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CALCULATING REQUIRED LOOP INDUCTANCE

NEMA requires detector amplifier units to operate between 50 and 700 microhenries. In other words, if an inductance loop assembly (consisting of the loop and lead-in) has a total inductance of more than 50 but less than 700 microhenries, any detector meeting NEMA standards should operate successfully with this assembly.

It therefore becomes important to be able to calculate the expected inductance of a given loop assembly. The following is a simple approximate procedure for doing so:

1. **STEP 1:** Calculate the inductance of the lead-in cable using a value of 0.23 microhenries per foot.

2. **STEP 2:** Calculate the inductance of each "section" of the loop using the following values:

   1 wire section -> 0.5 microhenries/ft
   2 wire section -> 1.5 microhenries/ft
   3 wire section -> 3.0 microhenries/ft
   4 wire section -> 5.0 microhenries/ft
   5 wire section -> 7.0 microhenries/ft
   6 wire section -> 9.0 microhenries/ft
   7 wire section -> 11.0 microhenries/ft
   8 wire section -> 13.0 microhenries/ft

   A "section" is any portion of the loop having a consistent number of wires.

3. **STEP 3:** Add the lead-in inductance to the loop inductance to obtain the total inductance of the loop assembly.

A few examples illustrate this procedure:

EXAMPLE 1: Calculate the total inductance of a loop that is 6 foot wide by 20 feet long with three turns of wire, and which has a lead-in that is 1000 feet long (see Figure 1).

STEP 1: The inductance of the lead-in cable is 1000 ft x 0.23 microhenries/ft = 230 microhenries.

STEP 2: The inductance of each "section" of the loop is calculated as follows:

Front Section: 6 feet x 3.0 microhenries/ft = 18 microhenries
Back Section: 6 feet x 3.0 microhenries/ft = 18 microhenries
Right Section: 20 feet x 3.0 microhenries/ft = 60 microhenries
Left Section: 20 feet x 3.0 microhenries/ft = 60 microhenries

So the loop inductance is 18 + 18 + 60 + 60 = 156 microhenries. Note that, in the case of a simple rectangular loop, each section of the loop is merely one side of the loop.

STEP 3: Calculated Total Inductance = 230 + 156 = 386 microhenries Since this is in the 50 to 700 microhenry range, this loop assembly should work with any detector unit meeting NEMA standards.

EXAMPLE 2: Calculate the total inductance of a loop that is 6 foot wide by 30 feet long with two turns of wire, and having a 3 foot power head with an additional 2 turns of wire. The loop lead-in is 120 feet long (See Figure 2).

STEP 1: The inductance of the lead-in cable is 120 ft x 0.23 microhenries/ft = 28 microhenries.

STEP 2: The inductance of each "section" of the loop is calculated as follows:

Front of Power Head:	6 feet x 5.0 microhenries/ft = 30 microhenries
Back of Power Head:	6 feet x 5.0 microhenries/ft = 30 microhenries
Right Side of Power Head:	3 feet x 5.0 microhenries/ft = 15 microhenries
Left Side of Power Head:	3 feet x 5.0 microhenries/ft = 15 microhenries
Back Side:	6 feet x 1.5 microhenries/ft = 9 microhenries
Right Side:	27 feet x 1.5 microhenries/ft = 41 microhenries
Left Side:	27 feet x 1.5 microhenries/ft = 41 microhenries

The loop inductance totals 181 microhenries.

STEP 3: Calculated Total Inductance = 28 + 181 = 209 microhenries Since this is in the 50 to 700 microhenry range, this loop assembly should work with any detector unit meeting NEMA standards.

EXAMPLE 3: Calculate the total inductance of a quadrapole loop that is 6 foot wide by 60 feet long with two turns of wire. The loop lead-in is 900 feet long (See Figure 3).

STEP 1: The inductance of the lead-in cable is 900 ft x 0.23 microhenries/ft = 207 microhenries.

STEP 2: The inductance of each "section" of the loop is calculated as follows:

Front Side:	6 feet x 1.5 microhenries/ft = 9 microhenries
Back Side:	6 feet x 1.5 microhenries/ft = 9 microhenries
Right Side:	60 feet x 1.5 microhenries/ft = 90 microhenries
Left Side:	60 feet x 1.5 microhenries/ft = 90 microhenries
Center Section:	60 feet x 5.0 microhenries/ft = 300 microhenries

So the loop inductance totals 498 microhenries.

STEP 3: Calculated Total Inductance = 207 + 498 = 705 microhenries Since this is outside the 50 to 700 microhenry range, this loop assembly might not work with a detector unit meeting NEMA standards.

