
Energy Performance

r e p o r t

Turbocor Compressor West's Leagues Club, Newcastle



June 2003



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ENERGY PERFORMANCE REPORT
Turbocor Compressor:
West's Leagues Club,
Newcastle, NSW, AUSTRALIA

 **Executive Summary**

During May and June 2003, an energy performance test was conducted on a newly retro fitted Turbocor oil-free centrifugal compressor unit at the Western Suburbs Leagues Club premises in the Newcastle suburb of New Lampton. The single Turbocor unit replaced 2 of 4 Trane reciprocal compressors. Energy metering equipment was installed on the newly installed Turbocor compressor as well as the remaining reciprocal compressors (2 of) so as to provide a reference.

The new and existing compressors were run in parallel, on the same chilled water loop. All equipment was set-up so as to ensure that the new compressor and existing compressors were performing the same amount of work (Delta T) on the same amount of water (equal flow rate through each chiller).

The graphs below show a comparison of average energy use by each compressor system at various, specific load points and over all load points. For the graph (Fig 1.1) below, each load point recorded by the Turbocor energy meter, the various Reference loads for the same time periods (2 minute intervals) were averaged.

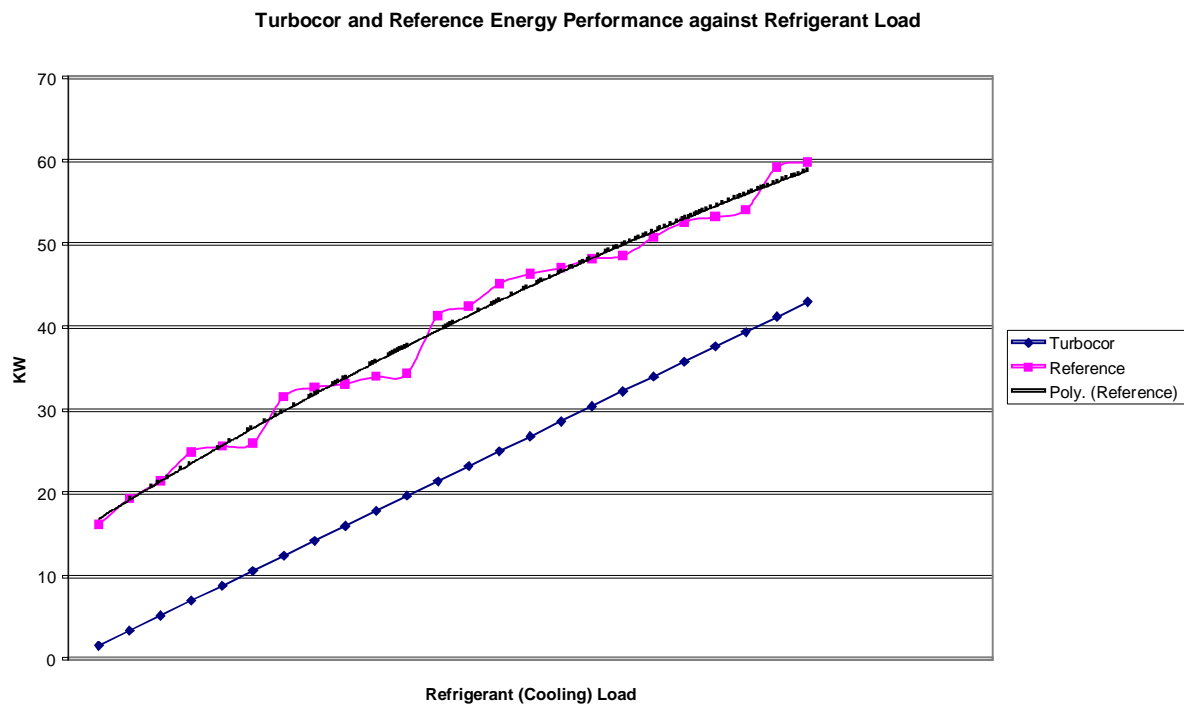


Fig. 1.1 Graph of energy use by Turbocor and Reference compressors against discrete cooling loads

Investigation of each compressors' energy usage at different load levels indicated an average power usage reduction of 47% compared with the reference system at any given load.

