BUILDING ENERGY MANAGEMENT AND REDESIGN RETROFIT (BEMARR)

ELECTRIC MOTORS

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1. GENERAL

1.01 When an energy conservation study is made, it will probably be found that electric motors are wasting energy. As discussed in this section, electric motors are usually oversized and are operated for long periods of time, often unnecessarily. Oversized motors that operate partially loaded not only use excess energy, but also lower the power factor of the building. This may result in a power factor penalty charge from the serving utility. The material used in this section supersedes that given in the *Building Energy Management and Redesign Retrofit (BEMARR) Manual* issued with GL 76-10-077 (EL-4857) dated October 7, 1976.

1.02 Whenever this section is reissued, the reason(s) for reissue will be given in this paragraph.

2. REPLACEMENTS

2.01 Because of oversizing by the original designers or because of reductions in loads due to slowing down fans, pumps, etc, there are undoubtedly many significantly oversized motors in use in the Bell System. Many motors are oversized, because at the time the building is designed, there is not sufficient data to size the motor to the exact load. Subsequently, to handle possible future loads the design engineer selects a larger motor than is necessary. Most of the time the anticipated loads never occur, and the end result is a lightly loaded motor wasting energy and lowering the building's power factor. Since motor efficiency varies with the motor load and is at a maximum at full load (see Fig. 1), there are opportunities to economically replace larger motors with smaller motors.

2.02 However, as the efficiency variation is small, from 50 to 125 percent of full load, it is recommended that consideration be given to replacing motors only where the actual load is less than 25 percent of the motor's rating as measured by a clamp on wattmeter (not ammeter), or as determined from the horsepower requirement of the driven equipment (eg, fan speed versus horsepower curves). The calculation of anticipated energy savings is crucially dependent upon an accurate estimate of annual hours of operation, which must take into account such things as fan cycling.

2.03 Realistic load increases must be allowed for anticipated growth when downsizing motors.

2.04 Any replacements of defective motors should be made with "high-efficiency" or "energy-saving" motors. The replacement motor should not necessarily be the same size as the old motor, but should be sized to the actual load.

3. SPEED CHANGING

3.01 One of the best ways to reduce motor energy consumption is to slow down the driven equipment to better match the actual heating, ventilating, or air-conditioning loads. Some practical methods of doing this are:

(a) The most common and easiest is to change pulley sizes for belt-driven equipment.

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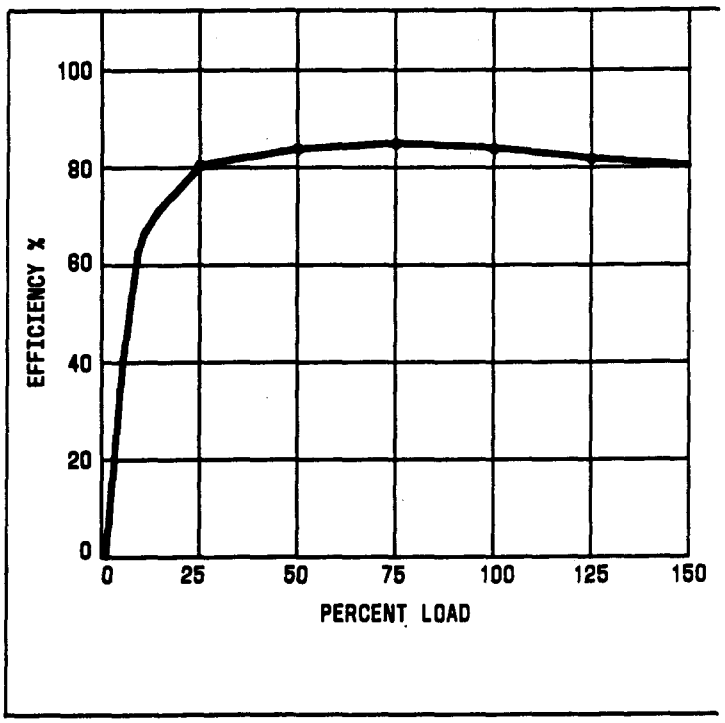

Fig. 1—Efficiency of Typical 3-Phase Motor

(b) Mechanical drives which will permit varying speed for varying loads are available.

(c) Consider use of variable frequency drive to reduce speed.

(d) For direct-drive equipment, it might be more economical to rewind the existing motor for a slower speed, than replace it.

4. VOLTAGE VARIATION

4.01 Within a 10 percent variation from rated voltage, efficiency typically does not vary greatly at full load. The effect of voltage variation is more pronounced, however, at a light load. (See Fig. 2.)

4.02 It is essential that phase voltages be balanced. Even a very small voltage unbalance will have a drastic negative effect on efficiency.

5. CYCLING

5.01 If it appears desirable to cycle certain motors off and on, it will be necessary to determine whether the motor and its controller can withstand the proposed cycle without premature failure or excessive maintenance. Bell System experience has shown that there have been few problems provided in which there are not more than four starts per hour, and the "off" cycle is at least 10 minutes. Large motors (above 75 horsepower) should be checked individually with the manufacturer.

6. REFERENCES

6.01 The information in this section is based on the following references:

- *How to Specify and Evaluate Energy-Efficient Motors*—General Electric Publication GEA-10951
- RL 78-11-117—*Buildings—High-Efficiency Electric Motors.*

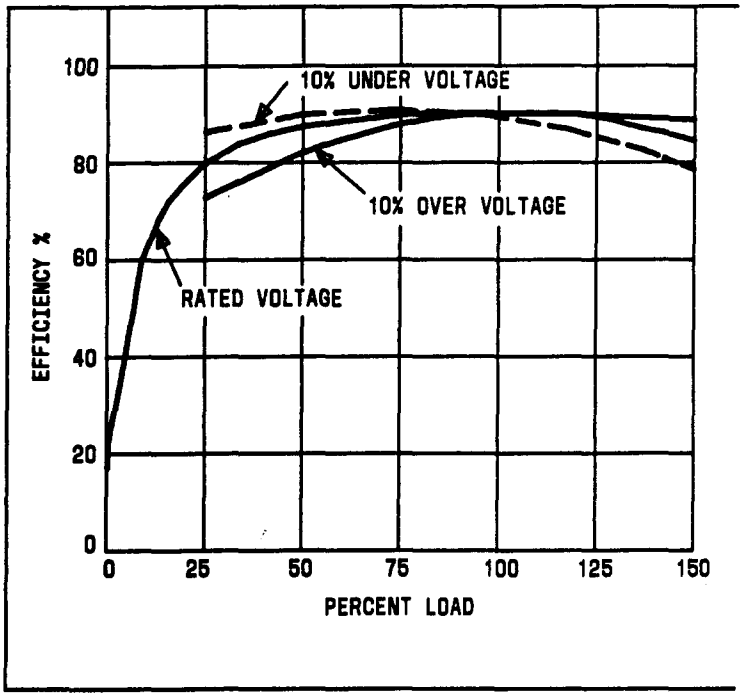

Fig. 2—Efficiency Sensitivity of Typical 3-Phase Motor