HYDROCARBON REFRIGERANT CONVERSION REPORT FOR CITIBANK HOUSE 37 ST. GEORGES TERRACE PERTH, W.A.

Prepared by:

MR SELWYN WALLACE
ENGAS AUSTRALASIA

DR LADAS TAYLOR
ENGAS AUSTRALASIA

INITIAL INSPECTION OF BUILDING AND EQUIPMENT

The building is an eighteen story building, comprising of a ground floor banking outlet and seventeen floors of offices. The building is situated in the heart of the Perth C.B.D. The air conditioning system is a central plant Water Cooled Chiller in a purpose built machinery room.

The Water Cooled Chiller provides the cooling for the building. It is a Carrier 30L Series Chiller, comprising of eight compressors configured in two circuits of four compressors each. **It has a nominal rated cooling capacity of 814 kilowatts.**

Despite its age the Chiller was operating well and had only minor issues but due to rising power costs and the rising costs of the refrigerant R22 the building owner needed to plan for the future.

Various options were available for the building owner. The first option was to replace the Chiller with a new more efficient type of Chiller using a refrigerant that was marginally more environmentally friendly than R22. The new Chiller would use the Chemical Refrigerant R134a which has a global warming potential of 1700. The second option was to convert the existing Chiller to a Hydrocarbon (HC) refrigerant with ZERO ozone depleting effect and absolute minimal global warming potential.[1]

The decision was made to keep the existing Chiller and convert it to use Engas M50 Hydrocarbon Refrigerant. The cost advantage of just replacing the refrigerant and not the Chiller was enormous, even when taking into account the additional works required to make it suitable and safe for a hydrocarbon refrigerant.

Prior to HC's being utilized in this system various modifications to the plant room and surroundings had to be made.

PLANT ROOM MODIFICATIONS

The original plant room layout encompassed the Chiller, all the pumps, the controls and the main switchgear.

There was no suitable ventilation; the lighting was of the standard fluorescent type. The pressure release valves had never been piped to the exterior of the building. The electrical panel on the Chiller was only just hanging on, with most of the retaining bolts missing.

[1] Global Warming Potential of R22	= 1700	+/- 100 years
Global Warming Potential of R134a	= 1300	+/- 100 years
Global Warming Potential of Engas M50	= 3	+/- 20 years

To prepare for the conversion Engas separated the Chiller from the rest of the mechanical and electrical equipment with an industry standard two hour rated partition wall. Two hour rated doors were fitted complete with fresh air intake vents.

The pressure release valves were piped to the outside of the building, with the piping correctly sized to ensure complete release with back pressure build up.

Four HC leak detectors were mounted in the new ‘Chiller only’ plant room and these were wired into a purpose built control system that in the event of a leak the Chiller and main power supply was completely isolated. A manual shut off push switch was also fitted.

This system also incorporated warning lights and audible signals plus it was also connected to a purpose built extract system using a spark proof motor. The ducting for the extract system was run through the roof and supported at suitable centres, to allow discharge of the plant room air away from buildings and people.

The lighting and switches were changed over to sealed type, as were the power outlets in the area.

Advice and warning signs were fixed to suitable highly visible positions.

CHILLER PREPARATION

A Grant 24 channel data logger was placed in the plant room with sensors located at all relevant positions.

Logging of the Chiller performance was undertaken for approximately 6 weeks at 15 min intervals, after which the data was downloaded and exported direct to an excel spread sheet.

The control and electrical panels were repaired, with new bolts. New door sealing was added, and all cable entry glands were sealed with silicone. Electrical terminals were checked for tightness and corrosion and rectifications were made where necessary.

General checks of the integrity of all valves and fittings were undertaken.

According to the on-site contractor the oil/lubricant was regularly tested (using an external lab) and was of good quality and did not require changing. We carried out on site, physical checks, on the oil/lubricant.

CHILLER CONVERSION

The existing refrigerant was recovered into suitable cylinders and stored prior to returning to the building owner.

The liquid line filters were replaced as necessary. The Chiller was then run on an extended vacuum, using the triple evacuation process. The oil/lubricant levels were checked.

The Chiller was then charged with Engas M50 to approximately 35% of the original R22 charge. The circuit was then extensively leak tested.

The electrical control system was then switched on. Small amounts of refrigerant were slowly added until optimal operating pressures were achieved. The Chiller operation was then monitored for 24 hours.

