall have the capacity and rating to meet the maximum actual demand likely to be produced by the connected load. Feeders shall be sized in accordance with 215.2 and Part III of Article 220. The generator set(s) shall have the capacity and rating to meet the demand produced by the load at any given time. Demand calculations for sizing of the generator set(s) shall be based on any of the following:

- (1) Prudent demand factors and historical data
- (2) Connected load
- (3) Feeder calculations based on Article 220
- (4) Any combination of above.

The sizing requirements in 700.4 and 701.4 shall not apply to hospital generator sets.

517.31 (E) Receptacle Identification. The cover plates for the electrical receptacles or the electrical receptacles themselves supplied from the essential electrical system shall have a distinctive color or marking so as to be readily identifiable.

(Revised) 517.33 Life Safety Branch. No function other than those listed in 517.33 (A) through (H) shall be connected to the life safety branch. The life safety branch of the essential electrical system shall supply power for the following lighting, receptacles, and equipment

517.33 (A) Illumination of Means of Egress. Illumination of means of egress, such as lighting required for corridors, passageways, stairways, and landings at exit doors, and all necessary ways of approach to exits. Switching arrangements to transfer patient corridor lighting in hospitals from general illumination circuits to night illumination circuits shall be permitted, provided only one of the two circuits can be selected and both circuits cannot be extinguished at the same time.

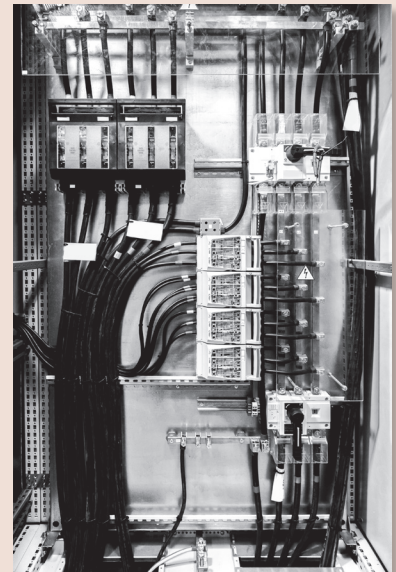
517.33 (B) Exit Signs. Exit signs and directional signs will be connected to the life safety branch of the emergency system.

(Revised) 517.33 (C) Alarm and Alerting Systems. Alarm and alerting systems including all of the following:

- (1) Fire alarms
- (2) Alarms required for systems used for the piping of nonflammable medical gases.
- (3) Mechanical, control, and other accessories required for effective life safety systems operation shall be permitted to be connected to the life safety branch.

517.33 Life Safety Branch (D) Communication Systems. Hospital communications systems, where used for issuing instructions during emergency conditions can be connected to the life safety branch.

(Revised) 517.33 Critical Branch (A) Task Illumination and Selected Receptacles. The critical branch of the essential electrical system shall supply power for task illumination, fixed equipment, selected receptacles, and special power circuits serving the following areas and functions related to patient care:



- (1) Critical care (Category 1) spaces that utilize anesthetizing gases – task illumination, selected receptacles, and fixed equipment.
- (2) The isolated power system in special environments.
- (3) Patient care Spaces – task illumination and selected receptacles in the following areas:
 - (a) Infant nurseries
 - (b) Medication preparation areas
 - (c) Pharmacy dispensing areas
 - (d) Selected acute nursing areas
 - (e) Psychiatric bed areas (omit receptacles)
 - (f) Ward treatment rooms
 - (g) Nurses' stations (unless adequately lighted by corridor luminaries)
- (4) Additional specialized patient care task illumination and receptacles, where needed.
- (5) Nurse call system
- (6) Blood, bone, and tissue banks
- (7) Telephone and data equipment rooms and closets
- (8) Task illumination, selected receptacles, and selected power circuits for the following:
 - (a) General care beds (at least one duplex receptacle in each patient bedroom)
 - (b) Angiographic labs
 - (c) Cardiac catheterization labs
 - (d) Coronary care units
 - (e) Hemodialysis rooms or areas
 - (f) Emergency room treatment areas (selected)
 - (g) Human physiology labs
 - (h) Intensive care units
 - (i) Postoperative recovery rooms (selected)
- (9) Additional task illumination, receptacles, and selected power circuits needed for effective facility operation, including single-phase fractional horsepower motors, shall be permitted to be connected to the critical branch.

EXAM QUESTIONS

- | | |
|---|---|
| <p>41. The essential electrical system is required to have adequate capacity to meet what for its connected loads?</p> <ol style="list-style-type: none"> A. The capacity for all battery backed up loads B. Minimum for life safety branches C. Maximum actual demand D. Emergency and all its normal operating systems | <p>43. How are the cover plates for the essential electrical system required to be identified?</p> <ol style="list-style-type: none"> A. Red B. Marked with a label as "EES" C. Just be different from the rest in some way D. Any listed answer |
| <p>42. The demand calculations in Article 517 for the sizing of generator conductor set(s) is required to be based on which of the following?</p> <ol style="list-style-type: none"> A. Connected load B. Feeder calculations based on Article 220 C. Prudent demand factors and historical data D. All listed answers | <p>44. What branch of the essential electrical system is required for all necessary ways of approach to exits?</p> <ol style="list-style-type: none"> A. Critical B. Life Safety C. Equipment D. Any listed answer |

45. Switching from day illumination to night illumination circuits for hospital corridor lighting is acceptable if what happens?
- Both are on
 - Both are off
 - Only one of the two circuits can be selected
 - Both circuits can be switched simultaneously
46. What branch of the essential electrical system is required to be used for all exit and directional signs used in health care facilities?
- Critical branch
 - Life safety branch
 - Equipment branch
 - Emergency branch
47. Mechanical, control, and other accessories required for effective _____ operations in Article 517 are required to be connected to the life safety branch.
- Life safety system
 - Critical System
 - Illumination
 - Any listed answer
48. What is the function of a hospital communication system?
- Issuing instructions during normal operations
 - Paging of staff members
 - Issuing instructions during emergency conditions
 - Communication between doctors and other staff members
49. The critical branch of the essential electrical system is required to supply power for patient care areas. Which of the following is not a patient care area?
- Medication preparation areas
 - General waiting rooms and corridors
 - Psychiatric bed areas
 - Infant nurseries
50. Task illumination, selected receptacles, and selected power circuits for General care beds provide power for?
- All lighting in patient rooms
 - All receptacles adjacent to bed location
 - Hallway receptacles closest to nurse's station
 - At least one duplex receptacle in each patient bedroom

517.34 Critical Branch (C) Subdivision of the Critical Branch. It shall be permitted to subdivide the critical branch into two or more branches.

Informational Note: It is important to analyze the consequences of supplying an area with only critical care branch power when failure occurs between the area and the transfer switch. Some proportion of normal and critical power or critical power from separate transfer switches may be appropriate.

(Revised) 517.35 Equipment Branch Connection to Alternate Power Source. The equipment system shall be installed and connected to the alternate power source such that the equipment described in 517.35(A) is automatically restored to operation at appropriate time-lag intervals following the energizing of the emergency system. Its arrangement shall also provide for the subsequent connection of equipment described in 517.35(B).

Exception: For essential electrical systems less than 150 kVA, deletion of the time-lag intervals feature for delayed automatic connection to the equipment system shall be permitted.

517.35 (A) Equipment for Delayed Automatic Connection. The following equipment shall be permitted to be arranged for delayed automatic connection to the alternate power source:

- Central suction systems serving medical and surgical functions, including controls. Such suction systems shall be permitted on the critical branch.
- Sump pumps and other equipment required to operate for the safety of major apparatus, including associated control systems and alarms.



- (3) Compressed air systems serving medical and surgical functions, including controls. Such air systems shall be permitted on the critical branch.
- (4) Smoke control and stair pressurization systems, or both.
- (5) Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood.
- (6) Supply, return, and exhaust ventilating systems for airborne infectious/isolation rooms, protective environment rooms, exhaust fans for laboratory fume hoods, nuclear medicine areas where radioactive material is used, ethylene oxide evacuation, and anesthesia evacuation. Where delayed automatic connection is not appropriate; such ventilation systems shall be permitted to be placed on the critical branch.
- (7) Supply, return, and exhaust ventilating systems for operating and delivery rooms.
- (8) Supply, return, exhaust ventilating systems and/or air-conditioning systems serving telephone equipment rooms and closets and data equipment rooms and closets.

Exception: Sequential delayed automatic connection to the alternate power source to prevent overloading the generator shall be permitted where engineering studies indicate it is necessary.

517.35 (B) Equipment for Delayed Automatic or Manual Connection. The following equipment shall be permitted to be arranged for either delayed automatic or manual connection to the alternate power source:

- (1) Heating equipment to provide heating for operating, delivery, labor, recovery, intensive care, coronary care, nurseries, infection/isolation rooms, emergency treatment spaces, and general patient rooms and pressure maintenance (jockey or make-up) pump(s) for water based fire protection systems.

Exception: Heating of general patient rooms and infection/isolation rooms during disruption of the normal source shall not be required under any of the following conditions:

- (a) The outside design temperature is higher than -6.7°C (20°F).
- (b) The outside design temperature is lower than -6.7°C (20°F), and where a selected room(s) is provided for the needs of all confined patients, only such room(s) need be heated.
- (c) The facility is served by a dual source of normal power.

Informational Note No. 1: The design temperature is based on the 97.5 percent design value as shown in Chapter 24 of the ASHRAE Handbook of Fundamentals (2013).

Informational Note No. 2: For a description of a dual source of normal power, see 517.30(C).

- (2) An elevator(s) selected to provide service to patient, surgical, obstetrical, and ground floors during interruption of normal power. In instances where interruption of normal power would result in other elevators stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of patients or other persons who may be confined between floors.
- (3) Hyperbaric facilities.
- (4) Hypobaric facilities.
- (5) Automatically operated doors
- (6) Minimal electrically heated autoclaving equipment shall be permitted to be arranged for either automatic or manual connection to the alternate source.
- (7) Controls for equipment listed in 517.35.
- (8) Other selected equipment shall be permitted to be served by the equipment system.



EXAM QUESTIONS

51. What is permissible for the critical branch of the essential electrical system to be subdivided into?
- A. Two or more branches
 - B. A Supplemental circuit
 - C. Exit sign circuit
 - D. Stairwell emergency lighting
52. Where is the equipment branch required to be connected?
- A. UPS System
 - B. Critical Branch
 - C. Alternate power source
 - D. General waiting rooms and corridors
53. Which of the following equipment is not permitted to be arranged for delayed automatic connection to the alternate power source with regards to health care facilities?
- A. Lighting control panels in critical care areas
 - B. Sump pumps and other equipment required to operate for the safety of major apparatus
 - C. Smoke control and stair pressurization systems, or both
 - D. Central suction systems serving medical and surgical functions, including controls
54. What type of sequential automatic connection to the alternate power source to prevent overloading the generator in a health care facility is permitted where engineering studies indicate it is necessary?
- A. Relayed
 - B. Delayed
 - C. Bypassed
 - D. Ramp-up
55. Article 517 does not allow what listed equipment to be arranged for either delayed automatic or manual connection to the alternate power source.
- A. Neo natal infant care unit machines
 - B. Automatically operated doors
 - C. Hypobaric facilities
 - D. Hyperbaric facilities

517.35 (C) AC Equipment for No Delayed Automatic Connection. Generator accessories, including but not limited to, the transfer fuel pump, electrically operated louvers, and other generator accessories essential for generator operation, shall be arranged for automatic connection to the alternate power source.

(Revised) 517.41 (A) Two Independent Power Sources. Essential electrical systems shall have a minimum of the following two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted.

(Revised) 517.41(B) Types of Power Sources. Where the normal source consists of generating units on the premises, the alternate source shall be either another generating set or an external utility service.

(Revised) 517.41 (C) Location of Essential Electrical System Components. Essential electrical systems shall be located to minimize interruptions caused by natural forces common to the area (e.g., storms, floods, earthquakes, or hazards created by adjoining structures or activities). Installations of electrical services shall be located to reduce possible interruption of normal electrical services resulting from similar causes as well as possible disruption of normal electrical service due to internal wiring and equipment failures. Feeders shall be located to give physical separation of the feeders of the alternate source and from the feeders of the normal electrical source to prevent possible simultaneous interruption.

(Revised) 517.42 Essential Electrical Systems (A) General. Essential electrical systems for nursing homes and limited care facilities shall be divided into the following two branches, the life safety branch and the equipment branch. The division between the branches shall occur at transfer switches where more than one transfer switch is required.

(Revised) 517.42 Essential Electrical Systems (B) Transfer Switches. Transfer Switches. The number of transfer switches to be used shall be based on reliability, design, and load considerations.