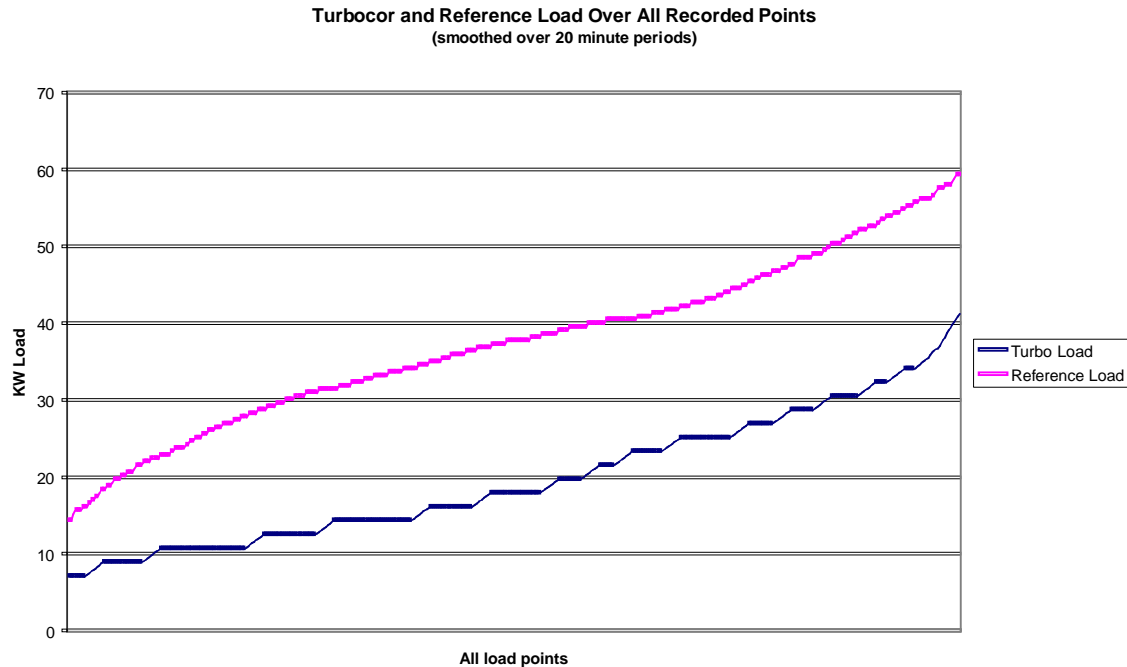


Fig. 1.2 Turbocor and Reference Load Over All Recorded Points

Over *all the actual loads* experienced during the performance test, an average reduction of 58% was recorded over the given operating conditions. Over the range of conditions monitored, a maximum reduction of 75% and a minimum reduction of 28% were experienced. This figure indicates the Turbocor compressor's excellent performance at moderate load conditions – atypical of regular centrifugal compressors.

From the data collected during June 2003, it is estimated that the above energy savings would translate to an annual reduction in energy consumption of approximately 55,000KWH or \$5,000 (at an average of 9 cents per KWH). There would also be a corresponding annual reduction in demand charges of approximately \$2,100 (at an average cost of \$98.40 per KVA per annum).

The following graph shows a typical run of the compressors. This run highlights the control capacity of the Turbocor compressor compared to the typical 'cutting in and out' and 'loading' of reciprocal compressors. When combined with the results outlined above, the Turbocor compressors show an advantage in two scenarios where a compromise would have to be made with traditional compressors (high load efficiency sacrificing low load efficiency and control and vice versa).

