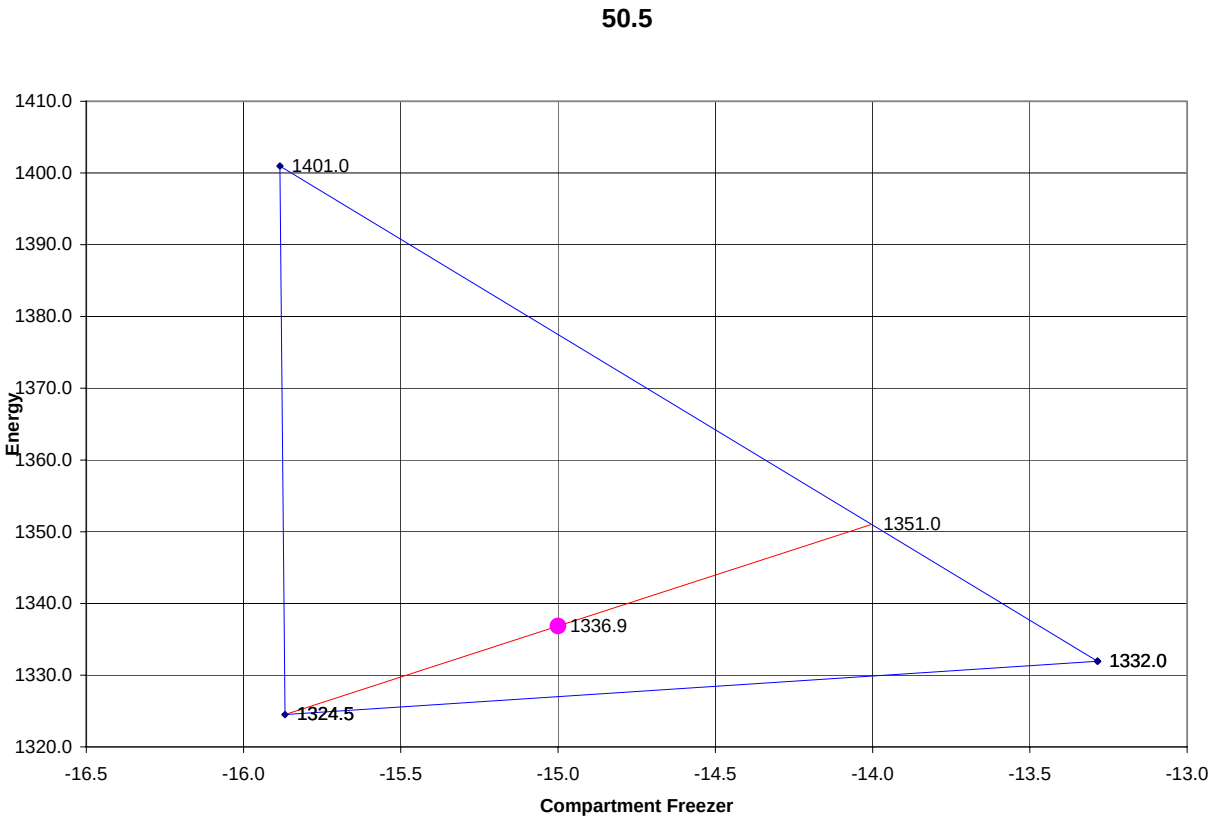
October 2007

Report 2007/13 for Equipment Energy Efficiency Program

Impact of Changes in AS/NZS4474.1-2007 on Energy Consumption



Prepared by Energy Efficient Strategies

Impact of Changes in AS/NZS4474.1-2007 on Energy Consumption

Prepared by Lloyd Harrington, Energy Efficient Strategies for E3, October 2007

Executive Summary

A revision of AS/NZS4474.1 was published on 15 August 2007. This new standard will be a prerequisite for registrations that use the new energy label which is scheduled for implementation in 2009. A change in the temperature determination period under AS/NZS4474.1-2007 to include the defrost and recovery period was expected to make the internal temperature appear slightly warmer and was therefore likely to result in a small energy increase when compared to results from testing to the 1997 edition of the standard. However, when the standard was published this impact had not been quantified.

