

Payback Period for Upsized Branch Circuit Conductors

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Abstract - Some advertisements claim that upsizing branch circuit conductors from a #12 AWG to a #10 AWG wire will lower electrical utility costs, by reducing losses. Furthermore, they say that the additional cost of the larger wire can be recuperated in less than a year. This paper will evaluate the validity of those claims.

temperature of the current carrying conductors will fluctuate based on the load of the circuit. In testing performed by the author, the temperature inside a 3/4" conduit varied from 23.5 to 28.8 degrees C as the load increased from five amps to thirteen amps. These measurements were taken with a thermistor at an ambient temperature of 22.2 degrees C (72 degrees F).

I. Conductor Properties

Every conductor consumes energy, producing heat, due to the inherent resistance of the conductor. This power loss is defined by the following equation:

$$P = I^2R, \quad (1)$$

where P is the power in watts, I is the current in amps, and R is the resistance expressed in ohms per 1000 ft, at 75 degrees C.

The resistance varies as the temperature of the conductor changes. The following equation is used to calculate the resistance, at temperatures other than 75 degrees C:

$$R_2 = R_1[1 + \alpha(T_2 - 75)], \quad (2)$$

where R₂ is the new resistance, R₁ is the resistance at 75 degrees C, $\alpha = 0.00323$ for copper conductors, and T₂ is the new temperature. Thus, as the temperature of the conductor increases or decreases, so does its resistance.

Table 9, of the 2002 National Electrical Code (NEC), lists the AC resistance values for UL-type RHH, stranded copper conductors, at 75 degrees C, grouped as three single conductors in metallic conduit. However, branch circuit conductors do not reach this temperature under normal operation. Equation 2 is needed to adjust these values to reflect the actual temperature of the conductors.

For a single phase, 20 amp branch circuit, in a room temperature environment, the

II. Savings

The amount of energy and money saved by upsizing conductors is dependant on circuit load and the length of time that the circuit is loaded. Equation (1) shows that as the current in a conductor increases, the power loss will increase exponentially.

The annual energy costs saved by upsizing to #10 AWG conductors is displayed in Table 1. The calculated savings are based on a 100 ft branch circuit at 30 degrees C, operating five days per week, fifty weeks per year, at a rate of \$0.025/kWh and \$10/kW demand.

Table 1
Annual Energy Cost Savings

Amps	Operating Hrs				
	24	18	12	8	4
15	\$8.31	\$7.15	\$6.00	\$5.23	\$4.46
12	\$5.32	\$4.58	\$3.84	\$3.35	\$2.86
10	\$3.69	\$3.18	\$2.67	\$2.32	\$1.98
7	\$1.81	\$1.56	\$1.31	\$1.14	\$0.97

III. Payback Period

Conductor costs (material and labor) were compared with the energy savings in Table 1 to determine the payback period for upsizing conductors from #12 AWG to #10 AWG. The payback period is based on an interest rate of four percent.

The average costs, including labor, for #12 AWG and #10 AWG stranded conductors are 30.1¢ per ft and 35.8¢ per ft, respectively. The

NEC allows both conductors to be run in the same size conduit, for a single phase circuit. The branch circuit consists of three conductors: phase, neutral and ground, enclosed in 3/4" electrical metallic tubing (EMT). All conductors were upsized, per the 2002 NEC.

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Figure 1 shows the results of the payback period, in relation to operating hours and load.

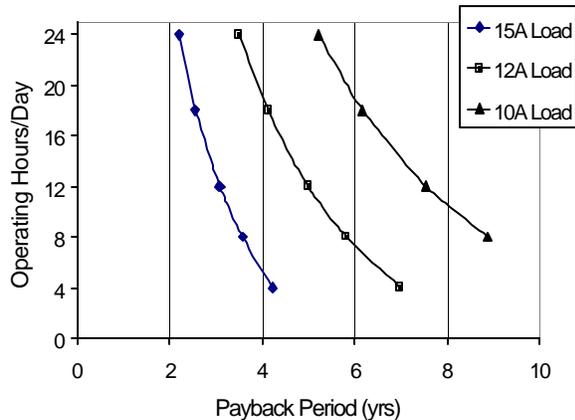


Figure 1. Payback Period

IV. Conclusion

Upsizing branch circuit conductors from #12 AWG to #10 AWG will reduce the power loss in the conductors. However, in order to justify the higher material cost for the #10 AWG wire, the load on the circuit and the operating time must be considered for a reasonable payback period.

References

Newnan, Donald G. *Engineering Economic Analysis*. Sixth edition. San Jose, Engineering Press, 1996.

NFPA Vol. 70, National Electrical Code, 2002.

IEEE Std 141-1993, *IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants* (red book), New York, Institute of Electrical and Electronics Engineers, 1993.

Grainger Catalog, No. 391, 2000-2001.

"One Wire Size Up Means Big Savings," n.d., <http://energy.copper.org/onesizeup.html>, (November, 2001).

R.S. Means Electrical Cost Data, 2000