

(Topic 9: Engineering better working and living environments:  
control and diagnostic systems to enhance A/C reliability and efficiency)

## Imprecisely Verifying Performance of Water Chilling Machines by Refrigerant-Circuit Measurements

M Bailey-McEwan

School of Mechanical, Aeronautical & Industrial Engineering  
University of the Witwatersrand, Johannesburg  
Private Bag 3, 2050 Wits, South Africa  
Telephone: 27 11 717-7325      Telefax: 27 11 717-7335  
E-mail: mbmcewan@mech.wits.ac.za

Water chilling machines for air-conditioning often fail to attain specified performance or optimal efficiency. Such failings and their penalties may not be evident without adequate performance monitoring and assessment. Techniques for monitoring on-site performance are well documented, but at many sites, accuracies of fitted instruments, particularly in water circuits liable to contamination, are not assured. Computing an overall energy balance from water-circuit measurements is widely used to verify indicated performance: an unacceptably large energy imbalance signifies unacceptable monitoring errors. However, this does not of itself identify such errors. To do so, indicated performance can be verified from independent measurements in the refrigerant circuit.

Often, though, one or more required measurements in the refrigerant circuit are unobtainable, because of lack of instrumentation or difficulty of measurement. It may nevertheless be possible to use the obtainable refrigerant-circuit measurements to *imprecisely* verify indicated performance, and hence at least to identify large, unacceptable errors therein. A graphical method for this purpose, the acceptability band plot, is presented. This displays the bands of error deemed acceptable for the indicated evaporator and condenser water loads - and the corresponding bands of COP and *unobtainable* refrigerant-circuit quantities. Together with an accompanying, implied water flow plot, this plot depicts the available evidence for unacceptable monitoring errors in indicated performance. The larger the energy imbalance, the more likely these plots are to identify such errors - on the basis of impossible or improbable COP, refrigerant-circuit quantities, or water flows. The acceptability band plot also aids in estimating the penalties of abnormal conditions in the refrigerant circuit. Two case studies illustrate the method.