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CRESSTEC carbon reducing energy saving solutions

Effects of preventable faults on air-conditioning systems at T1

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Prepared for the Ozone and Climate Protection, Atmosphere and Reporting Branch, Environment Protection Division, Department of Climate Change, Energy, the Environment and Water

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The results of this report only apply to the specifically identified unit under test, under the conditions of the tests.

This test report does not extend to any modification of the system. This test report cannot be applied to another product.

Where test results are subject to a pass/fail criterion and the laboratory uncertainty of measurements may affect the outcome of the pass/fail decision, these results are noted with the pass or fail designation based on the measured results and accompanied with a notation that the pass/fail result is within the bounds and subject to the uncertainty of measurement of the laboratory.

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4 Introduction

This report is a summary of the report titled "NP-0009 REP01v1 Cresstec REED" produced by CSIRO Energy, National HVAC Performance Test Facility for Cresstec. This report aims to summarise and analyse the results and the potential impacts.

5 Declaration

I declare that the details stated in this report summary are correct and are based on the original report.

Author:	Brendon Hazlewood	09/06/2022
Authorising Officer:	Ian Nankivell	09/06/2022

6 Customer Details

This report was prepared by Cresstec Pty Ltd for the Ozone and Climate Protection, Atmosphere and Reporting Branch, Environment Protection Division, Department of Climate Change, Energy, the Environment and Water.

7 Executive Summary

This report aims to summarise and discuss the impacts of refrigerant over and under charge on system performance based on testing conducted by the CSIRO for Cresstec.

Both cooling capacity and power usage follow a logarithmic relationship to charge, with a reduction in charge resulting in ever decreasing reduction in cooling capacity and power.

Increases in charge appeared to have diminishing returns but did overall provide more cooling capacity at a higher efficiency, albeit only marginally. This suggests that an increase in charge could be favourable in certain conditions.

Charge levels that are close to baseline are particularly interesting as the small relative change in cooling capacity is unlikely to be noticed by the equipment owner but did have an impact on system efficiency. This would suggest that this type of fault would not be easily discoverable and could have long term impacts for the customer.

8 Device Under Test

8.1 Information

Table 1 - Device Under Test Information

Manufacturer / Brand	Withheld	
Model Name	Indoor	Withheld
	Outdoor	Withheld
Serial Number	Indoor	Withheld
	Outdoor	Withheld
Air Conditioner Type	Ducted Split System	
Air Conditioner Functions	Both Cooling and Heating	
Air Conditioner Air Distribution	Internal Fan	
Heat Transfer Medium	Air	
Mounting		
Rated Voltage	230V	
Rated Frequency	50 Hz	
Variable speed compressor?	No	

8.2 Installation

As per CSIRO report NP-0009 REP01 Version 1.

9 Test Conditions

As per CSIRO report NP-0009 REP01 Version 1.

10 Test Methodology

As per CSIRO report NP-0009 REP01 Version 1

11 Test Schedule

Test schedule as per CSIRO report NP-0009 REP01 Version 1.

12 Overview of Results

Table 2 shows the results as they appear in the CSIRO report. To better understand these results, they have been re-summarised as relative changes to a baseline (100% charge). This is shown in Table 3 and Figure 1.

Table 2 - Test results from original report

Test	Test Condition	Refrigerant Charge	Calculated Cooling Capacity (kW)	Total Power to Equipment (kW)	Energy Efficiency Ratio (EER)
1	AS/NZS3823.1.2 T1	50% / 1.59 kg	1.31	2.406	0.54
2	AS/NZS3823.1.2 T1	60% / 1.91 kg	4.42	2.644	1.67
3	AS/NZS3823.1.2 T1	70% / 2.21 kg	5.51	2.602	2.12
4	AS/NZS3823.1.2 T1	80% / 2.51 kg	6.91	2.734	2.53
5	AS/NZS3823.1.2 T1	90% / 2.85 kg	7.78	2.792	2.79
6	AS/NZS3823.1.2 T1	100% / 3.15 kg	8.00	2.822	2.83
7	AS/NZS3823.1.2 T1	110% / 3.48 kg	8.03	2.822	2.85
8	AS/NZS3823.1.2 T1	120% / 3.79 kg	8.24	2.874	2.87

Table 3 - Relative change in results compared to a baseline (100% charge)

Test	Test Condition	Refrigerant Charge	% Change in Cooling Capacity (kW)	% Change in Total Power (kW)	% Change in EER
1	AS/NZS3823.1.2 T1	50% / 1.59 kg	-83.6%	-14.7%	-81%
2	AS/NZS3823.1.2 T1	60% / 1.91 kg	-44.8%	-6.3%	-41%
3	AS/NZS3823.1.2 T1	70% / 2.21 kg	-31.1%	-7.8%	-25%
4	AS/NZS3823.1.2 T1	80% / 2.51 kg	-13.6%	-3.1%	-11%
5	AS/NZS3823.1.2 T1	90% / 2.85 kg	-2.8%	-1.1%	-2%
6	AS/NZS3823.1.2 T1	100% / 3.15 kg	0.0%	0.0%	0%
7	AS/NZS3823.1.2 T1	110% / 3.48 kg	0.4%	0.0%	0%
8	AS/NZS3823.1.2 T1	120% / 3.79 kg	3.0%	1.8%	1%