Analysis of detailed test data was undertaken on 31 models to determine the internal temperatures under the old and new test methods in order to quantify this impact.

The analysis of results showed that the new test method has virtually no impact on fresh food temperatures; on average Group 5T freezer temperatures appeared to be 0.33K warmer while on average Groups 5B and 5S freezer temperatures appeared to be about 0.2K warmer.

Analysis of data over a range of temperature settings showed that the energy impact of changes to internal temperatures for refrigerators was typically 1% to 2% per degree C in the fresh food compartment and typically 2% to 4% per degree C in the freezer compartment, although this can vary by model.

Combining these two pieces of analysis, it was found that the average energy impact of the test method change was 1% for Group 5T, 0.5% for Group 5B and 0.3% Group 5S.

It is recommended that no adjustment for energy labelling star ratings be made as a result of the test method change. It is recommended that an adjustment based on average energy impacts by Group be made to the relevant Minimum Energy Performance Standards (MEPS) levels for Groups 5T, 5B, 5S and 7.

The data in this paper will be used to inform the debate when government and industry negotiate the relevant changes to AS/NZS4474.2-2008, which will include the new star rating algorithms. The other key input into the adjustment of MEPS levels will be the change in MEPS definition from average to maximum energy which is covered in a separate paper.

Comments on this paper or any additional information that industry wishes to be tabled and considered by government when MEPS levels adjustments are made should be submitted to:

- Australia: Catherine Corver, Equipment and Appliances Team, Australian Greenhouse Office, telephone (02) 6274 2267, Catherine.Corver@environment.gov.au
- New Zealand: Alastair Childs, Products Team, Energy Efficiency and Conservation Authority, (04) 470 2200, alastair.childs@eeca.govt.nz

Overview

This paper quantifies the impact of the test method change on a total of 31 refrigerator-freezer models of Groups 5T, 5B and 5S that have been sold on the Australian market over the period 2004 to 2007. Some data for Group 7 is also provided. Existing one minute test data provided by Test Research was reanalysed to quantify the differences in the test methods. The assistance of Choice and Test Research (a division of the Australian Consumers' Association (ACA)) is gratefully acknowledged.

The first step was to quantify the change in apparent internal temperatures that arose from the change in test method. It was found that the new test method had a negligible impact on the temperature of fresh food compartments. The new test method had an impact on the temperature of freezer compartments of 0.2K warmer for Groups 5B and 5S and 0.33K warmer for Group 5T.

The second step of the analysis was to quantify the impact that changes in internal temperature will have on the energy consumption of refrigerators. The analysis found that the energy impact of changes in internal temperatures appears to be consistent across groups. This is typically 1% to 2% energy increase per degree decrease in temperature for the fresh food compartment and typically 3% to 4% energy increase per degree decrease in temperature for the freezer compartment (this factor appears to increase slightly as the freezer compartment share becomes larger). Of course the values for individual models vary somewhat, but most conventional models seem to be in this broad range.

The third step was to combine these two factors to determine the overall energy impact of the new test method. The average energy impact was 1% for Group 5T, 0.5% for Group 5B and 0.3% Group 5S. A couple of models had an energy impact that was of the order of 2% or more.

It should be noted that the test data provided was for commercially available models that were sold on the Australian market over the past 3 years and so no optimisation to the change in test method was undertaken. However, it would appear that from the test data there are a number of design options to minimise the temperature rise impact of the defrost and recovery period as the results varied by model and some models showed no measurable impact of the change in test method on either temperatures or energy. It is expected that manufacturers will be able to gradually implement design measures to minimise the impact of the test method on temperatures and energy over time. Such developments are likely to result in smaller temperature rises in the freezer compartment during defrost and recovery and result in better food preservation conditions.

