Pre-certification

PVC and Rilrld Aluminum Conduit Expansion

Rules 12-1100 to 12-1122 govern the use of PVC conduit for electrical installations. It should be noted that in rule 12-1102 it specifies that PVC conduit shall not be used in hazardous locations, or where enclosed in thermal insulation. This rule also specifies the use ofPVC in buildings of non-combustible construction. PVC is not to be used where the temperature exceeds 75 degrees C. Rule 12-1114 specifies the maximum distance between supports for PVC conduit as well as two or more PVC conduits run parallel to each other using a common strap. Rule 12-1118 states that expansion joints are required if the amount of expansion exceeds 45mm, unless the conduit is embedded in concrete. Another iniportant note is that a separate bonding conductor needs to be installed in every run ofPVC to ensure electrical continuity for the bond.

Rule 12-1012 should be consulted when dealing with the expansion of other types of conduit such as rigid aluminum conduit. This rule will send you to an expansion calculation chart in appendix B. This expansion chart will provide the proper expansion co-efficient for each major type of conduit. An example calculation is given below the chart to demonstrate how the calculation is to be done. Remember this for the C ofQ exam!
It is rule 12-1118 and appendix B that must be consulted to calculate PVC expansion. Appendix B specifies the coefficients for conduits used to calculate linear expansion, and it also gives the formula to use to calculate the amount of expansion. Therefore it is not necessary to memorize this formula but it is important to understand how to use it correctly.

How to determine the amount of expansion in conduit.

First- Calculate the temperature differential in degrees C

Second- From appendix B apply the coefficient of expansion for the appropriate conduit

Third- Apply the length of conduit run in meters

Fourth- Calculate the amount of expansion in mm using the formula:

LENGTH OF RUN IN METERS X TEMPERATURE DIFFERENTIAL IN DEGREES C X COEFFICIENT = AMOUNT OF EXPANSION IN mm

How to determine the length of run 'before an expansion joint is required using PVC conduit.

First- Apply the maximum amount of expansion from rule 12-1118 (45mm)

Second- Calculate the temperature differential

Third- apply the coefficient of expansion for PVC (.0520) from appendix B

Fourth- Calculate the length of run in meters before an expansion joint is required using the formula:

$$\frac{\text{AMOUNT OF EXPANSION ALLOWED(45mm for PVC)}}{\text{TEMPERATURE DIFFERENTIAL X COEFFICIENT}} = \text{Length of conduit permitted without an expansion coupling}$$

Pre-certification PVC
Conduit Expansion

Practice Questions for **PVC** and **Rigid Aluminum** Conduit Expansion:

1. Calculate the length of expansion of a 20M run of PVC conduit in a location where the minimum temperature is expected to be -23°C and the maximum temperature is expected to be +30°C?

2. A 25M run ofPVC needs to be installed in a location where the temperature range is expected to be from -45°C to + 30°C. How much will the run of conduit expand in mm?

3. On the roof of a factory, a 22M run ofPVC conduit is about to be installed. The min. temp. is -20°C and the max. temp. is +40°C. How many expansion joints (if any) are required?

4. What is the maximum length between expansion joints for a run ofPVC in an area where the temperature differential is 68°C?

5. What is the maximum distance between expansion joints for a run ofPVC where the min. temp. is -25°C and the max. temp. is + 35°C?

6. If a run ofPVC is to be installed in a location where the temperature ranges from -15°C to +29°C, what is the maxit;num distance between two junction boxes that the conduit can be without the use of an expansion joint?

7. What is the length of expansion of a 12M run ofPVC in an area where the temp. ranges from -45°C to +45°C?

8. What is the calculated amount of expansion for a 31 meter run of Rigid Aluminum conduit installed in an area where the minimum winter temperature is -30°C and the maximum summer temperature is + 35°C?

9. How much will a 19 meter run of rigid aluminum conduit expand in an environment where the minimum temperature is -20°C and the maximum temperature is + 30°C?

10. What amount of expansion will a run of rigid steel conduit have if the minimum temperature is -40°C and the maximum temperature is +40°C?

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Conduit and Tubin!! Fill

It is also important to remember that when the insulation designation is not given in the code book, rule 121014 tells us to calculate based on field measurement. Another important note is to use Table D5 for the area of bare conductors (keep in mind the different types of stranding configurations). Don't forget that derating of the ampacity of the conductors installed in the raceway must still be taken into consideration using TABLE 5C.

Practice Questions:
Calculate the correct size of conduits for the following conductors.