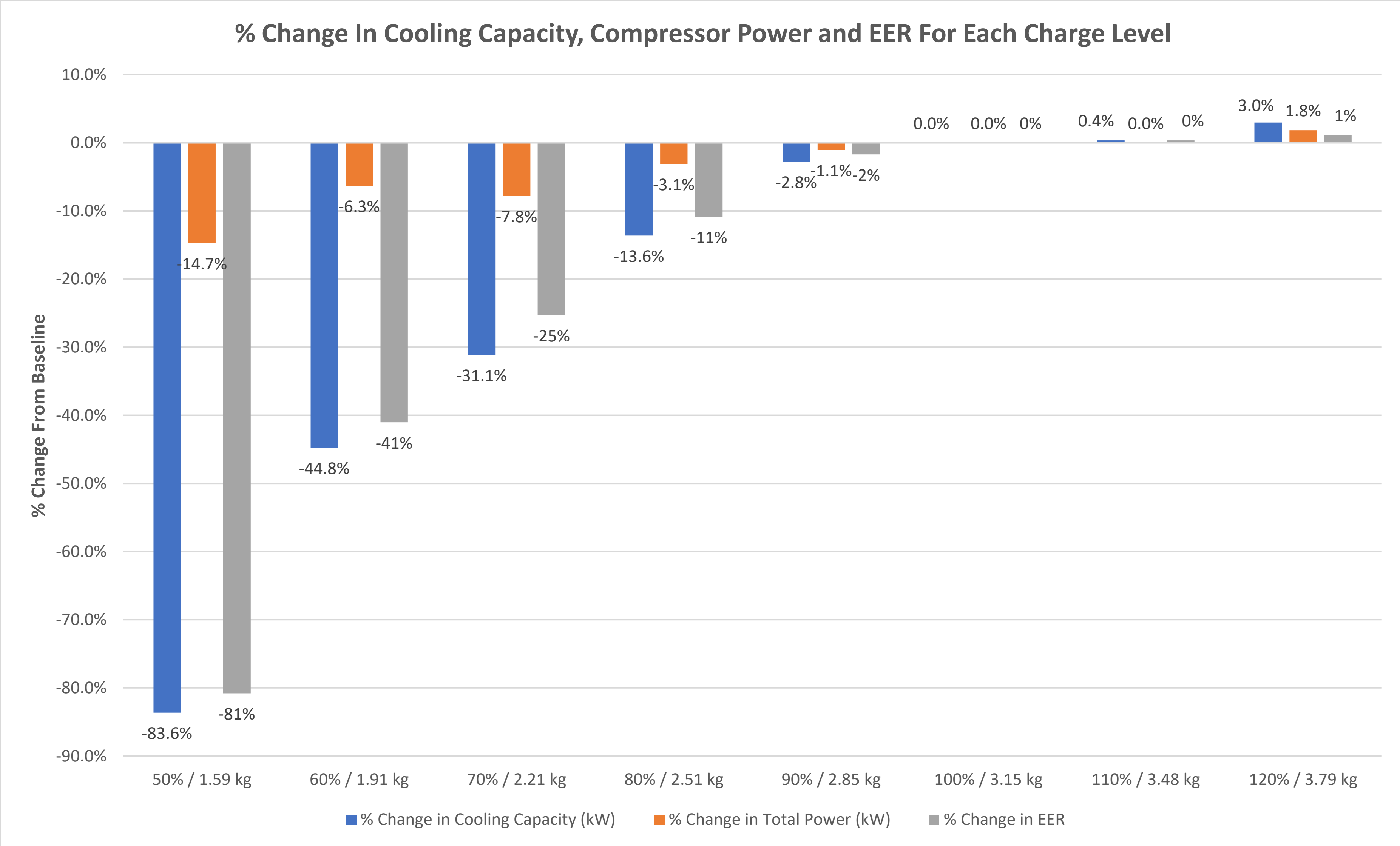

Figure 1 - Relative changes in results compares to a baseline (100% charge)

13 Analysis

From Table 3 and Figure 1 we see that both cooling capacity and total power follow a logarithmic relationship to charge. As charge decreases, both decrease at an ever-increasing rate.

The impact of this is that a system that has a leak or has been incorrectly commissioned with a reduced charge will run less efficiently. Interestingly the unit became more efficient with an increase in charge, but the relative increase is small. This does suggest that there are circumstances where more than the recommended charge can be useful.

It is difficult to know at which point a drop in cooling capacity would manifest as increased room temperature sufficient to alert the equipment owner to the fault, but it is reasonable to say that a charge of 90%, 110% or 120% may not have a significant enough effect on indoor room temperature to be noticed. Conversely charges at 80% or below have a large relative change in cooling capacity that it is expected to influence indoor room temperature and thus may more easily be identified by equipment owners.

