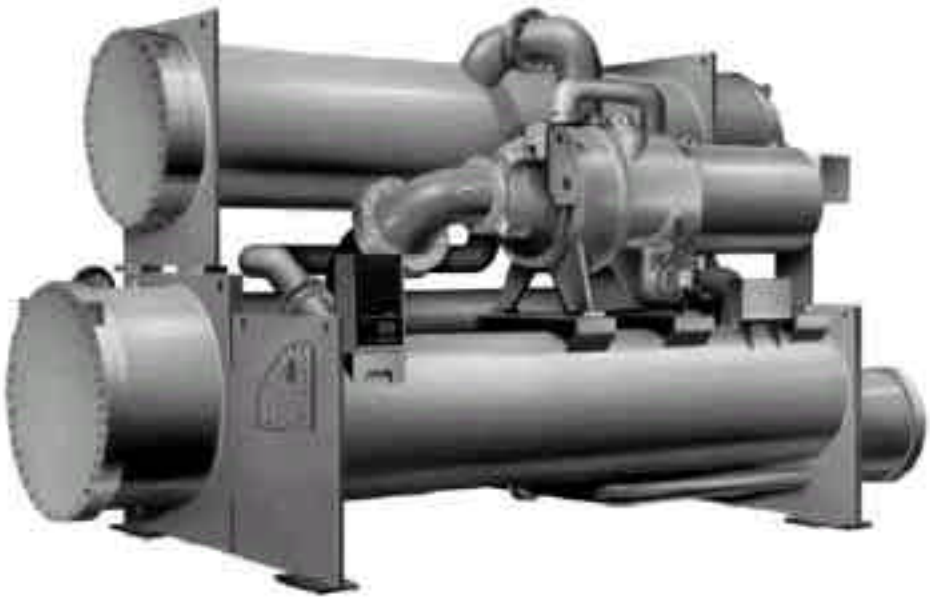
Refrigeration Chiller Performance Analysis at Various Loads



Henry Manczyk, C.P.E., C.E.M.
Director of Facilities Management
Monroe County, Rochester, N.Y.

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REFRIGERATION CHILLER/PERFORMANCE ANALYSIS AT VARIOUS LOADS

Henry Manczyk, CPE, CEM,
Director of Facilities Management, Monroe County, New York

This illustration shows that a chiller loaded to 100% of its designed capacity will operate at maximum efficiency kilowatt cost per ton.

For example, a unit made by Carrier Corporation (Model #19EB8973DM) has a cooling capacity of 1,100 tons. With an entering condenser water supply temperature from an adjacent river at 75 degrees Fahrenheit, the designed kilowatt use per ton is 0.626 at 100% of design capacity.

This chiller also operates at different loads such as 75, 50, or 25 percent of capacity. The lower the capacity that the chiller is operating, the higher the kilowatt use per ton will result in this particular design.

For example, let's assume a complex of buildings where all buildings operate during regular business hours, but one building (“A) operates after normal business hours. Building “A” uses an average of 90 tons per hour of the 1,100-ton capacity chiller, or 8% of capacity. This inefficient use of the chiller results in an unnecessarily high kilowatts per ton.

There are several methods of determining the efficiency of a chiller using only 8% of designed full-load capacity. Two of them are:

1) Power regression and;
2) Polynomial regression

In our example using the power regression method, we find that kilowatt per ton use is 1.539; and under the polynomial regression method the use of the kilowatt per ton is 1,465.

Since the design of the chiller is 0.626 kilowatts per ton if run at maximum capacity, and up to 0.949 if run at 25% of capacity, it is inefficient to run the unit at any capacity under 25%.

This being the case, the recommendation would be the following:

1) Install a smaller chiller in the main refrigeration plant to accommodate smaller loads, or
2) Install a stand-alone system dedicated for that facility (Building "A") running after regular hours to match the building's existing load.

The facility could also evaluate the use of chilled water thermal storage to take advantage of lower nighttime electric rates or just to provide the needs of Building “A”.

See attached illustrations.

References:

Chiller data provided by local Carrier branch office.