1. 4- #8 TW-75
   3- #1/0 T-90 nylon 4-
   #4 TWU-75

2. 8- 250 kcmil RW90XLPE(600V)jacketed 2-
   4/0TW-75
   3- #12 T-90 nylon

3. 7- #3 TWU-75 10-
   #14 T-90 nylon 11-
   # 1 TW-75

4. 3- #2 RW90XLPE(1000V)unjacketed 3-
   #2 T -90 nylon
   4- #2 TWU-75
   5- # 10 bare bonding conductor

5. 3- #1/0 RWU-90XLPE
   12- #3/0 RW90XLPE(1000V)unjacketed
   13- #12 T-90 nylon
   14- #6 TW-75

6. 23- #14 TW-75
   14- #12 T-90 nylon
   15- #12 RW90XLPE(600V)jacketed
   10- #6 TWU-75
   1- #10 bare solid bond conductor

7. What is the maximum number of#14 T-90 allowed in a 41mm conduit?

8. What is the maximum number of # 2 T -90 allowed in a 103 mm conduit?

9. How many #10 RW-90 XLPE 600V, no jacket conductors are permitted in a 21mm raceway?

10. How many # 12 TW -7 5 aluminum conductors are allowed in a 27mm raceway?

Pre-certification
Maximum Number of Conductors in a Box

Rule 12-3034 governs the maximum number of conductors in a box. Subrule 1 explains how to determine which conductors count and on what conditions. Subrule 2 explains the use of table 23 and if any additional hardware or wire connectors need to be accounted for in the reduction of the max. number of conductors allowed in the box. Subrule 3 basically explains the procedure to use when a device such as a GFCI is installed in a box. Subrule 4 specifies on the procedure to use when Table 23 cannot be used
(when different sizes of conduct0rs are in one box, or if the box size is not listed on table 23) It explains the use of Table 22 the amount of usable space per insulated conductor.

Example one: Calculate the maximum allowable number of#14 conductors allowed in a 4 11/16" X 2 1/8" square box that requires 7 marrettes to be used?

Answer: From Table 23 ,28 #14 conductors are allowed in a 4 11/16" X 2 1/8" box. We must reduce that number by 3 due to the use of the 7 marrettes. Therefore the correct answer would be 25 #14 A WG conductors would be the max. number of conductors allowed in that box.

Before an example is given for the use of Table 22, it is important that we realize that one milliliter is the same as one cubic centimeter. It is also important that we realize that even-though metric is predominantly used in the code book, a fmal conversion from cubic centimeters to cubic inches may be necessary as trade sizes of boxes have remained in cubic inches.

Example Two: Calculate the size of box required for the following:

4- #14 T-90 nylon 5-
#12 R-90
6- #10 T-90 nylon 7-
#8 T-90 nylon

Answer: From Table 22
4- #14 T-90 nylon = 4 X 24.6 = 98.4 cubic centimeters 5- #12 R-90 = 5 X 28.7 = 143.5 cubic centimeters 6- #10 T-90 nylon = 6 X 36.9 = 221.4 cubic centimeters 7 - #8 T -90 nylon = 7 X 45.1 = 315.7 cubic centimeters

total 779 cubic centimeters

Convert 779 cubic centimeters to cubic inches (use conversion chart in code book)

= 779 X 0.061 = 47.5 cubic inches

Therefore a 4" x 4" x 4" = 64 cubic inches

Pre-certification

Maximum Number of Conductors in a Box

Practice Questions:

Calculate the proper trade size of box for the following conductor combinations:

1. 3- #14 T-90 nylon 6- #12 T-90 nylon 7- #12 TW-75
   8- #8 RW-90XLPE

2. 16- #14 TW-75
   14- #12 T-90 nylon
   15- #10 RW-90
   16- #8 T -90 nylon

3. 3- 14/3 NMD-90 6- 14/4 AC-90 7- #14 T-90
   8- #6 T-90

4. 45- #12 T-90 nylon
   34- #10 RW-90
   35- #14 T-90 nylon
   12- #6 RW-90

5. How many # 14 T-90 nylon conductors are allowed in a box trade size of 6" X 6" X 6" ?

6. What is the maximum number of # 10 A WG conductors allowed in a box that is 8" X 8" X 4"?

7. There are 78- #10 T-90 conductors to be connected in a box (one marrette per pair of wires) what is the minimum size of box required for this application?

8. What is the minimum standard device box required for the following situation: -
   one standard duplex receptacle
   - three, 14/2 NMD-90 cables
   - one, 14/3 NMD-90 cable
   - six marrettes for connections

Pre-certification

Pull Box and Junction Box Sizinl!