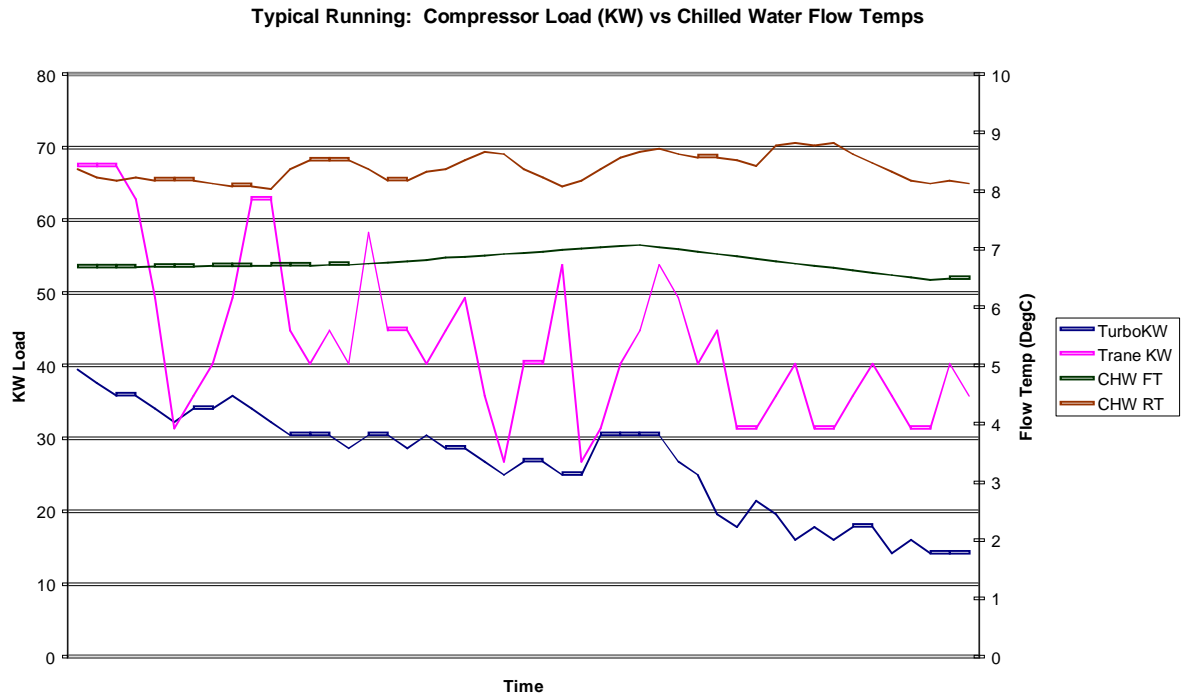


Fig 1.3 Typical Energy Consumption Profile for Turbocor and Reference Compressor compared to Flow Temps 20th June, 2003

In addition to the energy savings outlined above, the Turbocor unit was also found to be light, compact and extremely quiet.

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Background

From www.turbocor.com :

“The revolutionary Turbocor family of compressors, the world's first totally oil-free compressors, are specifically designed for the Heating, Ventilation, Air Conditioning and Refrigeration (HVACR) industry. The convergence of aerospace and industrially proven magnetic bearing, variable-speed centrifugal compression and digital electronic technologies enables the Turbocor family of compressors (nominal 60-150 ton capacity range at ARI standard conditions) to achieve the highest compressor efficiencies for middle-market water-cooled, evaporatively cooled and air-cooled HVACR product applications.

Magnetic Bearings

- The Turbocor family of compressors' rotor shafts and impellers levitate during rotation and float on a magnetic cushion.
- Two radial and one axial magnetic bearing are employed.
- Bearing sensors feed back real-time orbit information to digitally controlled bearings.
- Centered rotation is instantaneously self-corrected and maintained.
- When not powered, the rotor is supported by carbon composite, touchdown bearings designed for years of use.

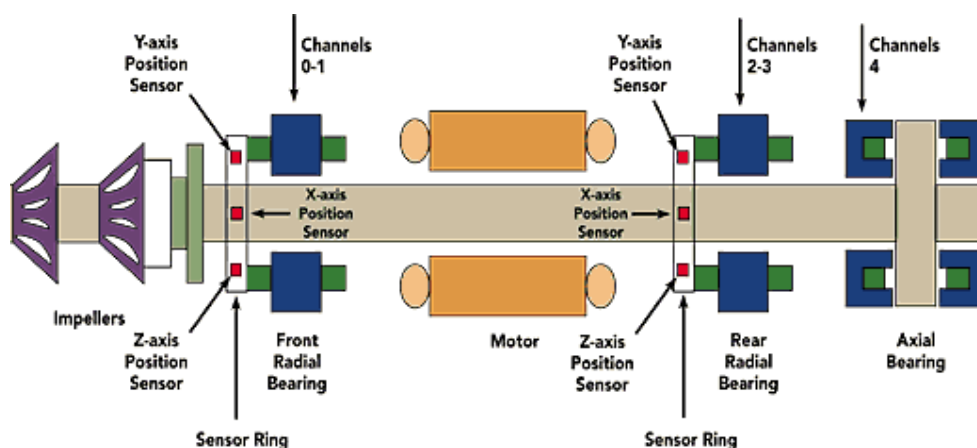


Fig. 2.1 Magnetic Bearing Schematic

Variable Speed

- The Turbocor compressor speed adjusts to changes in load and/or condensing temperature.
- As compressor speed reduces due to lower loads and /or condensing temperatures, energy consumption dramatically reduces. Part load energy

efficiency is outstanding, with energy savings greater than 30% compared to traditional screw compressors.