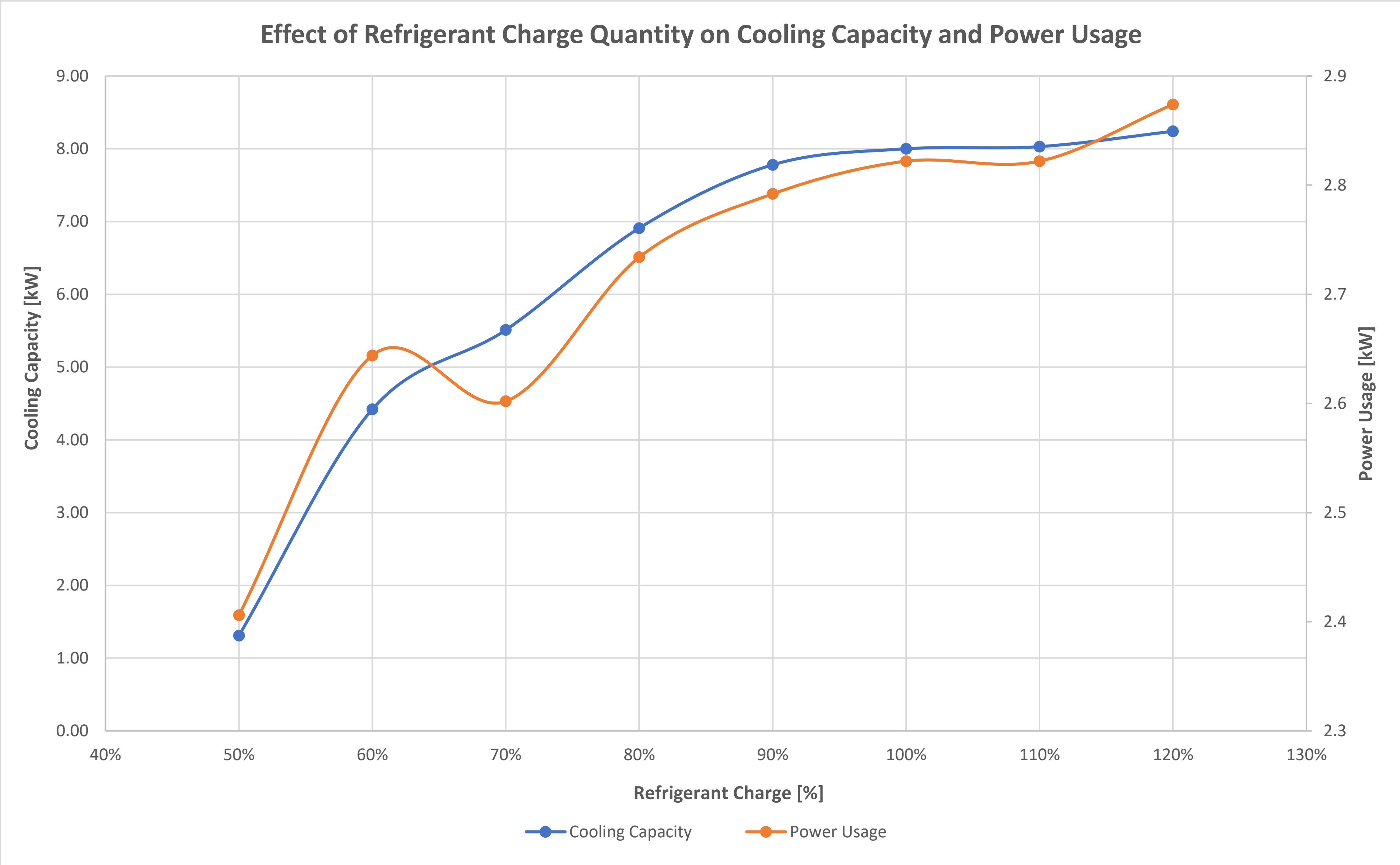

Figure 2 - Relationship between cooling capacity and power usage against charge

Figure 2 above shows the approximately logarithmic relationship between cooling capacity and power usage as a function of charge.

Whilst we cannot comment with confidence on charge levels outside the test range it can be expected that the relationship does not hold true for all charge levels and will find a limit at some point. The upper limit is likely bound by the high-pressure safety switch and the low limit bound by the low-pressure safety switch.

14 Conclusion

We conclude from the results that the amount of refrigerant charge in the system has a significant impact on cooling capacity, power usage and efficiency. The impact becomes more severe the further charge is decreased. Charge levels that are close to baseline are particularly interesting as they are unlikely to be noticed by the equipment owner but do have an impact on system efficiency.

15 Further Work

It is important to note that this testing was conducted in constant temperature conditions. That is, the test rooms will provide as much heat load as is required to settle at the desired temperature. If the unit has a reduced cooling capacity the test room would decrease the heat load until it matches the cooling capacity. This is significant as it masks the real-world effect of the change in cooling capacity. Under normal conditions we expect that a significant reduction in cooling capacity would manifest as an increase in room temperature, but because this test maintains a constant temperature this does not occur. This is not to say that the constant temperature tests are not useful, only in that they will only show the maximum cooling capacity capable in that condition.

It is recommended that further studies are conducted to link the changes in cooling capacity to indoor room temperatures such that these results may be applied to real world scenarios.