Background

AS/NZS4474.1 was first published in 1997 and evolved out of the original refrigerator test method set out in AS1430. The subsequent regulatory standard AS/NZS4474.2 was based on a number of documents including AS2575.1 and AS2575.2 which were

developed to support the original energy labelling program in 1989 (these were also published as NZS6205.1 and NZS6205.2).

The publication of AS/NZS4474.1 in 1997 was a big step forward and represented the most coherent approach to the testing of refrigerators at the time. The robustness of the test method is demonstrated by the small number of minor amendments that occurred in the 10-year period to 2007.

On 15 August 2007, a revision to AS/NZS4474.1 was published. In broad terms, the main objective of the revision was to deal with a range of new technologies and to make some refinements to some elements of the test method. A range of clarifications and editorial updates were also made. However, the changes can mostly be regarded as evolutionary rather than revolutionary. A detailed list of changes is set out in the public comment drafts DR06500 and DR07173CP. These were released in August 2006 and March 2007 respectively.

One aspect where significant effort was applied was in the area of anti-circumvention of the test method (or in plain parlance, efforts to stop so called “cheating”). In this respect, some new mandatory performance measures were included in the standard in Clause 3.7.3. These new requirements, in simplistic terms, are:

- A maximum time (20 minutes) that any freezer sensor can be above 0°C;
- The defrost and recovery to within 2K of the pre-defrost temperature must not exceed 2 hours;
- Individual temperature control cycles cannot be warmer than the compartment average (or the target temperature) by more than 2K at any time after the defrost and recovery period.

These measures were introduced to thwart design control strategies in some refrigerators to operate for significant periods at warmer temperatures in order to obtain an energy advantage under the test method (this is explained in more detail below) or to have slow defrost and recovery period.

The other area that close attention was paid to was in the operation of heaters and other auxiliary devices. It became apparent that some suppliers had designed units to switch off some devices in order to gain an energy advantage when the unit detected that a AS/NZS4474.1 energy test was being conducted. This practice has been specifically prohibited under the 2007 revision. Where such a control cannot be disabled for the energy test (ie auxiliaries continue to be switched off) then the energy impact is to be quantified (eg under a different ambient temperature or with door openings, by direct measurement of the wattage of the relevant heater) and twice the energy reduction added onto the tested energy consumption (on the basis that this is often an anti-frost or mullion heater which places heat into the compartment which then has to be removed by the refrigeration system).

The measures above will have no material impact on the tested energy consumption of well behaved refrigerators – they are targeting products that are poorly controlled or that seek to gain an unfair energy advantage from the test method. Performance limits have been included in the 2007 edition of the standard as the temperature control

strategies observed in some products are verging on dangerous in terms of food quality and preservation.

One other significant change was made to the test method, also to limit the advantage gain from controlling internal temperatures in order to gain an energy advantage. This was a change in the temperature determination period for frost free products, which was expected to have some energy impact and is quantified in this paper.

Temperature Determination Period

For frost free products, the energy determination period under AS/NZS4474.1 has always been (and continues to be, except it now starts from a more consistent measurement point) from the initiation of an automatic defrost until the subsequent automatic defrost (or 24 hours where the time between defrost exceeds 24 hours). This is to ensure that the energy taken for defrost and recovery during normal use is included in the measured energy consumption for the product under the test procedure.

When the energy consumption is determined for a particular control setting, the compartment temperatures are also measured in order to obtain a valid energy consumption point. Typically, several different control settings and internal temperature/energy consumption combinations are measured to allow interpolation to obtain the theoretical energy consumption at the required internal target temperatures.