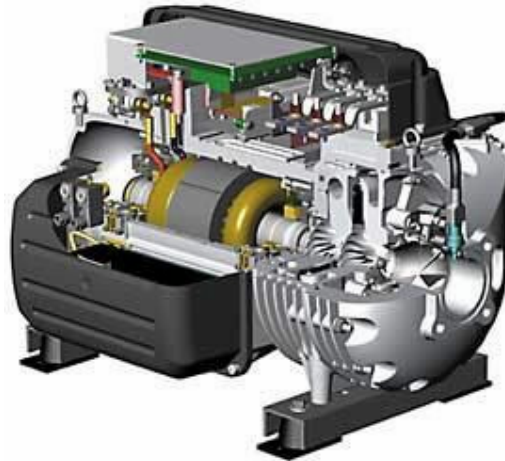


Fig. 2.2 Turbocor Compressor Cutaway showing control unit, impellers, motor, etc

Centrifugal Compression

- Centrifugal compression offers higher aerodynamic efficiency compared to any other compressor designs.
- Variable-speed drive provides best part load efficiency, and operates most effectively with centrifugal compression.
- Compressor has one (1) main moving part. The two impellers are keyed directly to the motor rotor as shown in the illustration.
- Compressor has two stages of centrifugal with the potential to incorporate an economizer cycle.
- Well-proven, long-life in central plant applications.”



Fig. 2.3 Turbocor impeller shaft

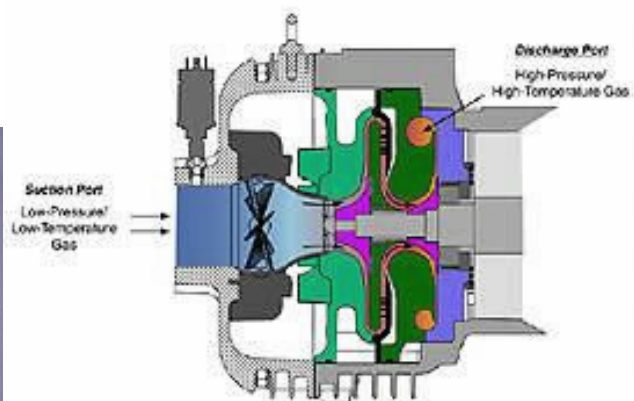


Fig. 2.4 Turbocor compressor gas flow diagram

Description of Site & Services

The Western Suburbs Leagues Club's Newcastle motel and club facility is located in New Lampton, Newcastle approximately 2 hours north of Sydney.

The club and motel complex is open 23 hours a day and includes a motel complex with laundry and heated pool as well as several gaming areas and eateries. A wide variety of plant is utilised through-out the site for the operation of the full fresh air Heating, Ventilation and Air Conditioning system.

Energy metering equipment was installed on the newly installed Turbocor compressor as well as the existing Trane (Reference) reciprocal compressors (2 of). The Turbocor compressor is rated at a refrigerant capacity of 280KW (driven by a DC motor rated at 62 KW) with each existing reciprocating compressor having a refrigerant capacity of 150 KW (motors each rated at 45KW (90 KW total)).

The existing, reference compressors were already fitted with electronic expansion valves to increase their energy performance.

The new and existing compressors were run in parallel on the same chilled water loop. All equipment was set-up so as to ensure that the new compressor and existing, reference compressors were performing the same amount of work (Delta T) on the same amount of water (equal flow rate through each chiller).