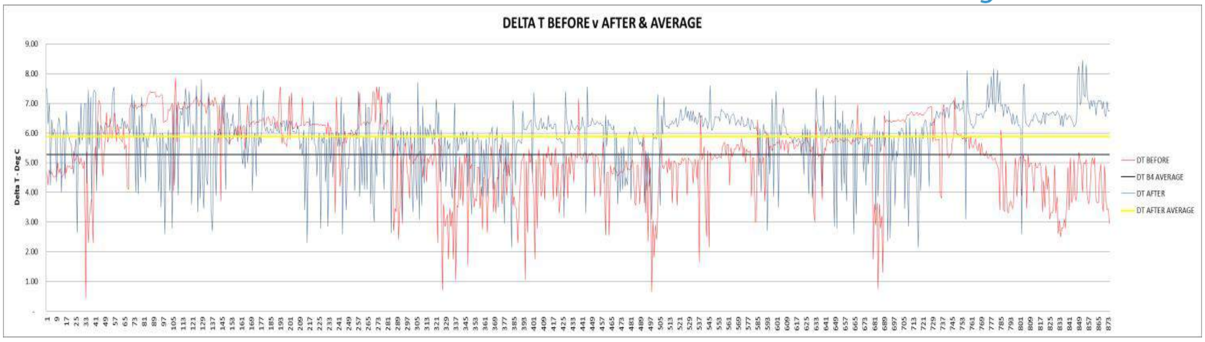
Engas safety labels and stickers were attached to various locations on the Chiller indicating that Engas M50 was in use in the Chiller.

Over the following 2 to 3 weeks further adjustments to the charge were made to further improve the performance. The head pressures were approximately 20% lower than when operating on R22.

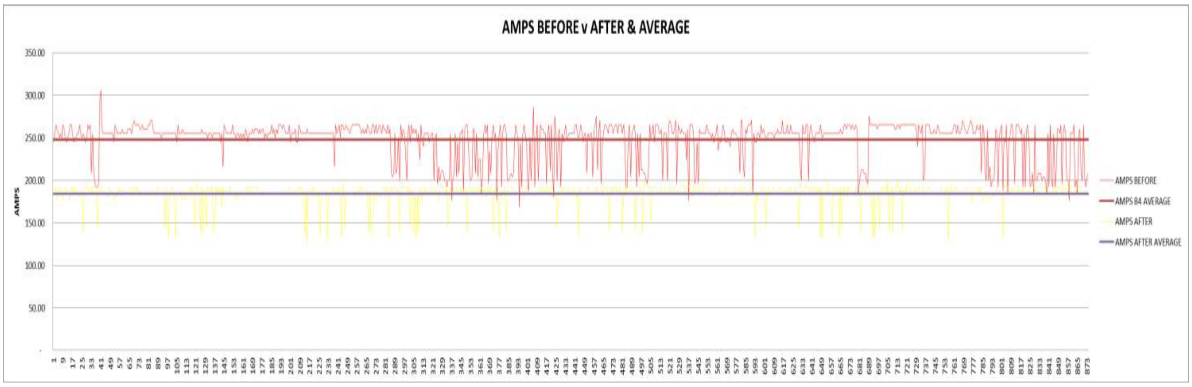
After an extended period and whist waiting for the return of warmer weather, the final data was downloaded from the logger for comparison with the data taken prior to the conversion.

THE DATA

From the data (chilled water flow and return temperatures) the Delta T was calculated. Averages were also calculated for each measurement point. These calculations were carried out for the pre and post data. Graphs of these averages were produced. These graphs are shown below.



Delta T – before and after the conversion.



System Running Amps – Before and After

***These charts are can be viewed in landscape in the attachments.*

The averages in data form are as follows:

	DISCH C 1 −C	DISCH C2 −C	SUCT C1 −C	SUCT C2 −C	CW SUPPLY −C	CW RETURN −C	DELTA T −C	COND W SUPPLY −C	COND W RETURN −C	PLANT ROOM TEMP −C	SYSTEM RUNNING AMPS
AVERAGE AFTER	44.89	40.51	11.43	13.16	8.64	14.57	5.93	26.67	28.45	23.77	183.96
AVERAGE BEFORE	61.62	51.53	10.06	15.22	8.24	13.51	5.27	27.11	29.12	27.93	247.60
DIFFERENCE	16.74	11.02	- 1.37	2.06	- 0.40	- 1.05	- 0.66	0.44	0.67	4.16	63.64
DIFFERENCE PER CENT	27.16	21.38	- 13.65	13.51	- 4.81	- 7.79	- 12.47	1.63	2.32	14.89	25.70

As can be seen the average Delta T (the measurement of the amount of work that is being done) is 5.27 Degrees Celsius before the conversion and 5.93 Degrees Celsius after conversion to Engas M50, showing a direct improvement of ‘work’ of 12.47%

The average system running amps before the conversion was 247.60 amps, whereas after conversion to Engas M50 the average system running amps was 183.96 amps. So the Chiller is doing 12.47% more work, but using 25.70% less power. These figures were confirmed by the building owner’s representative when he shared that the direct power bill for the period had reduced by approximately 25%.