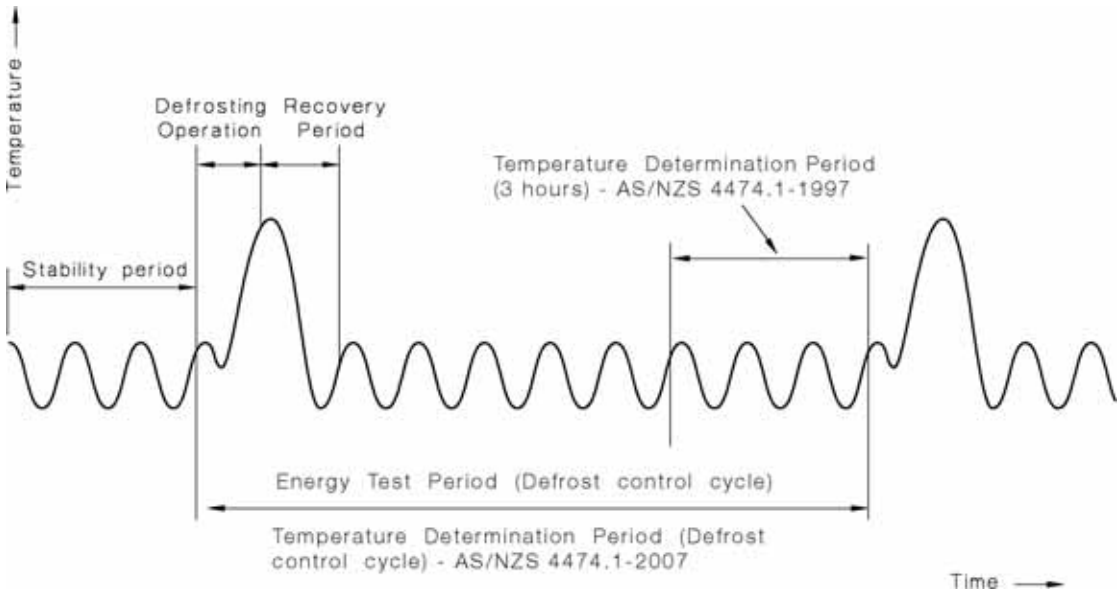
Under AS/NZS4474.1-1997, the temperature determination period was based on the average for the 3 hour period prior to the initiation of the next defrost (or the 3 hour period prior to the end of the test period at 24 hours if defrosts are further than 24 hours apart). The reason for this was that this period was usually quite stable and in the past, chart recorders were often used, so this provided a simple means of determining a comparable temperature measurement between tests.

Under AS/NZS4474.1-2007, the temperature determination period is now exactly the same as the energy determination period i.e. it is based on the average over the whole defrost control cycle (or from the start of the defrost control cycle to the end of the test period at 24 hours if defrosts are further than 24 hours apart).

These differences are set out in Figure 1 below.

It is important to note that this change to the temperature determination period only potentially affects frost-free models (Groups 5T, 5B, 5S and 7). No other groups will be affected by this change. Some other changes in AS/NZS4474.1-2007 were made with regard to the placement of freezer sensors in narrow tall compartments (such as freezers in Group 5S products), these changes have not been assessed in this paper, but are expected to be small to very small to negligible, and a possibility of giving a slightly colder temperature result in some cases.

Figure 1: Illustration of Temperature Determination Period – 1997 and 2007 standards



Note: The example above depicts a defrost control cycle which is less than 24 hours. Where the time between defrosts exceeds 24 hours, the energy test period and the new temperature determination period both terminate at the control event that is closest to 24 hours.

There is a range of reasons which prompted the change in the temperature determination period illustrated above to align with the whole test period.

- The final 3 hours of the test period is usually stable but may not be representative of the average temperature in the compartment over the energy determination period.
- Inclusion of the defrost and recovery period in the temperature determination period is mathematically simpler and makes the energy and temperature periods identical. All test labs must now use integration (sampling) of data at not more than 1 minute intervals and simple averaging of collected data is less prone to error. Separate determination of the final 3 hours of the test period is complex when using integrated data.
- Inclusion of the defrost and recovery period in the temperature determination period provides a strong incentive for manufacturers to minimise the temperature rise and duration of the defrost. This will improve food storage conditions. Temperature rises during the defrost and recovery is an area where there has been little incentive under the current test to improve the performance of products.
- As any pre-cool prior to a defrost is now included in the temperature determination period, manufacturers will now get a temperature benefit for any pre-cooling period that is included to minimise any adverse defrost warming of food.
- Inclusion of the defrost and recovery period in the temperature determination period is very likely to align with future requirements of a new international test method for refrigerators, which is currently under development.
- Products which have slow defrost and recovery periods or which maintain warm temperatures for long periods after a defrost in order to gain an energy

advantage will now no longer gain that advantage under the 2007 test method. Under the 1997 test method, a product could be relatively warm for say 18 hours and then have the temperature drop for 4 hours prior to a defrost and this would be classified as having the same internal temperature as a product that is stable and cold for a full 22 hours after defrost.