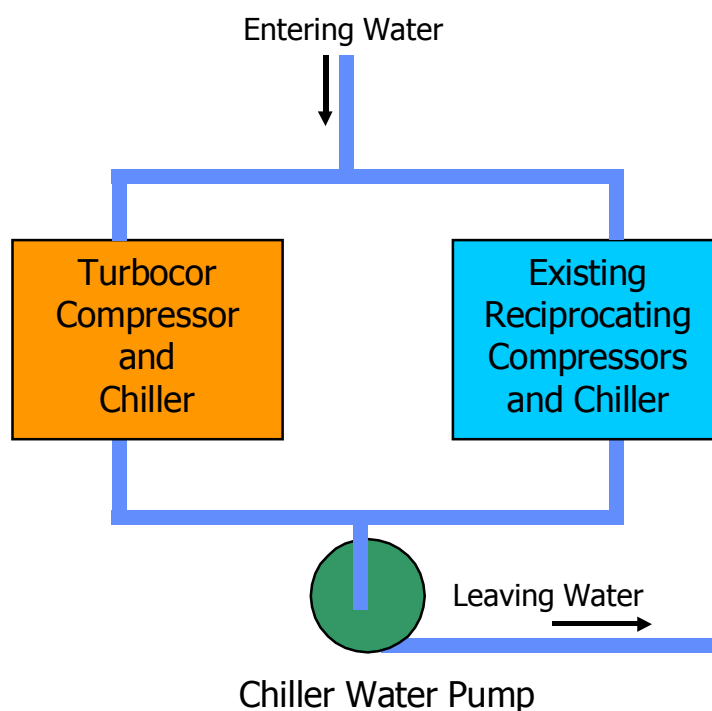


Fig. 3.1 Schematic of Compressor Lay-out

Comment From Site Manager

This comment was supplied by Ian Smith, Facility Manager for the Western Suburbs Leagues Club, Newcastle:

*RE: Turbocor Compressor Installation at
Western Suburbs Leagues Club Newcastle*

Dear Sir

We have been closely monitoring the performance and character of this machine for the last several months, while your firm BCM has been logging energy data.

This machine is a pleasure to work with. Its performance and economies are amazing.

There is no vibration, it is extremely quiet, lightweight and appears to be extremely rugged.

All oil problems are now nonexistent. There is now no such thing as over condensing. Its light load characteristics are far superior to anything I have seen, having been in the trade for over 30 years. The machine addresses under condensing, and, for that matter, any situation, with its own onboard controls and safeties.

The support from the manufacturer has been 100%, and is available 24/7 !

Try getting that anywhere else.

We are now installing a second machine, with more to be installed in the near future.

Yours Sincerely

Ian Smith

Data on Energy Consumption

Data on energy consumption includes (analysis below):

Appendix A: Typical Energy Consumption Profile for Turbocor and Reference Compressor compared to Flow Temps 20th June, 2003

Appendix B: Turbocor and Reference Energy Performance Against Discrete Refrigerant Loads

Appendix C: Turbocor and Reference Load Over All Recorded Points

Analysis of Energy

Typical Energy Consumption Profile for Turbocor and Reference Compressor compared to Flow Temps 20th June, 2003:

The graphs outlined in appendix A show a typical period of running with chilled water flow and return temperatures over laid with the relevant Turbocor and Reference compressor loads.

This plot highlights:

- The reduced energy consumption of the Turbocor compressor over a range of loads

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- The ability of the Turbocor compressor to smoothly change load to meet demand compared with loading and unloading of the reference compressor

Turbocor and Reference Energy Performance Against Discrete Refrigerant Loads:

The graphs outlined in appendix B show a comparison of average Reference and Turbocor compressor electrical loads at given refrigerant load points.

This plot highlights:

- The energy savings available with the Turbocor compressor over a wide range of discrete operating conditions.
- An average energy reduction over discrete refrigerant points of 47%

Turbocor and Reference Load Over All Recorded Points:

The graphs outlined in appendix C show a comparison of all Reference and Turbocor compressor electrical loads over the data collection period. This data has been smoothed over 20 minute periods (moving average over 10 x 2 minutes logging intervals).

This plot highlights:

- The energy savings available with the Turbocor compressor over a wide range of actual operating conditions. In particular, this highlights the large portion time the compressor spends at mid-load conditions where larger savings are evident.
- Over all operating conditions, an average energy reduction of 47%, a minimum energy reduction of 28% and a maximum energy reduction of 75%.

