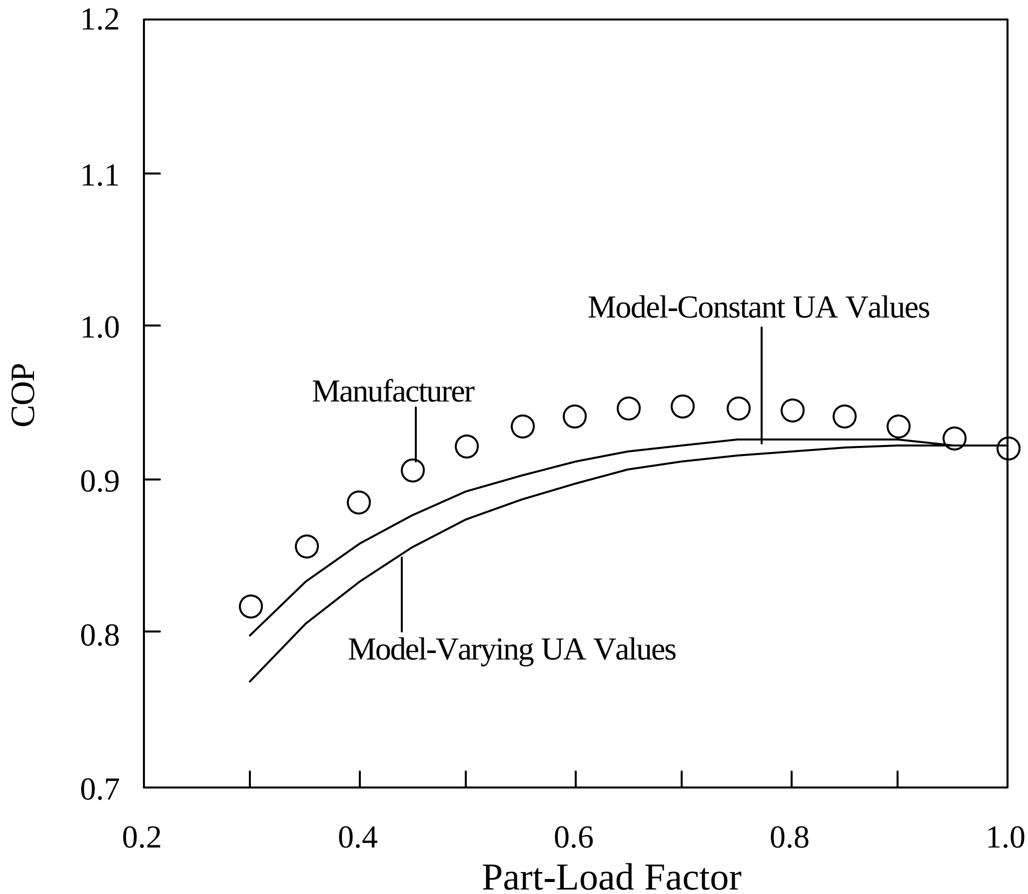

Figure 2.4 Model and manufacturer part-load performance. UA values vary due to the decreasing flow rates of the refrigerant and the solution.

2.4.1 Off-Design Part-Load Performance

The model part-load performance for a range of inlet cooling water temperatures was investigated. It was discovered that the operating parameters have interacting effects on the COP. For example, a COP ratio (COP/COP_{nom}) as a function of the load for an inlet cooling water temperature of 29.4 C (85 F) was obtained from the model. Also obtained from the model was a COP ratio as a function of the inlet cooling water temperature (based on full-load conditions). The COP ratio functions were used to calculate chiller part-load COP at various inlet cooling water temperatures other than the nominal, but did not give the same performance as the model. Rather the COP ratio functions underpredicted the model performance, especially at lower part-load factors and cooling water temperatures, with differences up to a maximum of 13 percent. In Figure 2.5, the model part-load performance at an inlet cooling water temperature of 21.1 C (70 F) is plotted, along with the COP as determined from the COP ratio functions mentioned. The two COPs differ by 10 percent at a part-load factor of 0.30, and shows the importance of the model.