Fortunately, most modern detector amplifiers have an inductance range that is much wider than is required by NEMA:

Detector Systems Model 613	-->	20 to 2500 microhenries
Microsense Model MN-C	-->	20 to 2000 microhenries
Canoga Model P404	-->	0 to 2000 microhenries

With any of these detector units the loop described in Example 3 would be acceptable.

Although calculating the inductance is the only way to determine the inductance of a planned loop assembly, the inductance of an existing loop assembly can be determined through field testing using a unit such as the Detector Systems model P/N 501 loop tester.

However, even for an existing assembly, the calculation procedure just discussed can come in very handy. Let's say a contractor, in violation of project specifications, installs the loop described in Example 1 on a weekend with no inspection. On Monday, the inspector tests the loop using an inductance tester and finds that the total inductance for the loop assembly is 300 microhenries, instead of the expected 386 microhenries. By simply re-doing the Example 1 calculations using two turns of wire instead of three, the inspector discovers that the contractor probably shorted the installation by one turn (since this new calculation produces a total inductance of 308 microhenries, which is much closer to the measured value).

FIGURE 1

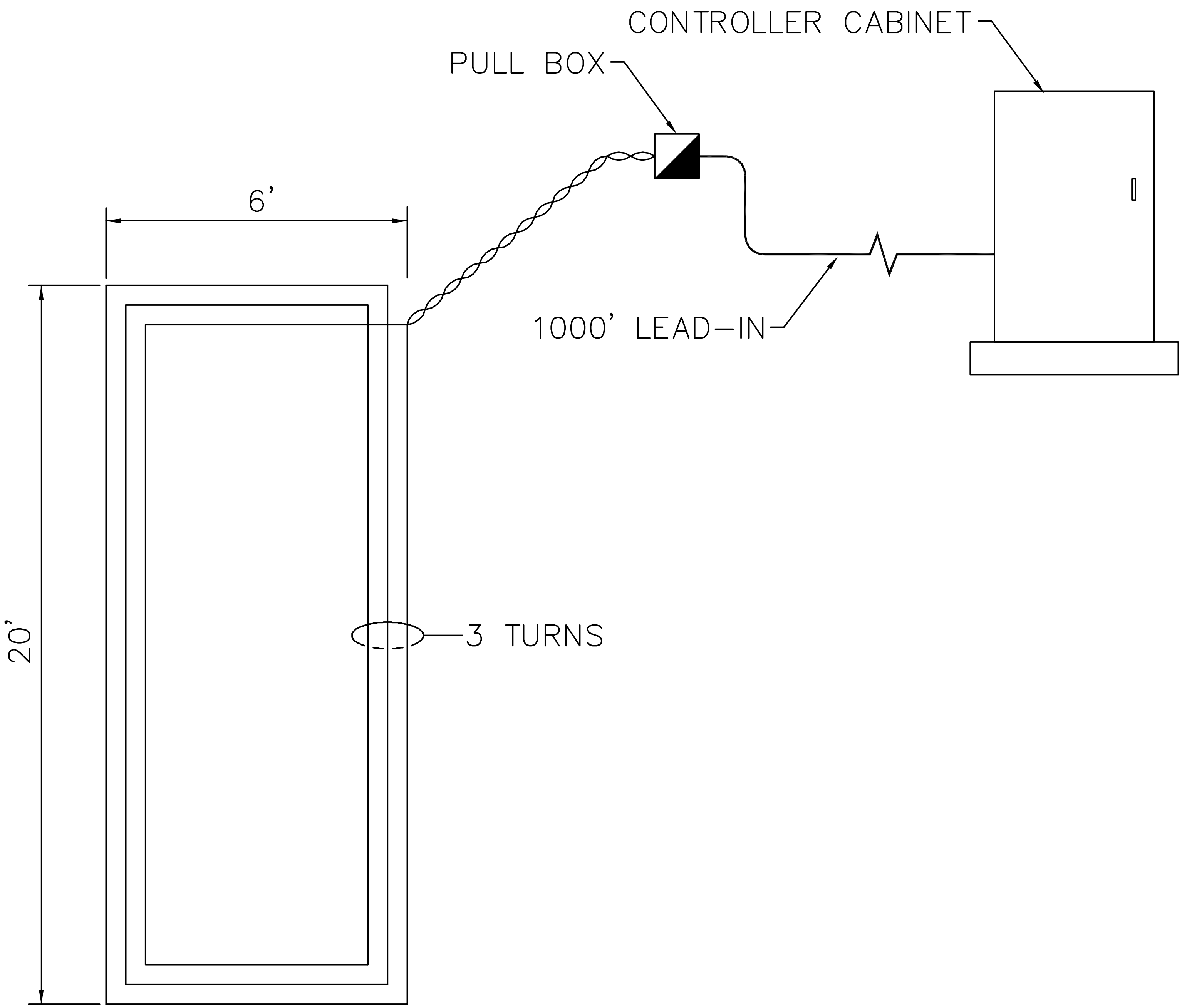

FIGURE 2

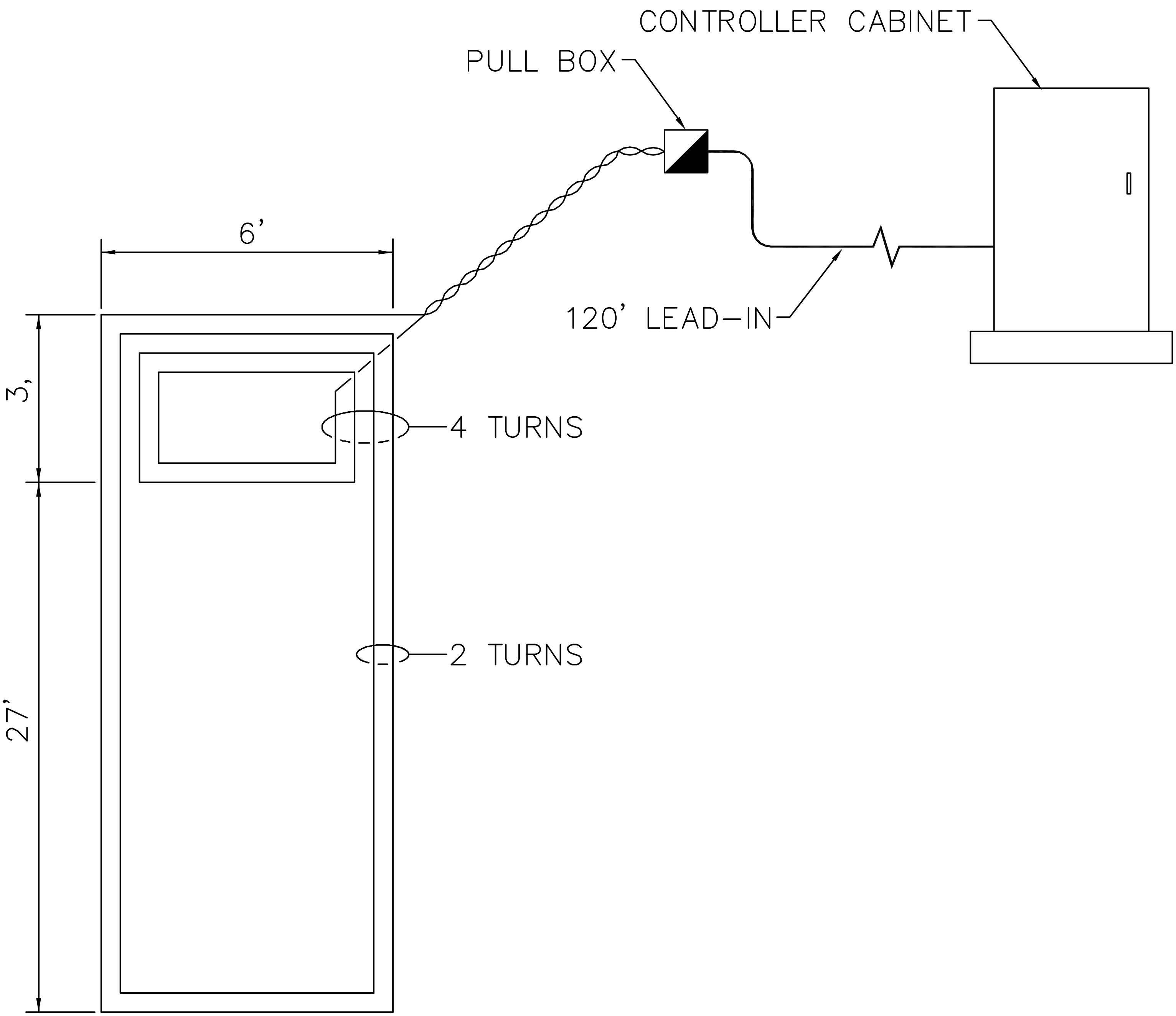

FIGURE 3