- (1) Each branch of the essential electrical system shall have one or more transfer switches.
- (2) One Transfer switch shall be permitted to serve one or more branches or systems in a facility with a continuous load on the switch of 150 kVA (120 kW) or less.

517.42 Essential Electrical Systems (C) Capacity of System. The essential electrical system shall have adequate capacity to meet the demand for the operation of all functions and equipment to be served by each branch at one time.

(Revised) 517.42 Essential Electrical Systems (D) Separation from Other Circuits. The life safety branch and equipment branch shall be kept entirely independent of all other wiring and equipment.

These circuits shall not enter the same raceways, boxes, or cabinets with other wiring except as follows:

- (1) In transfer switches
- (2) In exit or emergency luminaires supplied from two sources
- (3) In a common junction box attached to exit or emergency luminaires supplied from two sources

The wiring of the critical branch shall be permitted to occupy the same raceways, boxes, or cabinets of other circuits that are not part of the life safety branch.

517.42 Essential Electrical Systems (E) Receptacle Identification. The electrical receptacles or the cover plates for the electrical receptacles supplied from the life safety or equipment branches shall have a distinctive color or marking to be readily identifiable.

517.43 Automatic Connection to Life Safety Branch. The life safety branch shall be installed and connected to the alternate source of power so that all functions specified herein shall be automatically restored to operation within 10 seconds after the interruption of the normal source. No functions other than those listed in 517.43(A) through (G) shall be connected to the life safety branch. The life safety branch shall supply power for the following lighting, receptacles, and equipment.

517.43 Automatic Connection to Life Safety Branch (A) Illumination of Means of Egress. The illumination of means of egress as is necessary for corridors, passageways, stairways, landings, and exit doors and all ways of approach to exits. Switching arrangement to transfer patient corridor lighting from general illumination circuits shall be permitted, providing only one of two circuits can be selected and both circuits cannot be extinguished at the same time.

517.43 Automatic Connection to Life Safety Branch (B) Exit Signs. Exit signs and exit directional signs.

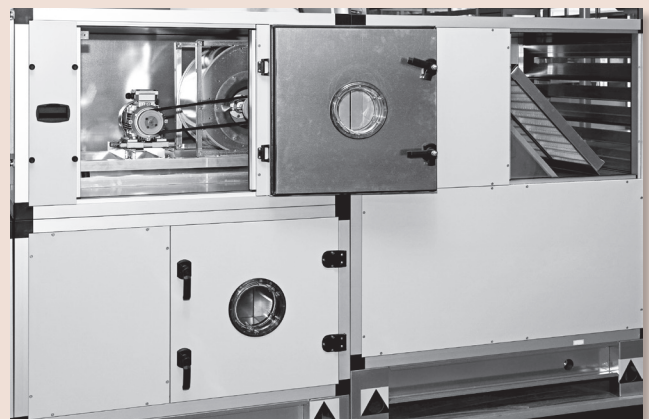
517.43 Automatic Connection to Life Safety Branch (C) Alarm and Alerting Systems. The alarm and alerting systems connected to the life safety branch circuit including the following:

- (1) Fire alarms
- (2) Alarms required for systems used for the piping of nonflammable medical gases

517.43 Automatic Connection to Life Safety Branch (D) Communications Systems. The communications systems, where used for issuing instructions during emergency conditions.

517.43 Automatic Connection to Life Safety Branch (E) Dining and Recreation Areas. Sufficient lighting in dining and recreation areas to provide illumination to exit ways at a minimum of 5ft-candels.

517.43 Automatic Connection to Life Safety Branch (F) Generator Set Location. Task illumination and selected receptacles in the generator set location.



517.43 Automatic Connection to Life Safety Branch (G) Elevators. Elevator cab lighting, control, communications, and signal systems.

(Revised) 517.44 Connection to Equipment Branch. The equipment branch shall be installed and connected to the alternate power source so that the equipment listed in 517.44(A) shall be automatically restored to operation at appropriate time-lag intervals following the restoration of the life safety branch to operation.

The equipment branch arrangement shall also provide for the additional connection of equipment listed in 517.44(B).

Exception: For essential electrical systems under 150 kVA, deletion of the time-lag intervals feature for delayed automatic connection to the equipment system shall be permitted.

EXAM QUESTIONS

56. What type of connection is required to be made to the alternate power source for generator accessories essential for generator operation?
 - A. Solidly grounded
 - B. Manual
 - C. Automatic
 - D. Remote
57. What is the minimum amount of independent power sources required to make up the essential electrical system?
 - A. Three
 - B. One
 - C. Five
 - D. Two
58. Careful consideration must be given to the location of the essential electrical system components to minimize interruptions due to what?
 - A. Regular scheduled maintenance
 - B. Natural forces
 - C. Load demands
 - D. Life safety circuits
59. A limited care facility's essential electrical system is required to be comprised of how many separate branches?
 - A. 1
 - B. 4
 - C. 3
 - D. 2
60. What determines the number of transfer switches to be used for a limited care facility's Essential Electrical System?
 - A. Load considerations
 - B. Design
 - C. Reliability
 - D. All listed answers
61. The essential electrical system in a nursing home is required to have adequate capacity for what listed option?
 - A. Have interlocking disconnects
 - B. Power all branches simultaneously
 - C. Meet the demand for the operation of all functions and equipment to be served by each branch at one time
 - D. All listed answers
62. How is the life safety branch of the essential electrical system in a nursing home is required to be installed?
 - A. Separated from all other wiring and equipment
 - B. Combined and identified from all other wiring and equipment
 - C. Combined with the equipment branch raceway
 - D. No Special requirements
63. What branch is permitted to occupy the same raceways, boxes, or cabinets of other circuits that are not part of the life safety branch?
 - A. Life support
 - B. Emergency
 - C. Critical
 - D. Life safety

64. What is the maximum time the life safety branch circuit has to automatically restore power after the interruption of the normal source occurs?
- 20 seconds
 - 10 seconds
 - 30 seconds
 - 15 seconds
65. What branch of the essential electrical system is required for all necessary ways of approach to exits in nursing homes?
- Critical
 - Life Safety
 - Equipment
 - Any listed answer
66. Switching from day illumination to night illumination circuits for nursing home corridor lighting is acceptable if what happens?
- Both are on
 - Both are off
 - Only one of the two circuits can be selected
 - Both circuits can be switched simultaneously
67. What branch of the essential electrical system is required to be used for all exit and directional signs used in limited care facilities?
- Critical branch
 - Life safety branch
 - Equipment branch
 - Emergency branch
68. Which of the following is NOT required to be connected to the life safety branch in a limited care facility?
- Generator set
 - Elevators
 - Parking lot lights
 - Dining and recreation
69. What is the maximum KVA that deletion of the time-lag intervals feature for delayed automatic connection to the equipment branch is permitted?
- 150 kVA
 - 200 kVA
 - 100 kVA
 - 500 kVA

(Revised) 517.44 Connection to Equipment Branch (A) Delayed Automatic Connections to Equipment Branch.

The following equipment shall be permitted to be connected to the equipment branch and shall be arranged for delayed automatic connection to the alternate power source:

(1) Task illumination and selected receptacles in the following:

- Patient care spaces
- Medication preparation spaces
- Pharmacy dispensing areas
- Nurses' stations (unless adequately lighted by corridor luminaries)

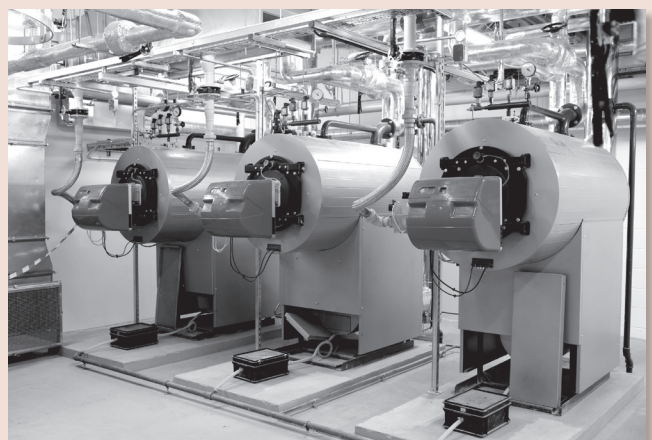
(2) Supply, return, and exhaust ventilating systems for airborne infectious isolation rooms

(3) Sump pumps and other equipment required to operate for the safety of major apparatus and associated control systems and alarms

(4) Smoke control and stair pressurization systems

(5) Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood

(6) Nurse call systems



(Revised) 517.44 Connection to Critical Branch (B) Delayed Automatic or Manual Connection to the Equipment Branch. The following equipment shall be permitted to be connected to the critical equipment branch circuit and shall be arranged for either delayed automatic or manual connection to the alternate power source:

(1) Heating equipment to provide heating for patient rooms.

Exception: Heating of general patient rooms during disruption of the normal source shall not be required under any of the following conditions:

- (1) The outside design temperature is higher than -6.7°C (20°F).
- (2) The outside design temperature is lower than -6.7°C (20°F) and where a selected room(s) is provided for the needs of all confined patients, only such room(s) need be heated.
- (3) The facility is served by a dual source of normal power as described in 517.41(C), Informational Note.

Informational Note: The outside design temperature is based on the 97.5 percent design values as shown in Chapter 24 of the ASHRAE Handbook of Fundamentals (2013).

- (4) Elevator service — in instances where disruption of power would result in elevators stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of passengers. For elevator cab lighting, control, and signal system requirements, see 517.43(G).
- (5) Additional illumination, receptacles, and equipment shall be permitted to be connected only to the critical branch.

517.60 Anesthetizing Location Classification (A) Hazardous (Classified)

Location. (1) Use Location. In a location where flammable anesthetics are employed, the entire area shall be considered to be a Class I, Division 1 location that extends upward to a level 1.52 m (5 ft) above the floor. The remaining volume up to the structural ceiling is considered to be above a hazardous (classified) location.

517.60 Essential Electrical Systems for Other Health Care Facilities.

(2) Storage Location. Any room or location in which flammable anesthetics or volatile flammable disinfecting agents are stored shall be considered to be a Class I, Division 1 location from floor to ceiling.



EXAM QUESTIONS

70. Which of the following does NOT have to be connected to the delayed automatic connection of the critical branch circuit?
 - A. Waiting rooms
 - B. Pharmacy dispensing areas
 - C. Medication preparation areas
 - D. Nurses' stations (unless adequately lighted by corridor luminaries)
71. Sump pumps are some of the equipment permitted to be connected to the _____ and arranged for auto delay.
 - A. Life safety
 - B. Critical equipment branch
 - C. Emergency power
 - D. Equipment Branch
72. What do throw-over facilities allow?
 - A. Equipment operation for medical gas equipment
 - B. The temporary operation of any elevator for the release of passengers
 - C. Escalator power and function during a power loss situation
 - D. Annunciator panels for nursing stations
73. How high does the classification area extend vertically above flammable anesthetics use locations?
 - A. To the ceiling
 - B. 7 feet
 - C. 5 feet
 - D. 10 feet
74. How high does the classification area extend vertically above flammable anesthetics storage locations?
 - A. To the ceiling
 - B. 7 feet
 - C. 5 feet
 - D. 10 feet

517.60 Anesthetizing Location Classification (B) Other-Than-Hazardous (Classified) Location. Any inhalation anesthetizing location designated for the exclusive use of nonflammable anesthetizing agents shall be considered to be an other-than-hazardous (classified) location.

517.61 Wiring and Equipment (A) Within Hazardous (Classified) Anesthetizing Locations.

- (1) **Isolation.** Except as permitted in 517.160, each power circuit within, or partially within, a flammable anesthetizing location as referred to in 517.60 shall be isolated from any distribution system by the use of an isolated power system.
- (2) **Design and Installation.** Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment and the isolated power system shall be designed and installed in accordance with 517.160.
- (3) **Equipment Operating at More Than 10 Volts.** In hazardous (classified) locations referred to in 517.60, all fixed wiring and equipment and all portable equipment, including lamps and other utilization equipment, operating at more than 10 volts between conductors shall comply with the requirements of 501.1 through 501.25, and 501.100 through 501.150, and 501.30(A) and 501.30(B) for Class I, Division 1 locations. All such equipment shall be specifically approved for the hazardous atmospheres involved.
- (4) **Extent of Location.** Where a box, fitting, or enclosure is partially, but not entirely, within a hazardous (classified) location(s), the hazardous (classified) location(s) shall be considered to be extended to include the entire box, fitting, or enclosure.
- (5) **Receptacles and Attachment Plugs.** Receptacles and attachment plugs in a hazardous (classified) location(s) shall be listed for use in Class I, Group C hazardous (classified) locations and shall have provision for the connection of a grounding conductor.
- (6) **Flexible Cord Type.** Flexible cords used in hazardous (classified) locations for connection to portable utilization equipment, including lamps operating at more than 8 volts between conductors, shall be of a type approved for extra hard usage in accordance with Table 400.4 and shall include an additional conductor for grounding.
- (7) **Flexible Cord Storage.** A storage device for the flexible cord shall be provided and shall not subject the cord to bending at a radius of less than 75 mm (3 in.).