As the inlet cooling water temperature is lowered (subject to ambient wet bulb) the chiller performance improves. For comparison, the model COP at a constant inlet cooling water temperature of 29.4 C (85 F) and the model COP at a linearly decreasing inlet cooling water temperature from 29.4 C (85 F) to 21.1 C (70 F), are plotted in Figure 2.6 as a function of the part-load factor. The COP is significantly improved by lowering the inlet cooling water temperature as seen in Figure 2.6, and this suggests that an easily implemented control strategy involving the variation of this temperature can result in improved performance.

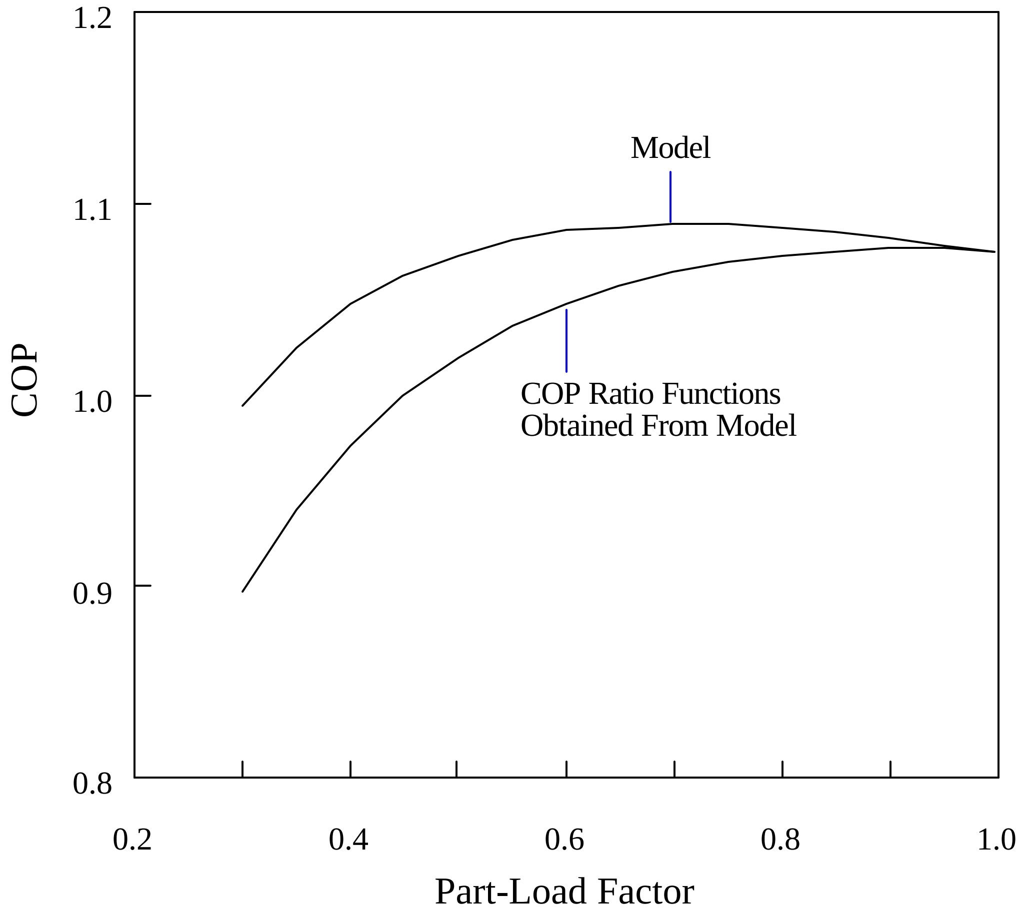

Figure 2.5 Comparison of the model part-load COP and the COP calculated from the COP ratio functions, both part-load COPs are for an inlet cooling water temperature of 21.1 C (70 F). The COP ratio functions were obtained from the model full-load performance at varying temperatures and the model part-load performance at nominal temperatures.