A pull box or junction box is sized according to rule 12-3036. This rule applies to boxes containing conductors or cables #4 A WG or larger, regardless whether or not they are in a raceway or part of a cable assembly. The intent of this rule is to prevent damage to the conductors when they are pulled or installed into the box. The rule is broken down into three major sections.

Part one: The first section deals with the depth of the box. The rule states that the minimum depth of the box is found by multiplying the largest conductor by 6 and then adding the diameter of the largest raceway or equivalent cable.

Part two: The second section deals with straight pulls. This is defined as when raceways or cables enter the box from one side and exit the box from the opposite side. The minimum dimension for this measurement is found by multiplying the largest raceway or equivalent cable by 8.

Part three: The third section deals with angle pulls and "U" pulls. The minimum dimension is found by multiplying the largest raceway by 6 and then adding the remainder of the raceways.

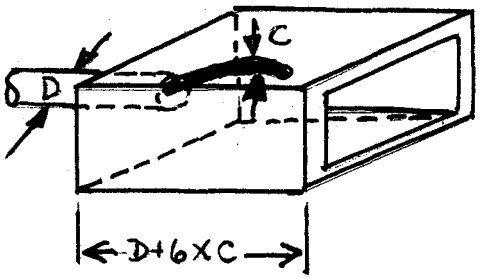
Part three A: There is another part of the rule that explains the minimum dimension between two conduits of an angle pull. This is simply found by multiplying the largest raceway or equivalent cable by 6 times.

Before any examples, it is important to understand that we must take the largest calculated dimension in order to find the correct size of box. A box has four sides. We must make four calculations based on the information given in rule 12-3036 and use the largest for length and the largest for width.

8.

Examples:

Part one:



Box *l.£JJf'm* ::

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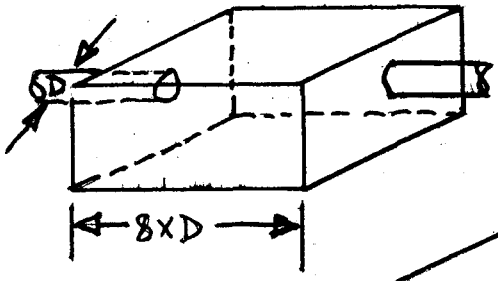
AJ.ts 1We cmIER 3 *IJ»IbiAlr5*

Part two:



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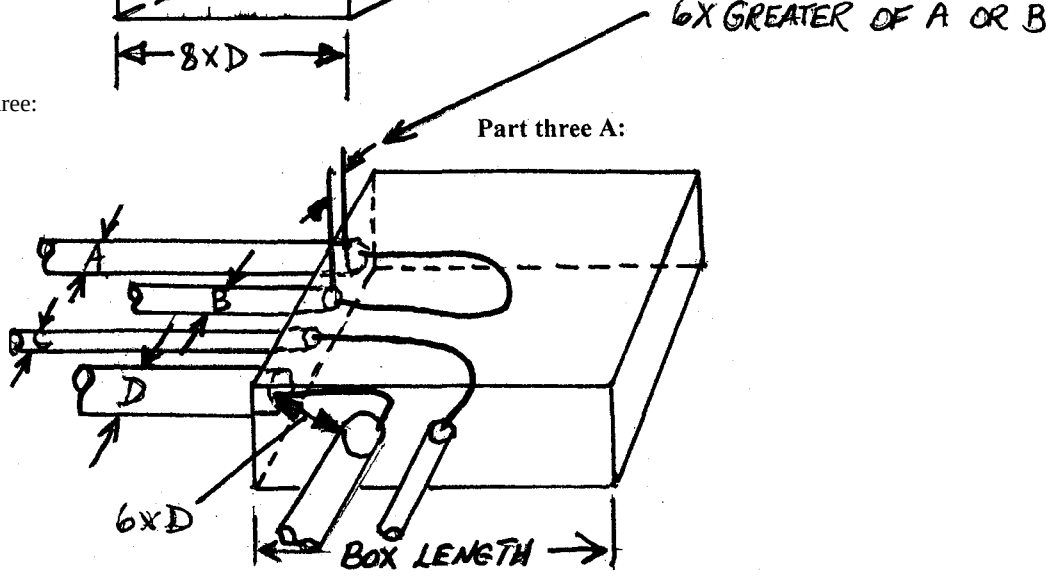

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Pre-certification
Pull Box and Junction Box Sizing: Practice Questions