517.61 Wiring and Equipment (B)(6) Above Hazardous (Classified) Anesthetizing Locations. Receptacles and attachment plugs rated 250 volts, for connection of 50- ampere and 60-ampere ac medical equipment for use above hazardous (classified) locations, to be arranged so that the 60-ampere receptacle will accept either the 50-ampere or the 60-ampere plug. Fifty ampere receptacles shall be designed so as not to accept the 60-ampere attachment plug. The attachment plugs shall be of the 2-pole, 3-wire design with a third contact connecting to the insulated (green or green with yellow stripe) equipment grounding conductor of the electrical system.

EXAM QUESTIONS

75. What type of location is an inhalation anesthetizing location designated for the exclusive use of nonflammable anesthetizing agents know as?
- Patient examination location
 - Class 1 Division 1
 - Nonflammable classified area
 - Other-than-hazardous (classified) location
76. What type of power supply are power circuits in or partially in a flammable anesthetizing location required to have?
- Variable current
 - Direct Current
 - Single phase
 - Isolated
77. What section requires a flammable anesthetizing location to be isolated from any other distribution systems?
- 517.61
 - 517.60
 - 517.32
 - 517.61(A)(7)
78. What is the maximum voltage between conductors that portable hospital equipment used in a hazardous location can be operated without having to meet the requirements of Article 501.30(A)?
- 12
 - 10
 - 11
 - 24
79. For what class and group are receptacles, including attachment plugs, required to be listed when used in a hazardous location?
- Class 2, Group D
 - Class 1, Group C
 - Class 1, Group A
 - Class 2, Group C
80. If a 60-amp receptacle and attachment plug are used above hazardous locations, the 60-amp plug is allowed to receive what listed amperage?
- 60 amps only
 - 50 amps only
 - Both 50 & 60 amps
 - No special requirement

517.63 Grounded Power Systems in Anesthetizing Locations (A) Battery-Powered Lighting Units. One or more battery-powered lighting units shall be provided and shall be permitted to be wired to the critical lighting circuit in the area and connected ahead of any local switches.

517.63 Grounded Power Systems in Anesthetizing Location (B) Branch-Circuit Wiring. The branch circuits supplying only listed, fixed, therapeutic and diagnostic equipment, permanently installed above the hazardous (classified) location and in other-than-hazardous (classified) locations, shall be permitted to be supplied from a normal grounded service, single- or three-phase system, provided the following apply:

- Wiring for grounded and isolated circuits does not occupy the same raceway or cable.
- All conductive surfaces of the equipment are connected to an equipment grounding conductor.
- Equipment (except enclosed X-ray tubes and the leads to the tubes) is located at least 2.5 m (8 ft) above the floor or outside the anesthetizing location.
- Switches for the grounded branch circuit are located outside the hazardous (classified) location.

Exception: Sections 517.63(B)(3) and (B)(4) shall not apply in other-than-hazardous (classified) locations.



517.63 Grounded Power Systems in Anesthetizing Location (C) Fixed Lighting Branch Circuits. The branch circuits supplying only fixed lighting shall be permitted to be supplied by a normal grounded service provided the following apply:

- (1) Such luminaires are located at least 2.5 m (8 ft) above the floor.
- (2) All conductive surfaces of luminaires are connected to an equipment grounding conductor.
- (3) Wiring for circuits supplying power to luminaires does not occupy the same raceway or cable for circuits supplying isolated power.
- (4) Switches are wall-mounted and located above hazardous (classified) locations.

517.63 Grounded Power Systems in Anesthetizing Location (D) Remote-Control Stations. Wall-mounted remote-control stations for remote-control switches operating at 24 volts or less shall be permitted to be installed in any anesthetizing location.

517.63 Grounded Power Systems in Anesthetizing Location (E) Location of Isolated Power Systems. Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment. Isolated power system equipment and its supply circuit shall be permitted to be located in an anesthetizing location, provided it is installed above a hazardous (classified) location or in other-than-hazardous (classified) location.

517.64 Low-Voltage Equipment and Instruments. (A) Equipment Requirements. Low-voltage equipment that is frequently in contact with the bodies of persons or has exposed current-carrying elements to comply with one of the following:

- (1) Operate on an electrical potential of 10 volts or less
- (2) Be approved as intrinsically safe or double-insulated equipment
- (3) Be moisture resistant

517.64 Low-Voltage Equipment and Instruments (B) Power Supplies. Power that is to be supplied to low-voltage equipment to comply with one of the following:

- (1) An individual portable isolating transformer (autotransformers shall not be used) connected to an isolated power circuit receptacle by means of an appropriate cord and attachment plug
- (2) A common low-voltage isolating transformer installed in other-than-hazardous (classified) location
- (3) Individual dry-cell batteries
- (4) Common batteries made up of storage cells located in other-than-hazardous (classified) location

517.64 Low-Voltage Equipment and Instruments (C) Isolated Circuits. Isolating-type transformers for supplying low-voltage circuits shall have both of the following:

- (1) Approved means for insulating the secondary circuit from the primary circuit
- (2) The core and case connected to an equipment grounding conductor

517.64 Low-Voltage Equipment and Instruments (D) Controls. Resistance or impedance devices shall be permitted to control low-voltage equipment but shall not be used to limit the maximum available voltage to the equipment.

517.64 Low-Voltage Equipment and Instruments (E) Battery-Powered Appliances. Battery-powered appliances shall not be capable of being charged while in operation unless their charging circuitry incorporates an integral isolating-type transformer.



517.64 Low-Voltage Equipment and Instruments (F) Receptacles or Attachment Plugs. Any receptacle or attachment plug used on low-voltage circuits to be of a type that does not permit interchangeable connection with circuits of higher voltage.

Informational Note: Any interruption of the circuit, even circuits as low as 10 volts, either by any switch or loose or defective connections anywhere in the circuit, may produce a spark that is sufficient to ignite flammable anesthetic agents.

EXAM QUESTIONS

81. How many battery powered lighting units are required in anesthetizing locations?
 - A. One
 - B. Three
 - C. Two
 - D. Five
82. How many provisions must be met for the branch circuits that supply fixed listed therapeutic equipment above hazardous locations so they can be supplied from a normal grounded service?
 - A. 3
 - B. 2
 - C. 4
 - D. 5
83. What is the maximum voltage where all wall-mounted remote-control stations for remote-control switches in anesthetizing locations can be installed in any location?
 - A. 28 Volts
 - B. 24 volts
 - C. 30 Volts
 - D. 36 Volts
84. What is isolated power system equipment required to be listed as?
 - A. Class 1 Division 2
 - B. Safety equipment
 - C. Isolated power equipment
 - D. Anesthetizing equipment
85. Which of the following is not a requirement for low voltage equipment that has exposed current-carrying elements in health care facilities?
 - A. Be moisture resistant
 - B. Operate on an electrical potential of 10 volts or less
 - C. Be listed and labeled as an exposed device
 - D. Be approved as intrinsically safe or double-insulated equipment
86. What is the core of an Isolation type transformers used for supplying low voltage circuits in health care facilities required to be connected to?
 - A. Delta windings
 - B. Wye windings
 - C. The center tap of B phase
 - D. Transformer Case
87. Resistance devices used in health care facilities are permitted to control equipment but are not permitted to limit the equipment's maximum allowable _____.
 - A. Line voltage
 - B. Load voltage
 - C. Low-voltage
 - D. Control voltage
88. Battery-powered appliances cannot be capable of being charged while in operation unless their charging circuitry incorporates what when used in health care facilities?
 - A. Integral isolating-type transformer
 - B. An AC inverter
 - C. Integral DC source
 - D. Grounding Electrode connection point
89. What are receptacles or attachment plugs used with low voltage equipment not permitted to interchange with in health care facilities?
 - A. Circuits of lower voltage
 - B. Non dedicated loads
 - C. Circuits of higher voltage
 - D. Non Transformed voltages specific to the equipment

517.71 Connection to Supply Circuit (A) Fixed and Stationary Equipment. Any fixed and stationary X-ray equipment shall be connected to the power supply by means of a wiring method complying with applicable requirements of Chapters 1 through 4 of this Code, as modified by this article.

Exception: Equipment properly supplied by a branch circuit rated at not over 30 amperes shall be permitted to be supplied through a suitable attachment plug and hard service cable or cord.

517.71 Connection to Supply Circuit (B) Portable, Mobile, and Transportable Equipment. Individual branch circuits shall not be required for portable, mobile, and transportable medical X-ray equipment requiring a capacity of not over 60 amperes.

517.72 Disconnecting Means (A) Capacity. The disconnecting means of adequate capacity for at least 50 percent of the input required for the momentary rating or 100 percent of the input required for the long-time rating of the X-ray equipment, whichever is greater, shall be provided in the supply circuit.

517.72 Disconnecting Means (B) Location. The disconnecting means shall be operable from a location readily accessible from the X-ray control.

517.72 Disconnecting Means (C) Portable Equipment. For equipment connected to a 120-volt branch circuit of 30 amperes or less, a grounding type attachment plug and receptacle of proper rating shall be permitted to serve as a disconnecting means.

517.73 Rating of Supply Conductors and Over current Protection (B) Therapeutic Equipment. The ampacity of conductors and rating of over current protective devices shall not be less than 100 percent of the current rating of medical X-ray therapy equipment.

Informational Note: The ampacity of the branch-circuit conductors and the ratings of disconnecting means and over current protection for X-ray equipment are usually designated by the manufacturer for the specific installation.

517.74 Control Circuit Conductors (B) Minimum Size of Conductors. Size 18 AWG or 16 AWG fixture wires as specified in 725.49 and flexible cords shall be permitted for the control and operating circuits of X-ray and auxiliary equipment where protected by not larger than 20-ampere over current devices.

517.75 Equipment Installations. All equipment for new X-ray installations and all used or reconditioned X-ray equipment moved to and reinstalled at a new location shall be of an approved type.

517.76 Transformers and Capacitors. Transformers and capacitors that are part of X-ray equipment shall not be required to comply with Articles 450 and 460. Capacitors shall be mounted within enclosures of insulating material or grounded metal.

517.77 Installation of High-Tension X-Ray Cables. Cables with grounded shields connecting X-ray tubes and image intensifiers shall be permitted to be installed in cable trays or cable troughs along with X-ray equipment control and power supply conductors without the need for barriers to separate the wiring.

517.78 Guarding and Grounding (A) High-Voltage Parts. All high-voltage parts, including X-ray tubes, shall be mounted within grounded enclosures. Air, oil, gas, or other suitable insulating media shall be used to insulate the high-voltage from the grounded enclosure. The connection from the high-voltage equipment to



X-ray tubes and other high-voltage components shall be made with high-voltage shielded cables.

517.78 Guarding and Grounding (B) Low-Voltage Cables. Low-voltage cables connecting to oil-filled units that are not completely sealed, such as transformers, condensers, oil coolers, and high-voltage switches, shall have insulation of the oil-resistant type.

517.78 Guarding and Grounding (C) Non-Current-Carrying Metal Parts. Non-current carrying metal parts of X-ray and associated equipment (controls, tables, X-ray tube supports, transformer tanks, shielded cables, X-ray tube heads, etc.) shall be connected to an equipment grounding conductor in the manner specified in Part VII of Article 250, as modified by 517.13(A) and (B).

517.160 Isolated Power Systems. (A)(6) Wire-Pulling Compounds. Wire-pulling compounds that increase the dielectric constant must not be used on the secondary conductors of the isolated power supply



EXAM QUESTIONS

90. X-ray equipment properly supplied by a branch circuit rated at not over _____ amperes is permitted to be supplied through a suitable attachment plug and hard service cable or cord.
- A. 10
 - B. 30
 - C. 15
 - D. 20

WCI Wisconsin Contractors Institute

CONTINUING
EDUCATION | FOR WISCONSIN
ELECTRICIANS

2017 NEC Article 680
3 Hours



WISCONSIN CONTRACTORS INSTITUTE

262-409-4282

www.wcittraining.com

DISCLAIMER NOTE: This course is APPROVED by the Wisconsin Department of safety and professional services for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes.