**ENERGY PERFORMANCE REPORT
Turbocor Compressor:
West's Leagues Club, Newcastle NSW, AUSTRALIA**

Auditor and Management Personnel

AUDITOR DETAILS

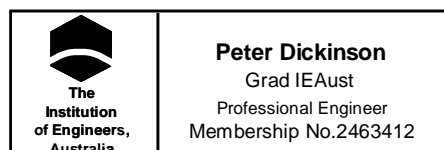
Name of Auditor:	Building Controls Management Pty Ltd
Nominated Individual:	Peter Dickinson
Start Date of Audit:	May 2003
Phone Number:	+61 2 6231 6581

SITE DETAILS

Name of Audit Site:	Western Suburbs Leagues Club, New Lampton NSW, AUSTRALIA
Address of Audit Site:	88 Hobart Road, New Lampton, NSW 2305
Name of Site Manager:	Ian Smith
Phone Number:	+61 2 4935 1200

Regards,

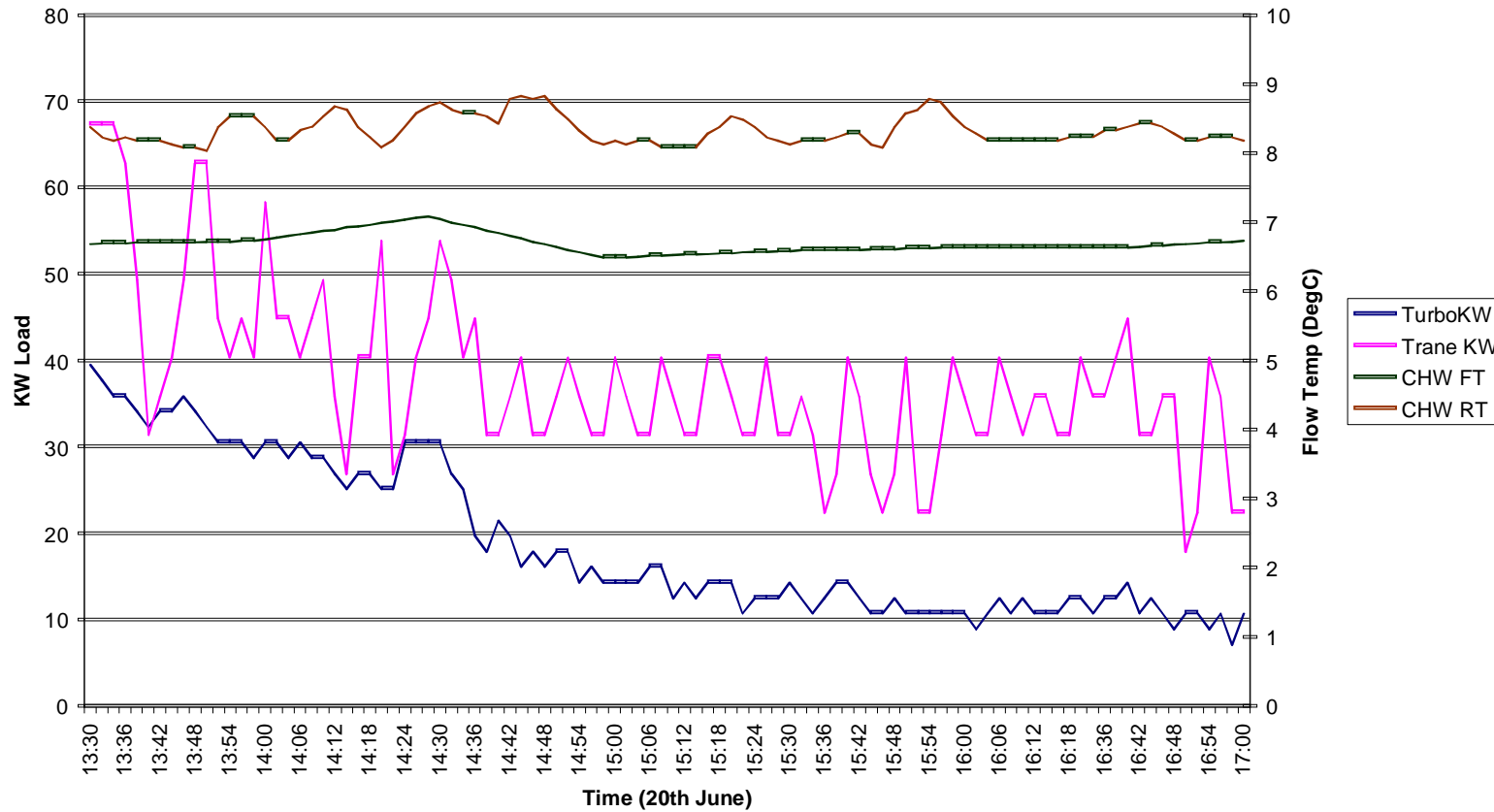