ENVIRONMENTAL IMPACT REDUCTION

GWPs (Global Warming Potential) are used by, among others, policymakers to compare the impact on the climate system of emission of different greenhouse gases. The GWP index is relative to carbon dioxide (CO_2), which is normalised at 1. As greenhouse gases differ in their atmospheric lifetimes, GWPs also have a time component. Time horizons of 20 years and 100 years are used to enable the proper evaluation on the environment.

Research has shown that for most Refrigeration or Air-conditioning systems the impact for Global Warming will be greater from energy consumption (Indirect Global Warming Impact) than from CO_2 equivalent emission (release) of refrigerants. (Direct Global Warming Impact)

Therefore the Total Equivalent Global Warming Impact = leakage + energy consumption.

Leakage

The Carrier Chiller Model 30LA - 890 has a specified refrigerant charge of 144 KGs of HCFC 22. (R22) Refrigerant R22 has a GWP of 4800 of CO_2 equivalent per KG over 20 years.

Therefore 691,200.00 KGs of CO_2 equivalent saved from the atmosphere.

Energy Consumption

The Carrier Chiller Model 30LA - 890 has a calculated electricity consumption of 2,079,693.91 kilowatt hours per year. (This is based on the Chiller compressors running 10 hours per day, 5 days per week, 42 weeks per year at 85% of full load amps, with a 25% saving after conversion to Engas M50) The estimated CO_2 emission per kWh generated equals .7 (This is an Industry Standard figure).

Therefore 697,158 x .7 = 488,010.6 x 25% = 122,002.65 x 20 years = 2,440,053.00

Total Equivalent Warming Impact

The total equivalent warming impact = 691,200.00 + 2,440,053.00 = 3,131,253.00 KGs.

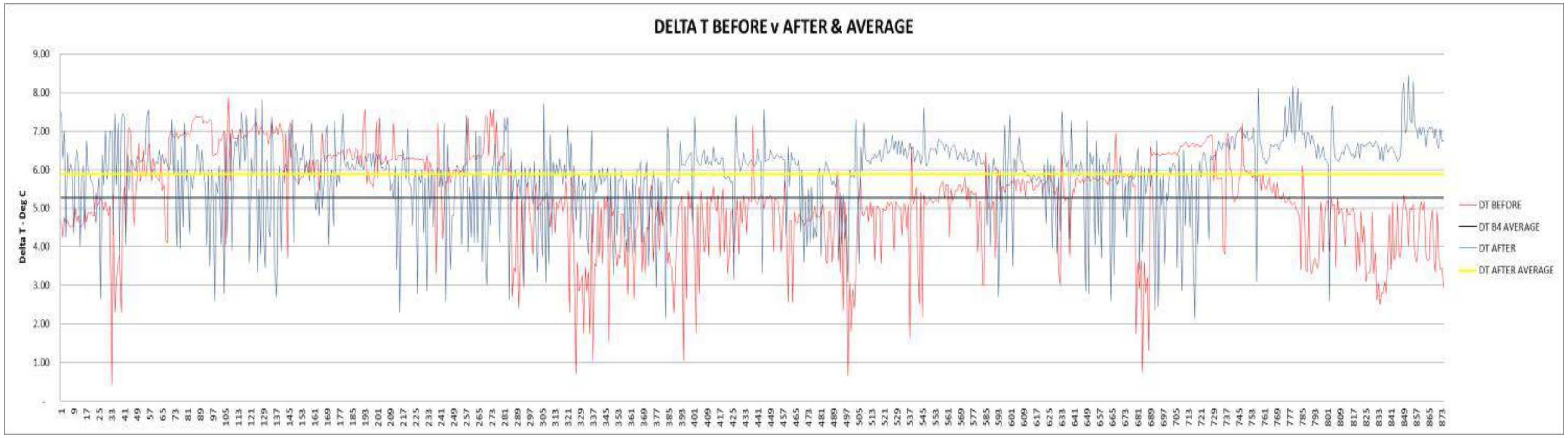
Conclusion

The Energy saving based on the recorded data and taking into consideration actual power saving appears to be 25.7 % at the point of the conversion.

The calculated environmental benefit is estimated at 3,131,253.00 KGs of CO_2 equivalent saved from the atmosphere over the next 20 years.

AUSTRALASIA
Cooling our world naturally

DELTA T – BEFORE AND AFTER



AMPS – BEFORE AND AFTER