CHILLER PERFORMANCE ANALYSIS

Recorded Data (Carrier):

Percent Of Capacity	KW/Ton
75%	0.652
50%	0.725
25%	0.971
15%	1.218

Determine efficiency (KW/Ton) at 8% of capacity:

2 Methods: 1) Power Regression
2) Polynomial Regression

From Power Regression (- - - - -):

$$y = 0.5676\ x^{-0.3948}$$

Percent Of Capacity	KW/Ton
8%	1.539

From Polynomial Regression (- - - - -):

$$y = -4.7695\ x^3 + 8.85383\ x^2 - 5.301\ x + 1.8371$$

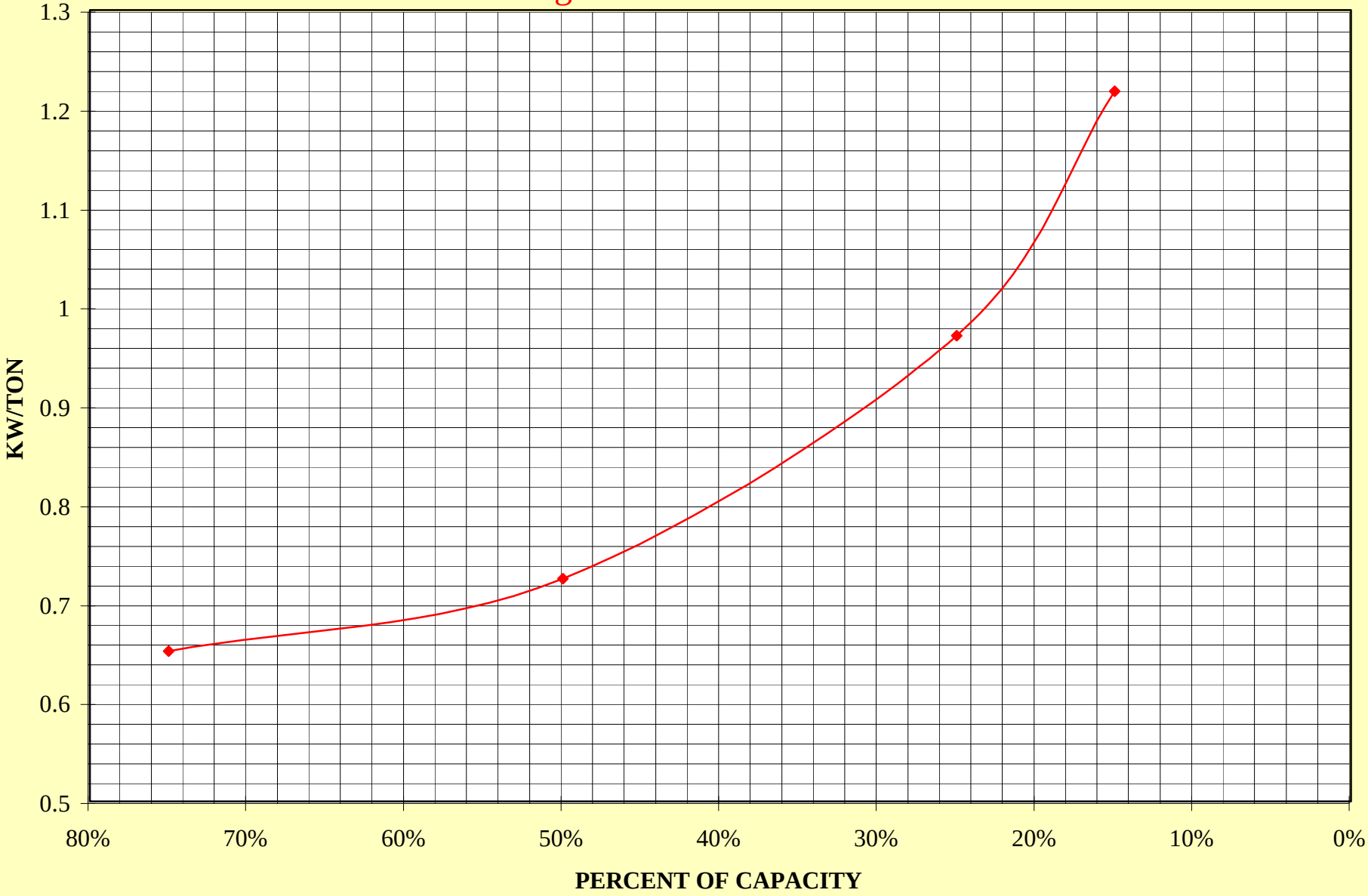
Percent Of Capacity	KW/Ton
8%	1.465

Summary:

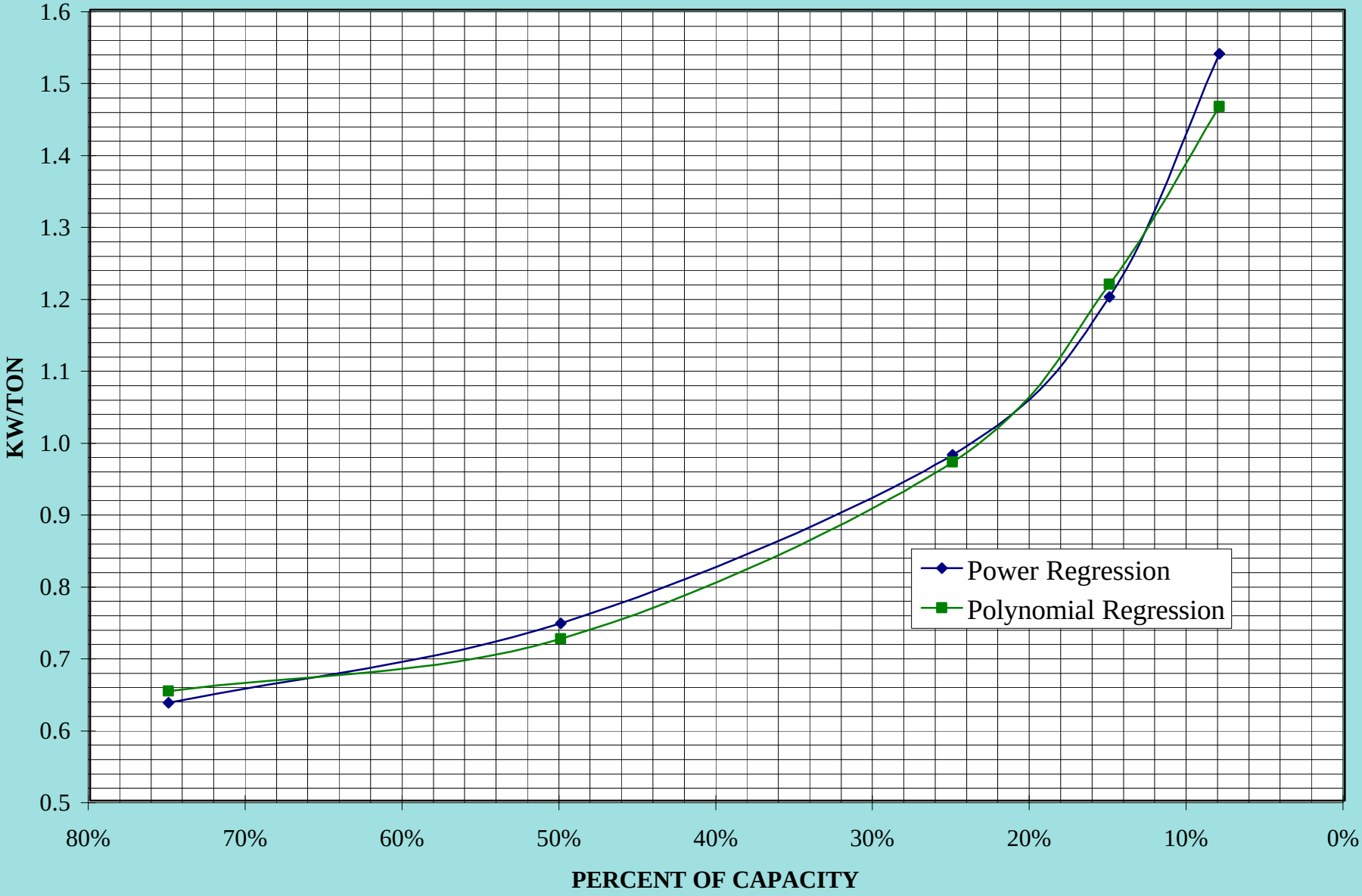
% Of Capacity	KW/Ton	
	Power Regression	Polynomial Regression
75%	0.636	0.652
50%	0.746	0.725
25%	0.981	0.971
15%	1.200	1.218
8%	1.539	1.465

CHILLER PERFORMANCE ANALYSIS

Original Recorded Data



PREDICTED CHILLER PERFORMANCE



REGRESSION ANALYSIS CHART

Power & Polynomial Regression Trendlines