Peter Dickinson
Managing Director



Appendix

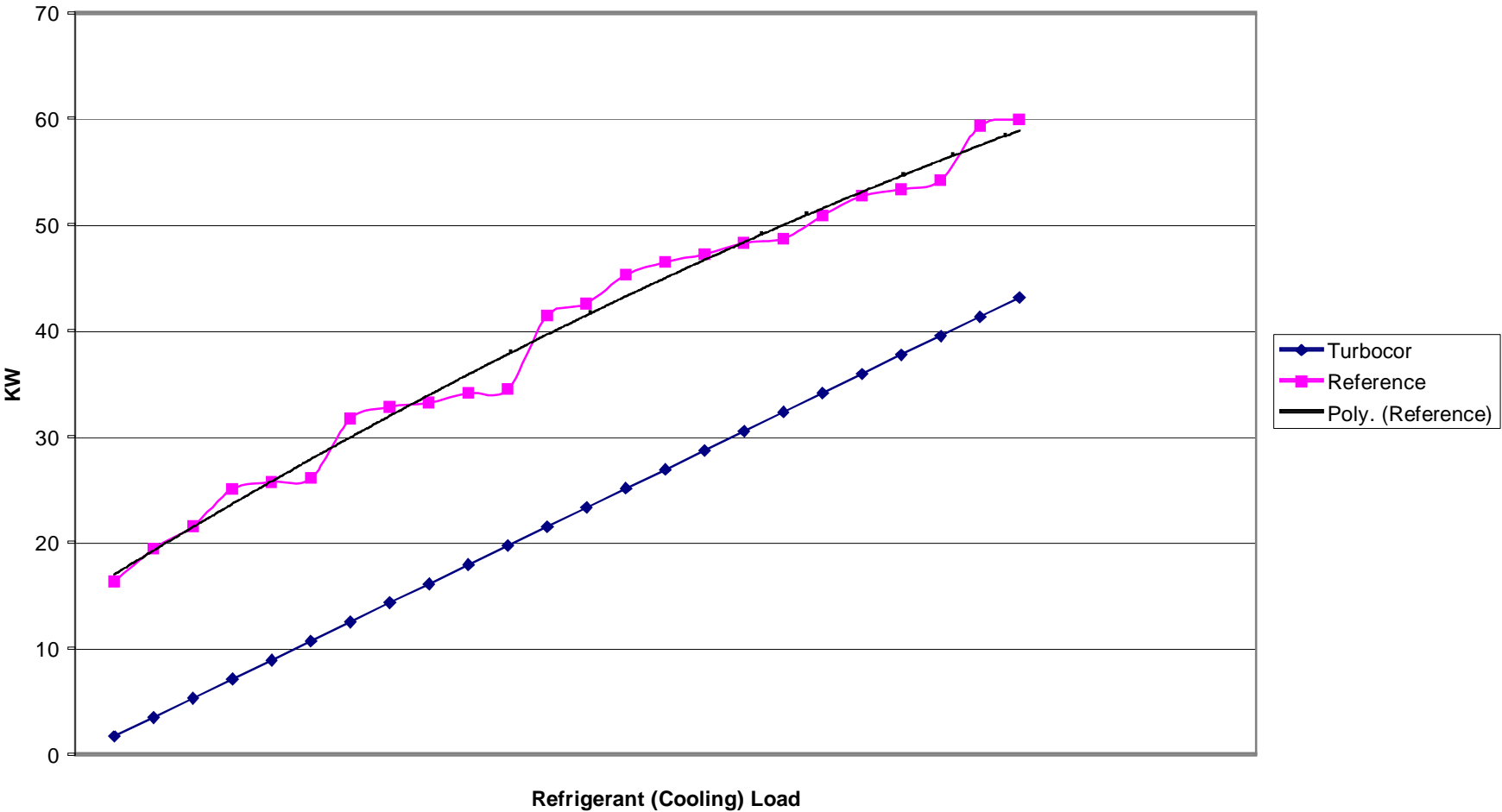
Appendix A: Typical Energy Consumption Profile for Turbocor and Reference Compressor compared to Flow Temps 20th June, 2003

Typical Running: Compressor Load (KW) vs Chilled Water Flow Temps



Appendix B: Turbocor and Reference Energy Performance Against Discrete Refrigerant Loads

Turbocor and Reference Energy Performance against Refrigerant Load



Appendix C: Turbocor and Reference Load Over All Recorded Points

Turbocor and Reference Load Over All Recorded Points
(smoothed over 20 minute periods)