ARTICLE 680

Article 680 is organized into 7 different parts that deal with specific requirements with regards to pools and bodies of water. The specific parts are as follows:

- I. General
- II. Permanently Installed Pools
- III. Storable Pools, Storable Spas, and Storable Hot Tubs
- IV. Spas and Hot Tubs
- V. Fountains
- VI. Pools and Tubs for Therapeutic Use
- VII. Hydro massage Bathtubs

Dry-Niche Luminaire. A luminaire intended for installation in the floor or wall of a pool, spa, or fountain in a niche that is sealed against the entry of water.

(NEW) 680.2 Electrically Powered Pool Lift. An electrically powered lift that provides accessibility to and from a pool or spa for people with disabilities.

Packaged Spa or Hot Tub Equipment Assembly. A factory fabricated unit consisting of water-circulating, heating, and control equipment mounted on a common base, intended to operate a spa or hot tub. Equipment can include pumps, air blowers, heaters, lights, controls, sanitizer generators, and so forth.

Hydro massage Bathtub. A permanently installed bathtub equipped with a recirculating piping system, pump, and associated equipment. It is designed so it can accept, circulate, and discharge water upon each use.

Permanently Installed Decorative Fountains and Reflection Pools. Those that are constructed in the ground, on the ground, or in a building in such a manner that the fountain cannot be readily disassembled for storage, whether or not served by electrical circuits of any nature. These units are primarily constructed for their aesthetic value and are not intended for swimming or wading.

Permanently Installed Swimming, Wading, Immersion, and Therapeutic Pools. Those that are constructed in the ground or partially in the ground, and all others capable of holding water in a depth greater than 1.0 m (42 in.), and all pools installed inside of a building, regardless of water depth, whether or not served by electrical circuits of any nature.



EXAM QUESTIONS

1. What part of Article 680 should be referenced when installing a permanently installed pool?
 - A. I
 - B. II
 - C. III
 - D. V
2. What are primarily constructed for their aesthetic value and are either in the ground, on the ground, or in a building and cannot be readily disassembled for storage?
 - A. Fountains
 - B. Permanently Installed Swimming, Wading, Immersion, and Therapeutic Pools
 - C. Storable Swimming, Wading, or Immersion Pool
 - D. Permanently installed decorative fountains and reflection pools

3. What term best describes an electrically powered lift that provides accessibility to and from a pool or spa for people with disabilities?
 - A. Powered Pool Lift, Electric
 - B. Electronically Powered Pool Lift
 - C. Electrically Powered Pool Lift
 - D. Powered Pool Lift, Electronic
4. Information regarding the installation requirements for Hydro Massage Bathtubs can be found in what part of Article 680?
 - A. V
 - B. I
 - C. III
 - D. VII
5. What term covers bathtubs with a recirculating piping system, pump, and associated equipment that is designed to be permanently installed?
 - A. Spa or hot tub
 - B. Hydro massage bathtub
 - C. Pool
 - D. Equipment, fixed
6. If installing a storable hot tub, what part of Article 680 should be referenced?
 - A. VII
 - B. I
 - C. III
 - D. V
7. What listed term is capable of holding water greater than the depth of 42 inches?
 - A. Contained Permanently Installed Swimming, Wading, Immersion, and Therapeutic Pools
 - B. Permanently Installed Decorative Fountains and Reflection Pools
 - C. Storable Swimming, Wading, or Immersion Pool
 - D. Self Therapeutic Tubs or Hydrotherapeutic Tanks
8. What best defines a fixture that is sealed from the entry of water that is installed in the floor or wall of pools, spas, or fountains?
 - A. Wet-niche Luminaire
 - B. Dry-niche Luminaire
 - C. No-niche Luminaire
 - D. Through-wall lighting assembly
9. What part of Article 680 deals with fountains?
 - A. V
 - B. I
 - C. III
 - D. VII
10. What is a factory fabricated unit consisting of water-circulating, heating, and control equipment mounted on a common base intended to operate a spa or hot tub?
 - A. Portable equipment
 - B. Spa or hot tub
 - C. Packaged spa or hot tub equipment assembly
 - D. Cord-and-plug-connected equipment
11. What part of Article 680 deals with the general requirements for pools and other structures that contain water and have electrical power?
 - A. III
 - B. I
 - C. VII
 - D. V

Pool. Manufactured or field-constructed equipment designed to contain water on a permanent or semi-permanent basis and used for swimming, wading, immersion, or therapeutic purposes.

Self-Contained Therapeutic Tubs or Hydrotherapeutic Tanks. A factory-fabricated unit consisting of a therapeutic tub or hydrotherapeutic tank with all water-circulating, heating, and control equipment integral to the unit. Equipment may include pumps, air blowers, heaters, light controls, sanitizer generators, and so forth.

Spa or Hot Tub. A hydro massage pool, or tub for recreational or therapeutic use, not located in health care facilities, designed for immersion of users, and usually having a filter, heater, and motor-driven blower. It may

be installed indoors or outdoors, on the ground or supporting structure, or in the ground or supporting structure. Generally, a spa or hot tub is not designed or intended to have its contents drained or discharged after each use.

Storable Swimming, Wading, or Immersion Pools; or Storable/Portable Spas and Hot Tubs. Swimming, wading, or immersion pools that are intended to be stored when not in use, constructed on or above the ground and are capable of holding water to a maximum depth of 1.0 m (42 in.), or a pool, spa, or hot tub constructed on or above the ground, with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension.

(NEW) 680.7 Grounding and Bonding Terminals. Grounding and bonding terminals shall be identified for use in wet and corrosive environments. Field-installed grounding and bonding connections in a damp, wet, or corrosive environment shall be composed of copper, copper alloy, or stainless steel. They shall be listed for direct burial use.

Article 680.8 Cord-and-plug-connected equipment. Fixed or stationary equipment other than underwater luminaires, for a permanently installed pool shall be permitted to be connected with a flexible cord and plug to facilitate the removal or disconnection for maintenance or repair.

680.10 Electric Pool Water Heaters. All electric pool water heaters shall have the heating elements subdivided into loads not exceeding 48 amperes and protected at not over 60 amperes. The ampacity of the branch-circuit conductors and the rating or setting of overcurrent protective devices shall not be less than 125 percent of the total nameplate-rated load.



PART 3 EXAM QUESTIONS

- | | |
|--|--|
| <p>12. What is generally designed to not have its contents drained or discharged after each use.</p> <ul style="list-style-type: none"> A. Hydro massage bathtub B. Pool C. Fountains D. Spa or hot tub | <p>14. What maximum depth is listed for a nonmetallic pool to still be considered storable?</p> <ul style="list-style-type: none"> A. 40 B. 46 C. 48 D. 42 |
| <p>13. What is designed to permanently or semi permanently contain water on the basis that it is used for swimming, wading, immersion, or therapeutic purposes?</p> <ul style="list-style-type: none"> A. Spa or hot tub B. Pool C. Fountains D. Hydro massage bathtub | <p>15. What best defines fixed or stationary equipment other than underwater luminaires for a permanently installed pool to facilitate the removal or disconnection for maintenance or repair?</p> <ul style="list-style-type: none"> A. Hydro massage bathtub B. Spa or hot tub C. Fountains D. Cord-and-plug-connected equipment |

16. What is a grounding terminal installed in the wet and corrosive environment around a pool required to be listed for?
- A. Moisture resistance
 - B. Hard usage
 - C. Direct burial
 - D. All listed answers

17. What is the maximum current electric pool water heaters are required to have their heating elements subdivided into?
- A. 48
 - B. 24
 - C. 60
 - D. 12

(NEW) 680.14 (A) General. Areas where pool sanitation chemicals are stored, as well as areas with circulation pumps, automatic chlorinators, filters, open areas under decks adjacent to or abutting the pool structure, and similar locations shall be considered to be a corrosive environment. The air in such areas shall be considered to be laden with acid, chlorine, and bromine vapors, or any combination of acid, chlorine, or bromine vapors, and any liquids or condensation in those areas shall be considered to be laden with acids, chlorine, and bromine vapors, or any combination of acid, chlorine, or bromine vapors.

(Revised) Article 680.21 Motors (A) Wiring methods (1) general. Wiring methods installed in the corrosive environment described in 680.14 shall comply with 680.14(B) or shall be type MC cable listed for that location. Wiring methods installed in these locations shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122 but not smaller than 12 AWG. Where installed in noncorrosive environments, branch circuits shall comply with the general requirements in Chapter 3.



Article 680.22 lighting, receptacles, and equipment (A) receptacles (1) Required Receptacle, Location. Where a permanently installed pool is installed at a dwelling unit(s), no fewer than one 125-volt, 15- or 20-ampere receptacle on a general-purpose branch circuit shall be located not less than 1.83 m (6 ft.) from, and not more than 6.0 m (20 ft.) from, the inside wall of the pool. This receptacle shall be located not more than 2.0 m (6 ft. 6 in.) above the floor, platform, or grade level serving the pool.

(Revised) 680.22 (A)(2) Circulation and Sanitation System, Location. Receptacles that provide power for water-pump motors or for other loads directly related to the circulation and sanitation system shall be located at least 1.83 m (6 ft) from the inside walls of the pool. These receptacles shall have GFCI protection and be of the grounding type.

680.22 Lighting, Receptacles, and Equipment (B) (1) New Outdoor Installation Clearances. In outdoor pool areas, luminaires, lighting outlets, and ceiling suspended (paddle) fans installed above the pool or the area extending 1.5 m (5 ft) horizontally from the inside walls of the pool shall be installed at a height not less than 3.7 m (12 ft) above the maximum water level of the pool.

EXAM QUESTIONS

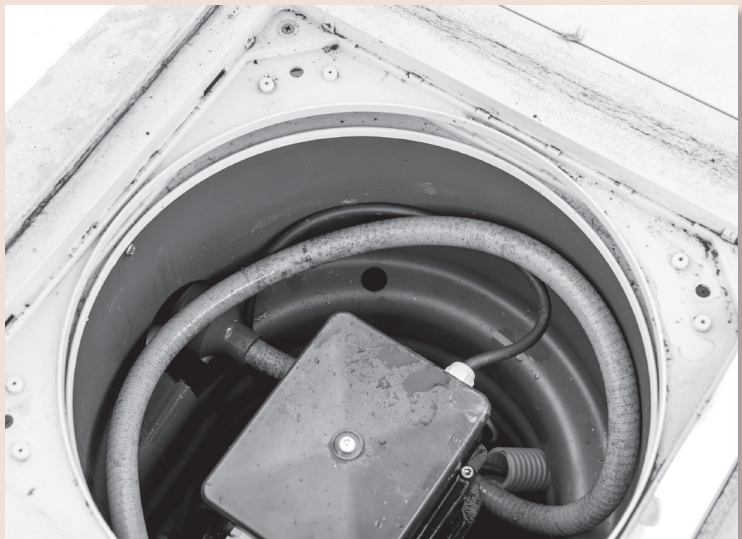
18. What type of environment is the storage of pool chemicals considered?
 - A. Particulate hazard
 - B. Class 1 division 1
 - C. Combustible
 - D. Corrosive
19. What table must be used when installing an equipment grounding conductor in a pool area?
 - A. 250.66
 - B. 250.122
 - C. 250.104
 - D. 250.102(D)
20. What is the minimum size an insulated copper equipment grounding conductor can be when installed in a pool area?
 - A. 12 AWG
 - B. 14 AWG
 - C. 10 AWG
 - D. 8 AWG
21. How far from the inside wall of a pool are receptacles that power water-pump motors for the sanitation system required to be?
 - A. 6 ft
 - B. 4 ft
 - C. 5 ft
 - D. 10 ft
22. How many 125-volt, 15- or 20-ampere receptacle are required to be installed around a permanent dwelling unit pool?
 - A. 4
 - B. 2
 - C. 1
 - D. 3
23. What is the minimum height above a pool that a paddle fan can be installed?
 - A. (7 ft 6 in)
 - B. (5 ft)
 - C. (12 ft)
 - D. (10 ft.)

680.22 Lighting, Receptacles, and Equipment (B) (2) Indoor Clearances. For installations in indoor pool areas, the clearances shall be the same as for outdoor areas unless modified as provided in this paragraph. If the branch circuit supplying the equipment is protected by a ground-fault circuit interrupter, the following equipment shall be permitted at a height not less than 2.3 m (7 ft 6 in.) above the maximum pool water level:

- (1) Totally enclosed luminaires
- (2) Ceiling-suspended (paddle) fans identified for use beneath ceiling structures such as provided on porches or patios

680.22 Lighting, Receptacles, and Equipment (B) (3) Existing Installations. Existing luminaires and lighting outlets located less than 1.5 m (5 ft) measured horizontally from the inside walls of a pool shall be not less than 1.5 m (5 ft) above the surface of the maximum water level, shall be rigidly attached to the existing structure, and shall be protected by a ground-fault circuit interrupter.