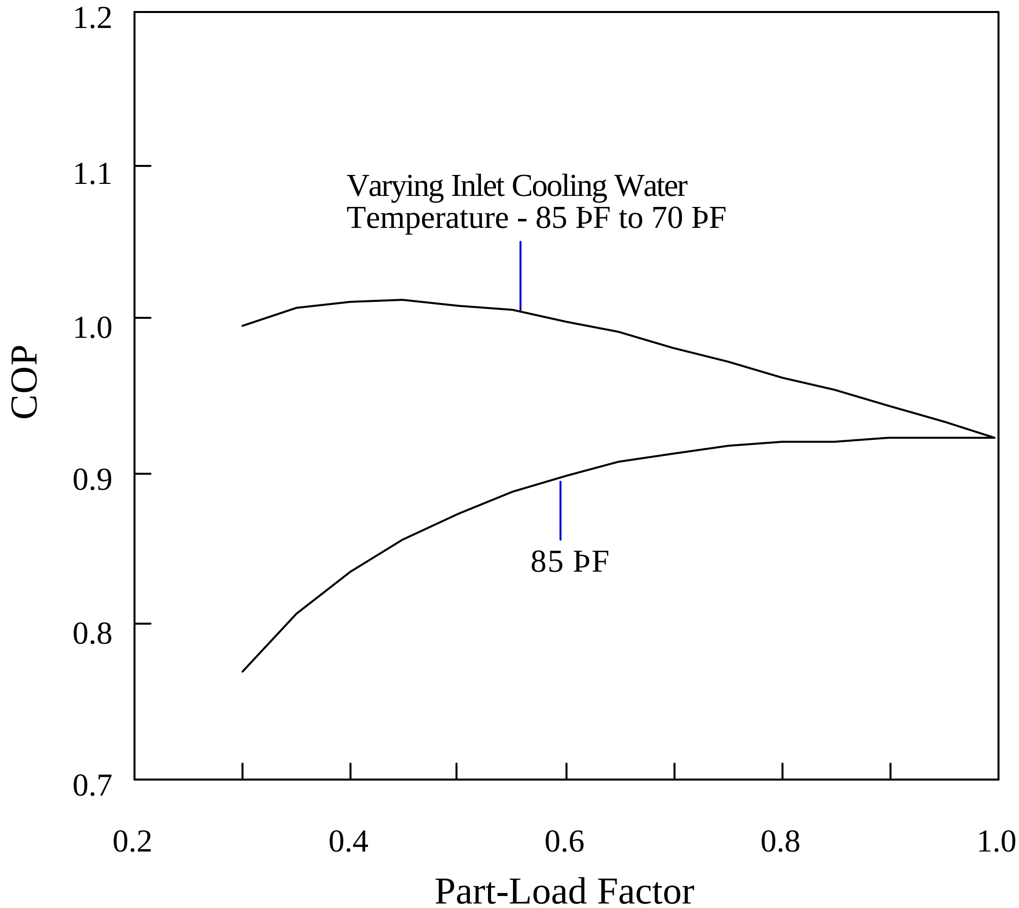

Figure 2.6 Model part-load COP in which the inlet cooling water temperature is varied linearly between 29.4 C (85 F) and 21.1 C (70 F) with the part-load factor, and the COP at an inlet cooling water temperature of 29.4 C (85 F).

2.5 Conclusions

A steady-state computer simulation model of a direct-fired double-effect water-lithium bromide absorption chiller in parallel flow configuration has been shown to compare favorably with manufacturer's catalog information for full and part-load conditions. The model was developed from first principles and calculates state point temperatures, pressures, and concentrations and the required energy input for a given load and operating condition. The model component UA values are mechanistic in that they vary according to solution and refrigerant flow rate variations from nominal. The parallel flow split between the two generators varies due to a concentration decrease in the high temperature generator. The nominal values for the model parameters such as the component UA values and the parallel flow split were determined by matching the calculated state points and COP against manufacturer operating data and COP at full-load nominal conditions. The calculated performance due to lowering the inlet cooling water temperature at full-load conditions agrees with the catalog's performance. Model performance for increasing the outlet chilled water temperature at full-load conditions slightly underpredicts the catalog performance. For chiller part-load performance, the model differs from the catalog data by a maximum of six percent at a part-load factor of 0.30. The model is judged satisfactory for use in control studies of varying the water circuit temperatures and flow rates, and for predicting chiller performance at off design conditions for which performance data is not available.