There are no significant issues with the new temperature determination period, other than that the measured freezer temperature when calculated according to the 2007 standard will (in most cases) appear slightly warmer when compared to the value calculated from the same test run according to the 1997 test method (although from the data measured, this is not necessarily the case and it is expected that manufacturers will be able to modify their products to minimise temperature rises). While the energy consumption value measured for a test period will not change, the small changes in internal temperature will have an impact on the energy consumption determined at the specified target temperatures. There is no physical difference in the measurements process – the difference lies in the post-test analysis of the data which is collected during the test.

To quantify the energy impact of the change in test method, two separate pieces of information are required:

- Firstly, the difference in the temperatures determined under the different test methods;
- Secondly, the impact of the temperature changes on the energy consumption of the refrigerator – essentially the energy sensitivity to changes in the fresh food and freezer compartments when performing an interpolation using the triangulation method.

Unfortunately, the temperature impact and the subsequent energy impact will vary from model to model as these factors are dependent on the individual product design and its energy performance.

Data Analysis Approach

In order to determine the temperature impact of the change in the temperature determination period, test data for a range of refrigerators were examined. To assist in the development of the new international test method, the Australian Consumers' Association (ACA) has kindly made available to government consultants (EES) detailed 1 minute test data for about 50 refrigerators which have been tested by Choice over the past 5 years. This data was further analysed for this project in order to assess the impact of the change in test method on energy consumption. The assistance of Test Research/Choice in this work, and in particular Geoff Day, is gratefully acknowledged. Note that some general information about each model has been made available with the raw test data (ID number, group, total gross volume), but in general, no detailed information on the origin, brand or model has been provided with the test data (although ACA can identify the details if required).

The test data is in the form of Excel files with 1 minute power, energy (cumulative) and temperature data recorded (3 fresh food and 5 freezer test points).

For the purposes of this paper, a total of 31 refrigerators-freezer models were analysed. These represent a broad range of products on the market through the period 2004 to 2007. Data was available for more units, but these have not been included because:

- They were for groups that were not relevant;
- Some group 7 data was available and analysed (3 models) but the results were not included. Temperature impacts were comparable to freezer compartments of Group 5.
- Some products have very complex energy profiles and for a few models it was not possible to separate the defrost events from normal operation in the time available (in some of these cases the defrost heater and compressor power were similar and identification of defrost control cycles was too labour intensive, this also applied to a couple of multiple defrost and dual compressor products).
- Some products had completely erratic behaviour and it was not possible to draw any sensible conclusions from the test data.
- Products that controlled their operation to take advantage of the test method were excluded.

For each of the 31 products, several test points were generally available which had been configured to give a range of internal temperature settings that were suitable for the determination of energy consumption under AS/NZS4474.1 (generally three test points that surrounded the target temperatures of -15°C and +3°C (called point Q in the standard) to allow triangulation of data). In almost all cases, the three test points selected were such that a valid energy point by triangulation could be determined using the temperatures determined in accordance with the 1997 standard. In a couple of cases, the small change in temperature under the 2007 standard just moved the point Q to be outside of the triangle, but the small extrapolation in these cases was probably acceptable. In a couple of cases, not all of the energy test data supplied was fully analysed in time for this paper (data for most models was spread across a number of raw data files, not all of which were processed), so the available test points did not fully surround point Q (again, the small extrapolation was probably acceptable). Two units did not have a valid range of energy points for triangulation (in these cases the controls did not allow adjustment of the internal temperatures to surround the point Q – one compartment was always too cold – below the target temperature) – these two models have been included for completeness, but the energy estimates obtained from these are not valid and have been ignored in the final analysis.