680.22 Lighting, Receptacles, and Equipment (B) (4) GFCI Protection in Adjacent Areas. Pool luminaires, lighting outlets, and ceiling-suspended (paddle) fans installed in the area extending between 1.5 m (5 ft) and 3.0 m (10 ft) horizontally from the inside walls of a pool shall be protected by a ground-fault circuit



interrupter unless installed not less than 1.5 m (5 ft) above the maximum water level and rigidly attached to the structure adjacent to or enclosing the pool.

(NEW) 680.22 (B)(7) Low-Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits, and Similar Equipment. Listed low-voltage gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment using low-voltage ignitors that do not require grounding, and are supplied by listed transformers or power supplies that comply with 680.23(A)(2) with outputs that do not exceed the low-voltage contact limit shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of the pool. Metallic equipment shall be bonded in accordance with the requirements in 680.26(B). Transformers or power supplies supplying this type of equipment shall be installed in accordance with the requirements in 680.24. Metallic gas piping shall be bonded in accordance with the requirements in 250.104(B) and 680.26(B)(7).

680.22 Lighting, Receptacles, and Equipment (C) Switching Devices. Switching devices shall be located around pools at least 1.5 m (5 ft) horizontally from the inside walls of a pool unless separated from the pool by a solid fence, wall, or other permanent barrier. Alternatively, a switch that is listed as being acceptable for use within 1.5 m (5 ft) shall be permitted.

(Revised) 680.23 Underwater luminaires (A)(2) Transformers and Power Supplies. Transformers and power supplies used for the supply of underwater luminaires, together with the transformer or power supply enclosure, shall be listed, Labeled, and identified for swimming pool and spa use. The transformer or power supply shall incorporate either a transformer of the isolated winding type, with an ungrounded secondary that has a grounded metal barrier between the primary and secondary windings, or one that incorporates an approved system of double insulation between the primary and secondary windings.

EXAM QUESTIONS

24. How are luminaires required to be protected that extend between 1.5 m (5 ft) and 3.0 m (10 ft) horizontally from the inside of a pool?
 - A. GFCI
 - B. AFCI
 - C. Water resistant lens covers
 - D. Nonmetallic fixture covers
25. What type of transformer/power supply can be used around pool areas besides one that incorporates an approved system of double insulation between the primary and secondary windings?
 - A. Transformer of the isolated winding type, with a grounded secondary that has an ungrounded nonmetallic barrier between the primary and secondary windings
 - B. Transformer of the isolated winding type, with a grounded secondary that has an ungrounded metal barrier between the primary and secondary windings
 - C. Transformer of the isolated winding type, with an ungrounded secondary that has a grounded metal barrier between the primary and secondary windings
 - D. No listed answer
26. How are luminaires and lighting outlets in existing pool locations required to be attached?
 - A. With guarded coverings
 - B. Securely
 - C. Openly
 - D. Rigidly
27. How far from the inside wall of a pool can a fire pit using low-voltage ignitors not requiring grounding supplied by a listed power supply be installed?
 - A. 6 ft
 - B. 4 ft
 - C. 5 ft
 - D. 10 ft
28. What is the minimum height above the max pool water level that a totally enclosed luminaire GFCI protected can be installed in an indoor pool area?
 - A. 3.7 m (12 ft.)
 - B. 1.5 m (5 ft)
 - C. 4.4 m (14.5 ft)
 - D. 2.3 m (7 ft 6 in)

29. What is the minimum distance horizontally from the inside walls of a pool that switching devices can be installed? Assume there is no permanent barrier between the pool and the switching device.

- A. 5 ft.
- B. 6 ft.
- C. 6 ft. 6 inches
- D. 7 ft. 6 inches

(Revised) 680.23 Underwater luminaires (A)(3) GFCI Protection, Lamping, Relamping, and Servicing. Ground-fault circuit-interrupter protection for personnel shall be installed in the branch circuit supplying luminaires operating at voltages greater than the low-voltage contact limit. 680.23 Underwater luminaires

680.23 (A)(5) Location, Wall-Mounted Luminaires. Luminaires mounted in walls shall be installed with the top of the luminaire lens not less than 450 mm (18 in.) below the normal water level of the pool, unless the luminaire is listed and identified for use at lesser depths. No luminaire shall be installed less than 100 mm (4 in.) below the normal water level of the pool.

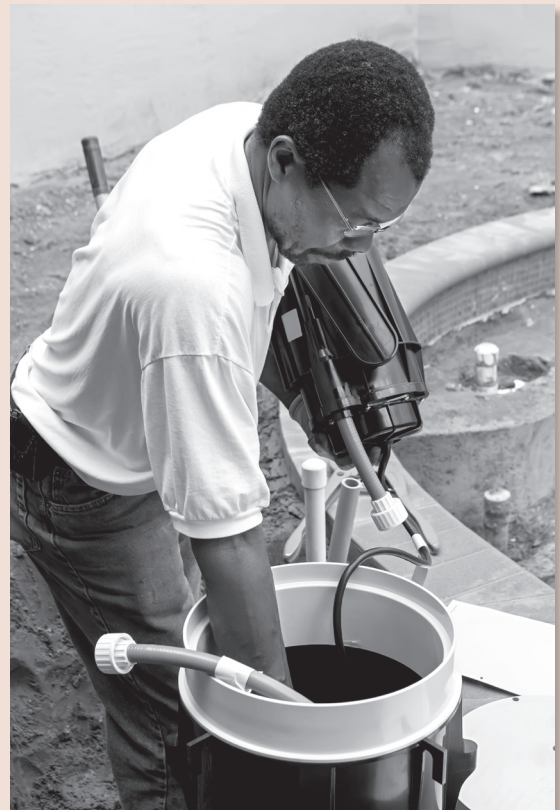
680.23 Underwater luminaires (B) Wet-Niche Luminaires (1) Forming Shells. Forming shells shall be installed for the mounting of all wet-niche underwater luminaires and shall be equipped with provisions for conduit entries. Metal parts of the luminaire and forming shell in contact with the pool water shall be of brass or other approved corrosion-resistant metal. All forming shells used with nonmetallic conduit systems, other than those that are part of a listed low-voltage lighting system not requiring grounding, shall include provisions for terminating an 8 AWG copper conductor.

680.23 Underwater luminaires (B) Wet-Niche Luminaires (2) Wiring Extending Directly to the Forming Shell. Conduits shall be installed from the forming shell to a junction box or other enclosure conforming to the requirements in 680.24. Conduit shall be rigid metal, intermediate metal, liquidtight flexible nonmetallic, or rigid nonmetallic.

(a) Metal Conduit. Metal conduit shall be approved and shall be of brass or other approved corrosion-resistant metal.

(b) Nonmetallic Conduit. Where a nonmetallic conduit is used, an 8 AWG insulated solid or stranded copper bonding jumper shall be installed in this conduit unless a listed low-voltage lighting system not requiring grounding is used. The bonding jumper shall be terminated in the forming shell, junction box or transformer enclosure, or ground fault circuit-interrupter enclosure. The termination of the 8 AWG bonding jumper in the forming shell shall be covered with, or encapsulated in, a listed potting compound to protect the connection from the possible deteriorating effect of pool water.

680.23 Underwater luminaires (B) Wet-Niche Luminaires (3) Equipment Grounding Provisions for Cords. Other than listed low-voltage lighting systems not requiring grounding wet-niche luminaires that are supplied by a flexible cord or cable shall have all exposed non-current carrying metal parts grounded by an insulated copper equipment grounding conductor that is an integral part of the cord or cable. This grounding conductor shall be connected to a grounding terminal in the supply junction box, transformer enclosure, or other enclosure. The grounding conductor shall not be smaller than the supply conductors and not smaller than 16 AWG.



680.23 Underwater luminaires (B) Wet-Niche Luminaires (4) Luminaire Grounding Terminations. The end of the flexible-cord jacket and the flexible-cord conductor terminations within a luminaire shall be covered with, or encapsulated in, a suitable potting compound to prevent the entry of water into the luminaire through the cord or its conductors. If present, the grounding connection within a luminaire shall be similarly treated to protect such connection from the deteriorating effect of pool water in the event of water entry into the luminaire.

680.23 Underwater luminaires (B) Wet-Niche Luminaires (5) Luminaire Bonding. The luminaire shall be bonded to, and secured to, the forming shell by a positive locking device that ensures a low-resistance contact and requires a tool to remove the luminaire from the forming shell. Bonding shall not be required for luminaires that are listed for the application and have no non-current-carrying metal parts.

680.23 Underwater luminaires (B) Wet-Niche Luminaires (6) Servicing. All wet-niche luminaires that shall be removable from the water for inspection, relamping, or other maintenance. The forming shell location and length of cord in the forming shell shall permit personnel to place the removed luminaire on the deck or other dry location for such maintenance. The luminaire maintenance location shall be accessible without entering or going in the pool water.

EXAM QUESTIONS

30. What must be done with flexible-cord jackets and conductors of a wet-niche luminaire that are terminated within the luminaire itself to prevent water from entering?
 - A. Encapsulated in a suitable potting compound
 - B. Taped
 - C. Nothing required
 - D. Glue
31. Nonmetallic conduit for a wet niche luminaire system is required to include provisions for terminating what size copper conductor?
 - A. 12 AWG
 - B. 10 AWG
 - C. 14 AWG
 - D. 8 AWG
32. The grounding of wet-niche luminaires using nonmetallic conduit is required to have a number 8 AWG installed unless this is used?
 - A. Grounding type fixture
 - B. Non-metallic junctionbox
 - C. Listed low-voltage lighting system
 - D. No listed answer
33. What is the minimum distance that the top of a luminaire lens can be set below the normal water level of a pool?
 - A. 24 in.
 - B. 18 in.
 - C. 36 in.
 - D. 12 in.
34. Which of the following is not an accepted means for connecting an equipment grounding conductor to wet-niche luminaires that are supplied by a flexible cord or cable?
 - A. Grounding terminal
 - B. Transformer enclosure
 - C. Split-bolt
 - D. Supply junction box
35. When re-lamping underwater luminaires at more than the low voltage contact limit, what is required to be installed to make sure there is a no shock hazard?
 - A. Install double insulated luminaires
 - B. AFCI
 - C. GFCI
 - D. All listed answers
36. How long is the cord of a wet-niche luminaire required to be for general maintenance?
 - A. 48 inches
 - B. No special instructions
 - C. Long enough to move to a deck or dry location
 - D. 60 inches

680.23 Underwater luminaires (C) Dry-Niche Luminaires. (1) Construction. A dry-niche luminaire shall have provision for drainage of water. Other than listed low voltage luminaires not requiring grounding, a dry-niche luminaire shall have means for accommodating one equipment grounding conductor for each conduit entry.

680.23 Underwater luminaires (C) Dry-Niche Luminaires. (2) Junction Box. A junction box shall not be required but, if used, shall not be required to be elevated or located as specified in 680.24(A)(2) if the luminaire is specifically identified for the purpose.

680.23 Underwater luminaires (D) No-Niche Luminaires. A no-niche luminaire shall meet the construction requirements of 680.23(B) (3) and be installed in accordance with the requirements of 680.23(B). Where connection to a forming shell is specified, the connection shall be to the mounting bracket.



680.23 Underwater luminaires (E) Through-Wall Lighting Assembly. A through-wall lighting assembly shall be equipped with a threaded entry or hub, or a nonmetallic hub, for the purpose of accommodating the termination of the supply conduit. A through wall lighting assembly shall meet the construction requirements of 680.23(B) (3) and be installed in accordance with the requirements of 680.23(B). Where connection to a forming shell is specified, the connection shall be to the conduit termination point.

(Revised) 680.23 (F)(1) Wiring Methods. Where branch-circuit wiring on the supply side of enclosures and junction boxes connected to conduits run to underwater luminaires are installed in corrosive environments as described in 680.14, the wiring method of that portion of the branch circuit shall be as required in 680.14(B) or shall be liquid-tight flexible nonmetallic conduit. Wiring methods installed in corrosive environments as described in 680.14 shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122, but not smaller than 12 AWG. Where installed in noncorrosive environments, branch circuits shall comply with the general requirements in Chapter 3.

Exception: Where connecting to transformers or power supplies for pool lights, liquidtight flexible metal conduit shall be permitted. The length shall not exceed 1.8 m (6 ft) for any one length or exceed 3.0 m (10 ft) in total

EXAM QUESTIONS

37. What is the smallest insulated copper equipment grounding conductor that can be installed to comply with 680.14?

- A. 10 AWG
- B. 12 AWG
- C. 14 AWG
- D. 8 AWG

38. What construction requirement must through-wall lighting assemblies for dry-niche luminaires meet according to Article 680?

