An Estimating Rule for Deep Space Station Control Room Equipment Energy Costs

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The cost of electricity to power equipment in control rooms of Deep Space Stations is about $1/yr/W. This rule can be used to estimate power costs for new equipment under development, helping to reduce life-cycle costs and energy consumption by justifying design alternatives that are more costly, but more efficient.

I. Introduction

With costs of energy steadily increasing, the Deep Space Network has become more conscious of the energy costs associated with electronic equipment. Specifications for new equipment generally require that development personnel consider energy conservation in the equipment design, and this consideration is being evaluated at design reviews.

There has thus arisen a need for a simple rule to estimate energy costs associated with new equipment for the Deep Space Stations. Many such rules exist in other fields. For example, building construction costs are estimated in dollars per square foot, with published values appropriate to geographical areas. Costs of photovoltaic cells are estimated in dollars per peak watt. A similar rule has been developed for estimating the cost of electricity required to operate equipment installed in the control rooms of Deep Space Stations.

II. Electricity Costs

There are two principal components in the cost of electricity for Deep Space Station (DSS) control room equipment. One is the direct cost of the electricity, whether purchased commercially or generated at the station. The other is associated with the heat produced by the equipment. Each station has an air conditioning system. This is designed to maintain the control room equipment within a controlled temperature range as well as to maintain the control room itself within an appropriate range for human comfort. Because of the large amount of heat generated by the equipment in a station, this is essentially a cooling load for the vast majority of outside climatic conditions. New control room equipment will add to the heat load on the air conditioning equipment, and the increased cooling load will produce an additional increment of electricity cost.

The cost of electricity at the Goldstone stations is approximately $0.063/kWh. This is chiefly commercial power. At the Madrid stations, the 1979 cost of power for local diesel generation equipment was $0.067/kWh. Figures for the Australian stations are believed to be about the same. A value of $0.065/kWh is used for the computations in this article.

Most DSS control room equipment is operated continuously, and this is assumed to be the case for new equipment to which the rule is to be applied. A load of one watt consumes 8.76 kWh in one year (8760 hours). With current electrical costs at $0.065/kWh, this is an annual cost of $0.57/yr/W for direct electrical usage.

The heat produced by equipment dissipating 8.76 kWh is 29,898 Btu. This is the amount of heat that must be removed from a DSS control room by its cooling system in a year for each watt of electrical power dissipated in equipment. Assuming an average cooling system energy efficiency rating (EER) of 7 Btu/Wh, the electricity required for cooling is 4271 Wh/yr. At $0.065/kWh, this is a cooling cost of $0.28/yr/W.

Adding the direct and cooling costs of electricity, the total cost of electricity for DSS control room equipment is approximately $0.85/yr/W at the present time. Electricity costs at the stations have been rising at a rate of about 15%/yr for the past few years, and the pattern is unlikely to change soon. At this rate, DSS control room equipment energy cost will be $1/yr/W in 1981. This value is easy to remember, and it is recommended as an estimating rule for energy costs in new equipment implementations.

III. Conclusion

The existence of a simple estimating rule makes it practical to trade off energy costs for capital costs in new equipment design. For example, DSS electronic equipment is typically powered by a commercial power supply which converts 110-volt, 60-Hz primary power to one or more DC voltages used by the equipment components. A conventional regulated power supply has a typical efficiency of 40 percent, while a switching regulated power supply has a typical efficiency of 75 percent. A conventional power supply delivering 100 watts to its load will require 250 watts of primary power, while the switching power supply under the same load will require only 133 watts. This difference of 117 watts will cost approximately $117/yr for additional energy. This is usually enough to pay for the added power supply cost in a matter of months.

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