To illustrate the data, charts from the analysis for a single unit are presented below. Note that each row (numbered on the X axis) represents one minute of data.

Figure 2: Example of compressor operation for Unit 50.5 (single run)

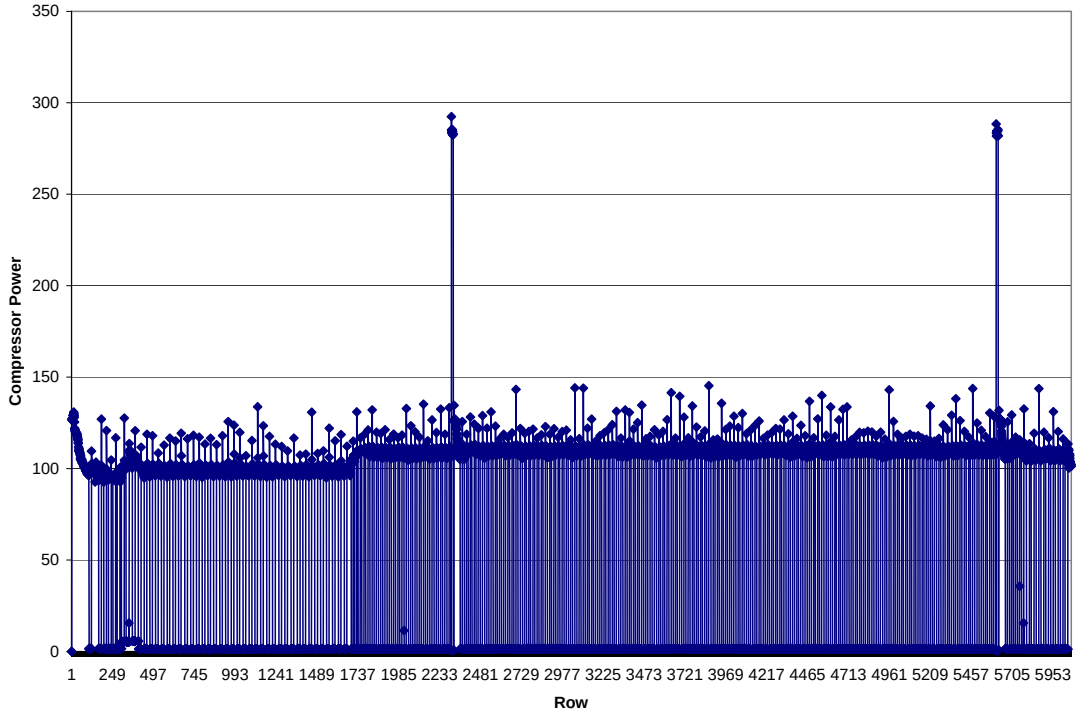
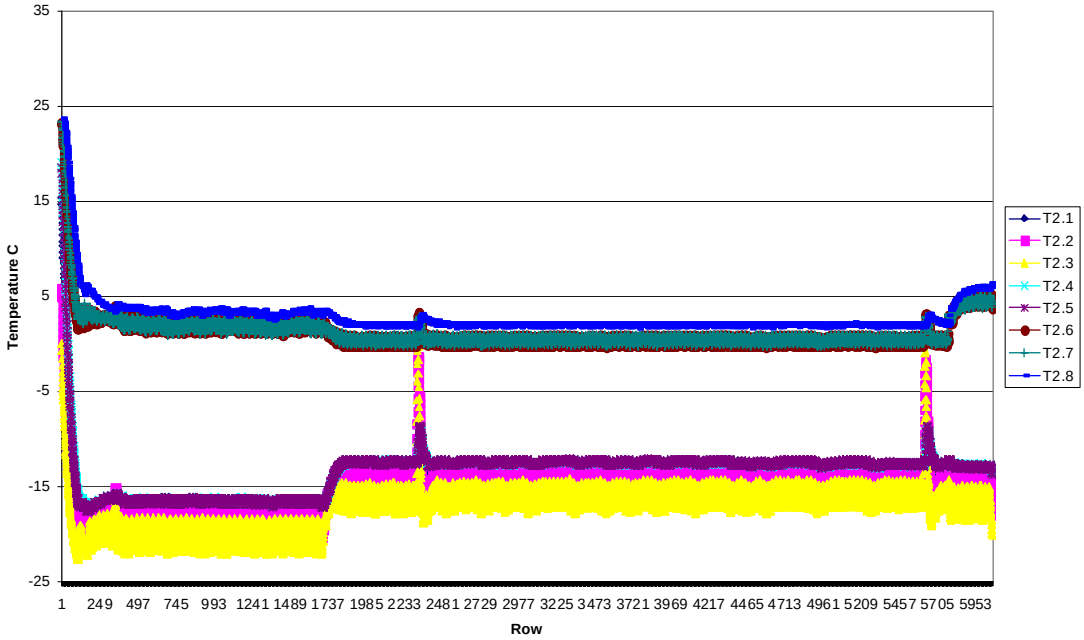