- A. 680.23 (A)
- B. 680.22 (B)
- C. 680.23 (E)
- D. 680.23 (B) (3)

39. How many equipment grounding conductor termination points are required for each conduit when using a dry-niche luminaire?
- A. 2
 - B. 3
 - C. 1
 - D. No Requirement
40. When is it permissible to use type AC cable on the supply side of enclosures and junction boxes connected to wet-niche and no-niche luminaires?
- A. Installed within buildings
 - B. When encased in concrete
 - C. When protected from moisture
 - D. AC cable is excluded from Article 680
41. What is the maximum total length permitted for liquid tight flexible conduit feeding a transformer that powers pool lighting?
- A. 1.8 m (6ft)
 - B. 3.0 m (10ft)
 - C. 1.5m (5ft)
 - D. 3.7 m (12ft)

680.23(F) Branch-Circuit Wiring (2) Equipment Grounding. Other than listed low-voltage luminaires not requiring grounding, all through-wall lighting assemblies, wet-niche, dry-niche, or no-niche luminaires shall be connected to an insulated copper equipment grounding conductor installed with the circuit conductors. The equipment grounding conductor shall be installed without joint or splice except as permitted in (F)(2)(a) and (F)(2)(b). The equipment grounding conductor shall be sized in accordance with Table 250.122 but shall not be smaller than 12 AWG.

Exception: An equipment grounding conductor between the wiring chamber of the secondary winding of a transformer and a junction box shall be sized in accordance with the overcurrent device in this circuit.

(a) If more than one underwater luminaire is supplied by the same branch circuit, the equipment grounding conductor, installed between the junction boxes, transformer enclosures, or other enclosures in the supply circuit to wet-niche luminaires, or between the field-wiring compartments of dry-niche luminaires, shall be permitted to be terminated on grounding terminals.

(b) If the underwater luminaire is supplied from a transformer, ground-fault circuit interrupter, clock-operated switch, or a manual snap switch that is located between the panelboard and a junction box connected to the conduit that extends directly to the underwater luminaire, the equipment grounding conductor shall be permitted to terminate on grounding terminals on the transformer, ground-fault circuit interrupter, clock-operated switch enclosure, or an outlet box used to enclose a snap switch.

680.23(F) Branch-Circuit Wiring (3) Conductors. Conductors on the load side of a ground fault circuit interrupter or of a transformer, used to comply with the provisions of 680.23(A)(8), shall not occupy raceways, boxes, or enclosures containing other conductors unless one of the following conditions applies:

- (1) The other conductors are protected by ground-fault circuit interrupters.
- (2) The other conductors are equipment grounding conductors and bonding jumpers as required per 680.23(B)(2)(b).
- (3) The other conductors are supply conductors to a feed through-type ground-fault circuit interrupter.



(4) Ground-fault circuit interrupters shall be permitted in a panelboard that contains circuits protected by other than ground-fault circuit interrupters.

680.24 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters (A) Junction Boxes (1) Construction. The junction box shall be listed, labeled, and identified as a swimming pool junction box and shall comply with the following conditions:

- (1) Be equipped with threaded entries or hubs or a nonmetallic hub
- (2) Be comprised of copper, brass, suitable plastic, or other approved corrosion-resistant material
- (3) Be provided with electrical continuity between every connected metal conduit and the grounding terminals by means of copper, brass, or other approved corrosion resistant metal that is integral with the box

680.24 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters. (A) Junction Boxes (2) Installation. Where the luminaire operates over the low voltage contact limit, the junction box location shall comply with (A)(2)(a) and (A)(2)(b). Where the luminaire operates at the low voltage contact limit or less, the junction box location shall be permitted to comply with (A)(2)(c).

(a) Vertical Spacing. The junction box shall be located not less than 100 mm (4 in.), measured from the inside of the bottom of the box, above the ground level, or pool deck, or not less than 200 mm (8 in.) above the maximum pool water level, whichever provides the greater elevation.

(b) Horizontal Spacing. The junction box shall be located not less than 1.2 m (4 ft) from the inside wall of the pool, unless separated from the pool by a solid fence, wall, or other permanent barrier.

(c) Flush Deck Box. If used on a lighting system operating at the low voltage contact limit or less, a flush deck box shall be permitted if both of the following conditions are met:

- (1) An approved potting compound is used to fill the box to prevent the entrance of moisture.
- (2) The flush deck box is located not less than 1.2 m (4 ft) from the inside wall of the pool.

EXAM QUESTIONS

42. What is NOT a construction requirement for junction boxes listed for use in swimming pool areas?

- A. Continuity between every connected metal conduit
- B. Equipped with threaded entries or hubs or nonmetallic hub
- C. Be of an approved corrosion-resistant material
- D. Having a weather proof seal, insulated attached lock nuts, and be listed

43. What is the equipment grounding conductor permitted to do if multiple underwater luminaries are supplied by the same branch circuit?

- A. Use split bolts for terminations
- B. Sized to the largest single conductor
- C. Terminate on grounding terminals
- D. Sized to the largest overcurrent device

44. What listed article is a luminaire that operates at the low voltage contact limit or less required to comply with?

- A. 680.24 (A) (2) (a)
- B. 680.24 (A) (2) (c)
- C. 680.24 (A) (2) (b)
- D. 680.24 (A) (2) (d)

45. What type of luminaire(s) does not require grounding with regards to Article 680?

- A. 120voltAC
- B. Listed low-voltage luminaires
- C. Variable voltage luminaire(s)
- D. All luminaries must be grounded

46. What is the minimum distance a flush deck box can be mounted from the inside wall of a pool?

- A. 3.0 m (10 ft)
- B. 100 mm (8 in)
- C. 1.2 m (4 ft)
- D. No minimum requirement

680.24 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters (C) Protection. Junction boxes and enclosures mounted above the grade of the finished walkway around the pool shall not be located in the walkway unless afforded additional protection, such as by location under diving boards, adjacent to fixed structures, and the like.

680.24 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters (D) Grounding Terminals. Junction boxes, transformer and power-supply enclosures, and ground-fault circuit interrupter enclosures connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall be provided with a number of grounding terminals that shall be no fewer than one more than the number of conduit entries.

680.24 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters (E) Strain Relief. The terminations of a flexible cord of an underwater luminaire within a junction box, transformer or power-supply enclosure, ground-fault circuit interrupter, or other enclosure shall be provided with a strain relief.

680.24 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters (F) Grounding. The equipment grounding conductor terminals of a junction box, transformer enclosure, or other enclosure in the supply circuit to a wet-niche or no-niche luminaire and the field-wiring chamber of a dry-niche luminaire shall be connected to the equipment grounding terminal of the panelboard. This terminal shall be directly connected to the panelboard enclosure.

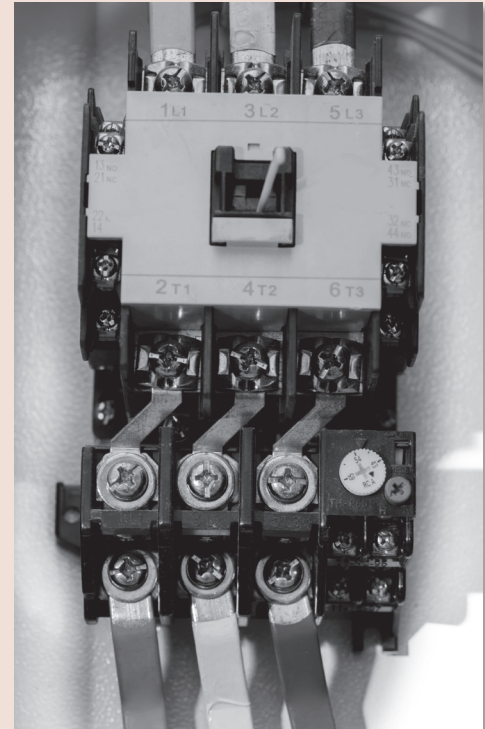
680.25 Feeders. These provisions shall apply to any feeder on the supply side of panelboards supplying branch circuits for pool equipment covered in Part II of this article and on the load side of the service equipment or the source of a separately derived system.

(Revised) 680.25(A) Feeders. Where feeders are installed in corrosive environments as described in 680.14, the wiring method of that portion of the feeder shall be as required in 680.14(B) or shall be liquidtight flexible nonmetallic conduit. Wiring methods installed in corrosive environments as described in 680.14 shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122, but not smaller than 12 AWG. Where installed in noncorrosive environments, feeders shall comply with the general requirements in Chapter 3.

680.25 Feeders (B) Aluminum Conduit. Aluminum conduit shall not be permitted in the pool area where subject to corrosion.

680.26 Equipotential Bonding (A) Performance. The equipotential bonding required by this section shall be installed to reduce voltage gradients in the pool area.

680.26 Equipotential Bonding (B) Bonded Parts. The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.



EXAM QUESTIONS

47. What is the flexible cord of an underwater luminaire within a junction box required to have installed?
- Strain relief
 - Forming shell
 - Approved lugs
 - An approved potting compound
48. What is the minimum number of grounding terminals required in a transformer or GFCI enclosures that extend to the forming shell or mounting bracket of a no-niche luminaire?
- At least eight
 - At least one for each conduit entry
 - One more than the number of conduit entries
 - No listed answer
49. Where are the equipment grounding conductor terminals of a transformer enclosure required to be connected?
- Conduit hub
 - Ground bar
 - Panelboard
 - Luminaire
50. What article is required to be followed when making the connections to bonded parts in pool areas?
- 250.66
 - 250.122
 - 250.32
 - 250.8
51. What table is required to be used to size equipment grounding conductors?
- 250.122
 - 250.66
 - 250.102(D)
 - 250.103(A)
52. Why is equipotential bonding in pool areas required?
- To complete the bonding system
 - Not required
 - Reduce voltage gradients
 - To have a clear and present path to ground
53. What part of Article 680 addresses feeders on the supply side of panelboards supplying branch circuits for pool equipment?
- III
 - II
 - I
 - IV
54. Where is a #6 AWG solid copper bonding conductor used to reduce voltage gradients in pool areas not required to connect?
- Remote panelboards
 - Luminaires
 - The forming shell
 - The rebar mat

680.26 Equipotential Bonding (B) Bonded Parts (1) Conductive Pool Shells. Bonding to conductive pool shells that shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Poured concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials.

(a) *Structural Reinforcing Steel.* Un-encapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with (b)(1) through (b)(4).

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing. The bonding shall be in accordance with 250.8 or other approved means.

(2) Conform to the contour of the pool

(3) Be arranged in a 300-mm (12-in.) by 300-mm (12-in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(Revised) 680.26 Equipotential Bonding (B) Bonded Parts (2) Perimeter Surfaces. The perimeter surface to be bonded shall be considered to extend for 1 m (3 ft) horizontally beyond the inside walls of the pool and

shall include unpaved surfaces and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a) or (2)(b) and shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four (4) points uniformly spaced around the perimeter of the pool. For nonconductive pool shells, bonding at four points shall not be required.



(a) *Structural Reinforcing Steel.* Structural reinforcing steel shall be bonded in accordance with 680.26(B)(1)(a).

(b) *Alternate Means.* Where structural reinforcing steel is not available or is encapsulated in a nonconductive compound, a copper conductor(s) shall be utilized where the following requirements are met:

- (1) At least one minimum 8 AWG bare solid copper conductor shall be provided.
- (2) The conductors shall follow the contour of the perimeter surface.
- (3) Only listed splices shall be permitted.
- (4) The required conductor shall be 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.
- (5) The required conductor shall be secured within or under the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below the subgrade.

680.26 Equipotential Bonding (B) Bonded Parts (3) Metallic Components. All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

680.26 Equipotential Bonding (B) Bonded Parts (4) Underwater Lighting. All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

EXAM QUESTIONS

55. Reinforcing steel is not required to be _____ when the steel is encapsulated in a non-conductive compound.
 - A. Thermally welded
 - B. Covered
 - C. Intrinsically safe
 - D. Bonded
56. With regards to conductive pool shells, what is considered a nonconductive material?
 - A. Plastered coatings
 - B. Fiberglass composite shells
 - C. Pneumatically applied concrete
 - D. All listed answers
57. If you have an unpaved perimeter surface that is 4 ft. wide, what is the minimum distance that the bonding grid must be extended horizontally into this surface?
 - A. .5 m (1.5 ft)
 - B. 1.5 m (5 ft)
 - C. 2.0 m (6 ft)
 - D. 1.0 m (3 ft)
58. When constructing a copper conductor grid for equipotential bonding in a pool area, what is the standard arrangement for the grid pattern?
 - A. 300-mm (12-in.) by 300-mm (12-in.)
 - B. 150-mm (6 in.) by 150-mm (6 in.)
 - C. 450-mm (18 in.) by 450-mm (18 in.)
 - D. 100-mm (4 in.) by 100-mm (4 in.)

59. How many points of connection does the bonding grid to perimeter surfaces need to have around pool areas?
- A. 2
 - B. 1
 - C. 4
 - D. No Listed Answer

60. When steel is encapsulated in a nonconductive compound, a copper conductor grid is required to be installed in accordance with what listed section?
- A. 680.26 (B) (1) (a)
 - B. 680.26 (B) (1) (b)
 - C. 250.8
 - D. 680.26 (B.) (1)

680.26 Equipotential Bonding (B) Bonded Parts (5) Metal Fittings. All metal fittings within or attached to the pool structure shall be bonded. Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.) shall not require bonding.

680.26 Equipotential Bonding (B) Bonded Parts (6) Electrical Equipment. Metal parts of electrical equipment associated with the pool water circulating system; including pump motors and metal parts of equipment associated with pool covers, including electric motors, shall be bonded.

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

Double-Insulated Water Pump Motors. Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the bonding grid to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool bonding grid and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

680.26 Equipotential Bonding (B) Bonded Parts (7) Fixed Metal Parts. All fixed metal parts shall be bonded including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames.

Exception No. 1: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded

Exception No. 2: Those greater than 1.5 m (5 ft) horizontally of the inside walls of the pool shall not be required to be bonded.

Exception No. 3: Those greater than 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures, shall not be required to be bonded.

680.26 Equipotential Bonding (C) Pool Water. Where none of the bonded parts is in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm² (9 in.²) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

680.27 Specialized Pool Equipment (A) Underwater Audio Equipment (1) Speakers. Each speaker shall be mounted in an approved metal forming shell, the front of which is enclosed by a captive metal screen, or equivalent, that is bonded to, and secured to, the forming shell by a positive locking device that ensures a low-resistance contact and requires a tool to open for installation or servicing of the speaker. The forming shell shall be installed in a recess in the wall or floor of the pool.



EXAM QUESTIONS

61. Where is the bonding jumper used with underwater audio equipment required to terminate?
- Speaker
 - Underwater bracket
 - Reclamation plate
 - Forming shell
62. Which of the following does not fall under the bonding of fixed metal parts around pools?
- Flexible metal conduit
 - Metal piping
 - Metal doors
 - Metal awnings
63. What is the largest dimension that isolated parts do not require bonding if penetrating into the pool structure at 1 inch or less?
- 200 mm (8 in)
 - 100 mm (4 in)
 - 25 mm (1 in)
 - 50 mm (2 in)
64. What is the minimum distance horizontally from the inside wall of a pool where all fixed metal parts of a pool area are not required to be bonded?
- 3 feet
 - 4 feet
 - 5 feet
 - 6 feet
65. What is the minimum amount of surface area required to bond and be in direct contact with pool water at all times?
- 18 inches²
 - 9 inches²
 - 4.5 inches²
 - No listed answer
66. Which of the following metal parts of electrical equipment with regards to pool areas is required to be bonded?
- Water circulating system
 - Pool covers
 - Electric motors
 - All listed answers

680.27 Specialized Pool Equipment (A) Underwater Audio Equipment (2) Wiring Methods. Rigid metal conduit of brass or other identified corrosion-resistant metal, liquidtight flexible nonmetallic conduit (LFNC-B), rigid polyvinyl chloride conduit, or reinforced thermosetting resin conduit shall extend from the forming shell to a listed junction box or other enclosure as provided in 680.24. Where rigid polyvinyl chloride conduit, reinforced thermosetting resin conduit, or liquidtight flexible nonmetallic conduit is used, an 8 AWG insulated solid or stranded copper bonding jumper shall be installed in this conduit. The bonding jumper shall be terminated in the forming shell and the junction box. The termination of the 8 AWG bonding jumper in the forming shell shall be covered with, or encapsulated in, a listed potting compound to protect such connection from the possible deteriorating effect of pool water.

680.27 Specialized Pool Equipment. (A) Underwater Audio Equipment (3) Forming Shell and Metal Screen. The forming shell and metal screen shall be of brass or other approved corrosion resistant metal. All forming shells shall include provisions for terminating an 8 AWG copper conductor.

680.27 Specialized Pool Equipment (B) Electrically Operated Pool Covers (1) Motors and Controllers. The electric motors, controllers,



and wiring shall be located not less than 1.5 m (5 ft) from the inside wall of the pool unless separated from the pool by a wall, cover, or other permanent barrier. Electric motors installed below grade level shall be of the totally enclosed type. The device that controls the operation of the motor for an electrically operated pool cover shall be located such that the operator has full view of the pool.

680.27 Specialized Pool Equipment (B) Electrically Operated Pool Covers (1) Motors and Controllers. (NEW) Exception: Motors that are part of listed systems with ratings not exceeding the low-voltage contact limit that are supplied by listed transformers or power supplies that comply with 680.23(A)(2) shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of the pool.

680.27 Specialized Pool Equipment (B) Electrically Operated Pool Covers (2) Protection. The electric motor and controller shall be connected to a circuit protected by a ground-fault circuit interrupter.

680.27 Specialized Pool Equipment (C) Deck Area Heating (1) Unit Heaters. Unit heaters shall be rigidly mounted to the structure and shall be of the totally enclosed or guarded type. Unit heaters shall not be mounted over the pool or within the area extending 1.5 m (5 ft) horizontally from the inside walls of a pool.

680.27 Specialized Pool Equipment (C) Deck Area Heating (2) Permanently Wired Radiant Heaters. Radiant electric heaters shall be suitably guarded and securely fastened to their mounting device(s). Heaters shall not be installed over a pool or within the area extending 1.5 m (5 ft) horizontally from the inside walls of the pool and shall be mounted at least 3.7 m (12 ft) vertically above the pool deck unless otherwise approved.

(NEW) 680.28 Gas-Fired Water Heater. Circuits serving gas-fired swimming pool and spa water heaters operating at voltages above the low-voltage contact limit shall be provided with ground-fault circuit-interrupter protection for personnel.

EXAM QUESTIONS

67. What is the minimum height vertically that wired radiant heaters around pool areas are required to be installed?
 - A. 17 ft.
 - B. 10 ft.
 - C. 15 ft.
 - D. 12 ft.
68. Unless separated by a wall, what is the minimum distance that motors and controllers can be from the inside of the pool?
 - A. 1.5 m (5 ft)
 - B. 1.2 m (4 ft)
 - C. 3.7 m (12 ft)
 - D. 1.0 m (3 ft)
69. Which of the following is not an approved wiring method for underwater audio equipment with regards to pool areas?
 - A. Rigid metal conduit of brass
 - B. Liquidtight flexible metal conduit
 - C. Rigid polyvinyl chloride conduit
 - D. Thermosetting resin conduit
70. When using reinforced thermosetting resin conduit for a pool area, a solid or stranded copper bonding jumper of what size is required to be in the conduit?
 - A. Non-insulated 6 AWG
 - B. Non-insulated 8 AWG
 - C. Insulated 6 AWG
 - D. Insulated 8 AWG
71. What are circuits serving gas-fired spa water heaters operating at voltages above the low-voltage contact limit required to be provided with?
 - A. Arc-fault circuit-interrupter
 - B. Ground-fault circuit-interrupter
 - C. Fused disconnects
 - D. Bi-metal overloads
72. What is the minimum distance horizontally from the inside wall of a pool that a unit heater can be installed?
 - A. 10 ft
 - B. 5 ft
 - C. 12 ft
 - D. No listed answer

680.31 Pumps. A cord-connected pool filter pump shall incorporate an approved system of double insulation or its equivalent and shall be provided with means for grounding only the internal and non-accessible non-current-carrying metal parts of the appliance. The means for grounding shall be an equipment grounding conductor run with the power-supply conductors in the flexible cord that is properly terminated in a grounding-type attachment plug having a fixed grounding contact member. Cord-connected pool filter pumps shall be provided with a ground-fault circuit interrupter that is an integral part of the attachment plug or located in the power supply cord within 300 mm (12 in.) of the attachment plug.

680.32 Ground-Fault Circuit Interrupters Required. All electrical equipment, including power-supply cords, used with storable pools shall be protected by ground-fault circuit interrupters. All 125-volt, 15- and 20-ampere receptacles located within 6.0 m (20 ft) of the inside walls of a storable pool shall be protected by a ground-fault circuit interrupter. In determining these dimensions, the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier.



Informational Note: For flexible cord usage, see 400.4.

680.33 Luminaires (A) Within the Low Voltage Contact Limit. A luminaire shall be part of a cord-and-plug-connected lighting assembly. This assembly shall be listed as an assembly for the purpose and have the following construction features:

- (1) No exposed metal parts
- (2) A luminaire lamp that is suitable for use at the supplied voltage
- (3) An impact-resistant polymeric lens, luminaire body, and transformer enclosure
- (4) A transformer or power supply meeting the requirements of 680.23(A)(2) with a primary rating not over 150 volts

680.33 Luminaires (B) Over the Low Voltage Contact Limit But Not over 150 Volts. According to this article, a lighting assembly without a transformer or power supply and with the luminaire lamp(s) operating at not over 150 volts shall be permitted to be cord-and-plug-connected where the assembly is listed as an assembly for the purpose. The installation shall comply with 680.23(A)(5), and the assembly shall have the following construction features:

- (1) No exposed metal parts
- (2) An impact-resistant polymeric lens and luminaire body
- (3) A ground-fault circuit interrupter with open neutral conductor protection as an integral part of the assembly
- (4) The luminaire lamp permanently connected to the groundfault circuit interrupter with open-neutral protection
- (5) Compliance with the requirements of 680.23(A)

680.34 Receptacle Locations. Receptacles shall not be located less than 1.83 m (6 ft) from the inside walls of a pool. In determining these dimensions, the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier.

EXAM QUESTIONS

73. When installing low voltage luminaires for storable pools, which of the following is a requirement for construction?
- A. Grounding of metal parts
 - B. Impact-resistant polymeric lens
 - C. Transformer must be rated over 150 volts
 - D. No Listed Answer
74. What are all storable pools that contain a pump required to be protected by?
- A. GFCI
 - B. AFCI
 - C. No special requirements
 - D. Quick acting overloads (QAO)
75. What is the shortest distance that a receptacle can be located from the inside wall of a storable pool?
- A. 2.0 m (7 ft 6 in)
 - B. 1.5 m (5 ft)
 - C. 1.83 m (6 ft)
 - D. 3.0 m (10 ft)
76. What is the approved system that a cord-connected pool filter pump is required to incorporate?
- A. Edison Fuses
 - B. Completely isolated
 - C. Be Double insulated
 - D. AFCI protected

680.41 Emergency Switch for Spas and Hot Tubs. A clearly labeled emergency shutoff or control switch for the purpose of stopping the motor(s) that provide power to the recirculation system and jet system shall be installed at a point readily accessible to the users and not less than 1.5 m (5 ft) away, adjacent to, and within sight of the spa or hot tub. This requirement shall not apply to one-family dwellings.

680.42 Outdoor Installations (A) Flexible Connections. Listed packaged spa or hot tub equipment assemblies or self-contained spas or hot tubs utilizing a factory-installed or assembled control panel or panelboard shall be permitted to use flexible connections as covered in 680.42(A)(1) and (A)(2).

- (1) Flexible Conduit. Liquidtight flexible metal conduit or liquidtight flexible nonmetallic conduit shall be permitted in lengths of not more than 1.8 m (6 ft) external to the spa or hot tub enclosure in addition to the length needed within the enclosure to make the electrical connection.
- (2) Cord-and-Plug Connections. Cord-and-plug connections with a cord not longer than 4.6 m (15 ft) shall be permitted where protected by a ground-fault circuit interrupter.



680.42 Outdoor Installations (C) Interior Wiring to Outdoor Installations. In the interior of a dwelling unit or in the interior of another building or structure associated with a dwelling unit, any of the wiring methods recognized or permitted in Chapter 3 of this Code shall be permitted to be used for the connection to motor disconnecting means and the motor, heating, and control loads that are part of a self-contained spa or hot tub or a packaged spa or hot tub equipment assembly. Wiring to an underwater luminaire shall comply with 680.23 or 680.33.

680.43 Indoor Installations. A spa or hot tub installed indoors shall comply with the provisions of Parts I and II of this article except as modified by this section and shall be connected by the wiring methods of Chapter 3.

Exception No. 1: Listed spa and hot tub packaged units rated 20 amperes or less shall be permitted to be cord-and plug-connected to facilitate the removal or disconnection of the unit for maintenance and repair.

Exception No. 2: The equipotential bonding requirements for perimeter surfaces in 680.26(B)(2) shall not apply to a listed self-contained spa or hot tub installed above a finished floor.

EXAM QUESTIONS

77. Besides being readily acceptable, what is an emergency switch for a spa or hot tub required to be?
- Within sight
 - Not less than 5 ft. away
 - Red in color
 - No higher than 5 ft. above finished grade
78. What type of raceway is permitted for a listed packaged hot tub assembly?
- Metal Clad Cable
 - Electrical metallic conduit
 - Liquidtight flexible nonmetallic conduit
 - Intermediate metal conduit\
79. Cord-and-plug connections are permitted in outdoor spa and hot tub installations as long as the cord is less than _____.
- 4.6 m (15 ft)
 - 3.0 m (10 ft)
 - 6.0 m (20 ft)
 - 3.7 m (12 ft)
80. What chapter's wiring methods are required to be used when installing wiring from the inside of a single-family dwelling to an outdoor spa or hot tub?
- Chapter 1
 - Chapter 2
 - Chapter 6
 - Chapter 3

680.43 Indoor Installations (A) Receptacles. At least one 125-volt, 15- or 20-ampere receptacle on a general-purpose branch circuit shall be located not less than 1.83 m (6 ft) from, and not exceeding 3.0 m (10 ft) from, the inside wall of the spa or hot tub.

(1) **Location.** Receptacles shall be located at least 1.83 m (6 ft) measured horizontally from the inside walls of the spa or hot tub.

(2) **Protection, General.** Receptacles rated 125 volts and 30 amperes or less and located within 3.0 m (10 ft) of the inside walls of a spa or hot tub shall be protected by a ground fault circuit interrupter.

(3) **Protection, Spa or Hot Tub Supply Receptacle.** Receptacles that provide power for a spa or hot tub shall be ground-fault circuit-interrupter protected.

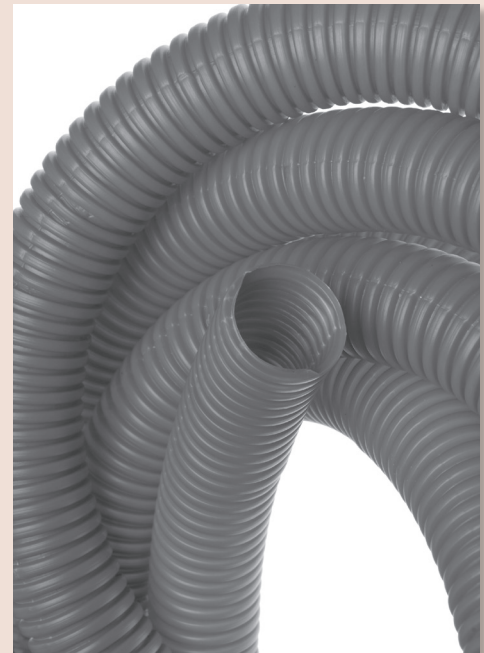
(4) **Measurements.** In determining the dimensions in this section addressing receptacle spacing, the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier.

680.43 Indoor Installations (B) Installation of Luminaires, Lighting Outlets, and Ceiling-Suspended (Paddle) Fans. (1) **Elevation.** Luminaires except as covered in 680.43(B)(2), lighting outlets, and ceiling-suspended (paddle) fans located over the spa or hot tub or within 1.5 m (5 ft) from the inside walls of the spa or hot tub shall comply with the clearances specified in (B)(1)(a), (B)(1)(b), and (B)(1)(c) above the maximum water level.

(a) *Without GFCI.* Where no GFCI protection is provided, the mounting height shall be not less than 3.7 m (12 ft).

(b) *With GFCI.* Where GFCI protection is provided, the mounting height shall be permitted to be not less than 2.3 m (7 ft 6 in.).

(c) *Below 2.3 m (7 ft 6 in.).* Luminaires meeting the requirements of item (1) or (2) and protected by a ground fault circuit interrupter shall be permitted to be installed less than 2.3 m (7 ft 6 in.) over a spa or hot tub:



- (1) Recessed luminaires with a glass or plastic lens, nonmetallic or electrically isolated metal trim, and suitable for use in damp locations
- (2) Surface-mounted luminaires with a glass or plastic globe, a nonmetallic body, or a metallic body isolated from contact, and suitable for use in damp locations

EXAM QUESTIONS

81. If a customer wants a fan above their indoor spa and there is GFCI protection, what is the minimum height that the fixture can be mounted?
 - A. 3.7 m (12 ft)
 - B. 2.3 m (7 ft 6 in)
 - C. 3.0 m (10 ft)
 - D. There must always be GFCI protection
82. If a customer wants a fan above their indoor spa and there is no GFCI protection, what is the minimum height that the fixture can be mounted?
 - A. 3.7 m (12 ft)
 - B. 2.3 m (7 ft 6 in)
 - C. 3.0 m (10 ft)
 - D. Must have GFCI protection
83. The receptacles for an indoor spa or hot tub must always be located so that the supply cord is?
 - A. Run so there is no tripping hazard
 - B. Kept from physical damage
 - C. Run to the shortest path
 - D. No special requirements
84. A customer has an indoor hot tub that is 9 ft. away from the nearest 15-amp outlet. What is the requirement for this outlet?
 - A. Must be 20 amps rated
 - B. No special requirement
 - C. GFCI protected
 - D. Must be 20 amps rated and GFCI protected

680.43 Indoor Installations (D) Bonding. The following parts shall be bonded together:

- (1) All metal fittings within or attached to the spa or hot tub structure
- (2) Metal parts of electrical equipment associated with the spa or hot tub water circulating system, including pump motors, unless part of a listed, Labeled, and identified self-contained spa or hot tub
- (3) Metal raceway and metal piping that are within 1.5 m (5 ft) of the inside walls of the spa or hot tub and that are not separated from the spa or hot tub by a permanent barrier
- (4) All metal surfaces that are within 1.5 m (5 ft) of the inside walls of the spa or hot tub and that are not separated from the spa or hot tub area by a permanent barrier

Exception: Small conductive surfaces not likely to become energized, such as air and water jets and drain fittings, where not connected to metallic piping, towel bars, mirror frames, and similar nonelectrical equipment, shall not be required to be bonded.

- (5) Electrical devices and controls that are not associated with the spas or hot tubs and that are located less than 1.5 m (5 ft) from such units; otherwise, they shall be bonded to the spa or hot tub system

680.43 Indoor Installations (E) Methods of Bonding. All metal parts associated with the spa or hot tub shall be bonded by any of the following methods:

- (1) The interconnection of threaded metal piping and fittings
- (2) Metal-to-metal mounting on a common frame or base
- (3) The provisions of a solid copper bonding jumper, insulated, covered, or bare, not smaller than 8 AWG



680.43 Indoor Installations (G) Underwater Audio Equipment. Underwater audio equipment shall comply with the provisions of Part II of this article.

680.44 Protection. Except as otherwise provided in this section, the outlet(s) that supplies a self-contained spa or hot tub, a packaged spa or hot tub equipment assembly, or a field assembled spa or hot tub shall be protected by a ground-fault circuit interrupter.

(A) Listed Units. If so marked, a listed, labeled, and identified self-contained unit or a listed, labeled, and identified packaged equipment assembly that includes integral ground-fault circuit interrupter protection for all electrical parts within the unit or assembly (pumps, air blowers, heaters, lights, controls, sanitizer generators, wiring, and so forth) shall be permitted without additional GFCI protection.

(B) Other Units. A field-assembled spa or hot tub rated 3 phase or rated over 250 volts or with a heater load of more than 50 amperes shall not require the supply to be protected by a ground-fault circuit interrupter.

680.50 General. The provisions of Part I and Part V of this article shall apply to all permanently installed fountains as defined in 680.2. Fountains that have water common to a pool shall additionally comply with the requirements in Part II of this article. Part V does not cover self-contained, portable fountains. Portable fountains shall comply with Parts II and III of Article 422.

EXAM QUESTIONS

- | | |
|--|---|
| <p>85. What part of Article 680 does not cover self-contained, portable fountains?</p> <ul style="list-style-type: none"> A. Part II B. Part III C. Part IV D. Part V | <p>88. What part of Article 680 is underwater audio equipment required to comply with?</p> <ul style="list-style-type: none"> A. Part III B. Part V C. Part IV D. Part II |
| <p>86. What part of Article 422 are portable fountains required to comply with?</p> <ul style="list-style-type: none"> A. II and III B. I and IV C. V D. VII and VIII | <p>89. Which of the following is not an acceptable means of bonding indoor spa and hot tubs?</p> <ul style="list-style-type: none"> A. Metal to metal on a common frame B. Using a solid copper bonding jumper, insulated, covered, or bare, not smaller than #10 AWG C. Interconnection of threaded metal piping D. Using a solid copper bonding jumper, insulated, covered, or bare, not smaller than 8 AWG |
| <p>87. When bonding metal piping for indoor spas and hot tubs, the metal bonding has to be made within _____ unless it is separated by a permanent barrier.</p> <ul style="list-style-type: none"> A. 1.5 m (5 ft) B. 3.0 m (10 ft) C. 1.83 m (6 ft) D. 1.0 m (3 ft) | |

680.51 Luminaires, Submersible Pumps, and Other Submersible Equipment. (F) Servicing. All equipment shall be removable from the water for re-lamping or normal maintenance. Luminaires shall not be permanently embedded into the fountain structure such that the water level must be reduced or the fountain drained for re-lamping, maintenance, or inspection.

680.55 Methods of Grounding (B) Supplied by a Flexible Cord. Electrical equipment that is supplied by a flexible cord shall have all exposed non-current-carrying metal parts grounded by an insulated copper equipment grounding conductor that is an integral part of this cord. The equipment grounding conductor shall be connected to an equipment grounding terminal in the supply junction box, transformer enclosure, power supply enclosure, or other enclosure.

680.62 Therapeutic Tubs (Hydrotherapeutic Tanks). Therapeutic tubs used for the submersion and treatment of patients, that are not easily moved from one place to another in normal use or that are fastened or otherwise secured at a specific location, including associated piping systems, shall conform to Part VI.

(A) Protection. Except as otherwise provided in this section, the outlet(s) that supplies a self-contained therapeutic tub or hydrotherapeutic tank, a packaged therapeutic tub or hydrotherapeutic tank, or a field-assembled therapeutic tub or hydrotherapeutic tank shall be protected by a ground fault circuit interrupter.

(1) Listed Units. If so marked, a listed, labeled, and identified self-contained unit or a listed, labeled, and identified packaged equipment assembly that includes integral ground-fault circuit-interrupter protection for all electrical parts within the unit or assembly (pumps, air blowers, heaters, lights, controls, sanitizer generators, wiring, and so forth) shall be permitted without additional GFCI protection.

(2) Other Units. A therapeutic tub or hydrotherapeutic tank rated 3 phase or rated over 250 volts or with a heater load of more than 50 amperes shall not require the supply to be protected by a ground-fault circuit interrupter.

680.62 Therapeutic Tubs (Hydrotherapeutic Tanks). (B) Bonding. The following parts shall be bonded together:

- (1) All metal fittings within or attached to the tub structure
- (2) Metal parts of electrical equipment associated with the tub water circulating system, including pump motors
- (3) Metal-sheathed cables and raceways and metal piping that are within 1.5 m (5 ft) of the inside walls of the tub and not separated from the tub by a permanent barrier
- (4) All metal surfaces that are within 1.5 m (5 ft) of the inside walls of the tub and not separated from the tub area by a permanent barrier
- (5) Electrical devices and controls that are not associated with the therapeutic tubs and located within 1.5 m (5 ft) from such units.

Exception: Small conductive surfaces not likely to become energized, such as air and water jets and drain fittings not connected to metallic piping, and towel bars, mirror frames, and similar nonelectrical equipment not connected to metal framing, shall not be required to be bonded.

680.62 Therapeutic Tubs (Hydrotherapeutic Tanks) (D) Grounding. (1) Fixed or Stationary Equipment. The equipment specified in (a) and (b) shall be connected to the equipment grounding conductor.

(a) Location. All electrical equipment located within 1.5 m (5 ft) of the inside wall of the tub shall be connected to the equipment grounding conductor.

(b) Circulation System. All electrical equipment associated with the circulating system of the tub shall be connected to the equipment grounding conductor.



EXAM QUESTIONS

- 90. When a fountain is connected by a flexible cord, where is the equipment grounding conductor required to be connected?**
- A. Main bonding jumper
 - B. Equipment bonding jumper
 - C. Equipment grounding terminal
 - D. No listed answer