Figure 3: Example of temperature data for Unit 50.5 (single run)



Note: In this example, the temperature and energy was determined for the period from row 2292 to row 3794 (24 hours).

A similar analysis was conducted for all 31 units.

Temperature Impact of the Temperature Determination Period

For all of the units included in this analysis, the defrost and recovery was fairly short and the temperature after the defrost and recovery was stable until the next defrost (as illustrated in Figure 3): in short these models were "well behaved".

The temperature for each run was determined in accordance with AS/NZS4474.1-1997 (ie for the final 3 hours prior to a defrost, or where the time between defrosts exceeds 24 hours, in the final 3 hours of the 24 hour test period). This value was compared with the temperature determined in accordance with AS/NZS4474.1-2007, which is average over the whole test period. For the 3 points used for each energy determination, the difference in the average temperature values determined to each standard was calculated. Where the difference shown is positive, this means that the value determined in accordance with the 2007 is warmer that the 1997 standard. In a few cases, the value is negative, which indicates that the manufacturer has been able to make the average temperature during the defrost and recovery colder than the stable period after the defrost. This is attained by minimising temperature rises during defrost and recovery and usually by pre-cooling prior to the activation of the defrost heater (any pre-cooling is counted as part of the defrost and recovery period).

The results have been examined for each group and the temperature impacts are summarised in the following table. Detailed results for each model are shown in Appendix A.

Table 1: Summary of Temperature Impacts by Group

Group	No of units	Fresh av diff K	Fresh max diff	Fresh min diff	Freezer av diff K	Freezer max diff	Freezer min diff
5T	15	0.05	0.13	0.00	0.33	0.55	0.10
5B	10	0.06	0.19	-0.06	0.22	0.40	-0.13
5S	6	0.02	0.06	-0.06	0.18	0.67 *	-0.09

Note: One unit (*) showed an average of 0.4K for 2 test points and 1.2K for a third test point that was very cold (-24°C) and there is some question regarding the representativeness of this colder point.

Overall the temperature impact was negligible for the fresh food compartments (0.1K or less for nearly all units) and about 0.2K on average for Groups 5B and 5S and about 0.33K for Group 5T.

In addition, 3 units from Group 7 were examined. The temperature impact for these 3 models was 0.02K, 0.3K and 0.37K, which is comparable to Group 5B (average 0.23K).

Energy Impact of the Temperature Changes

In order to quantify the energy impact of the above temperature changes that arise from the change in test method, an energy analysis for each individual model was conducted. An energy consumption interpolation (using the triangulation method) with the temperatures determined in accordance with AS/NZS4474.1-1997 was first conducted on three valid energy test points and this was compared to same analysis using the temperatures determined in accordance with AS/NZS4474.1-2007 for the

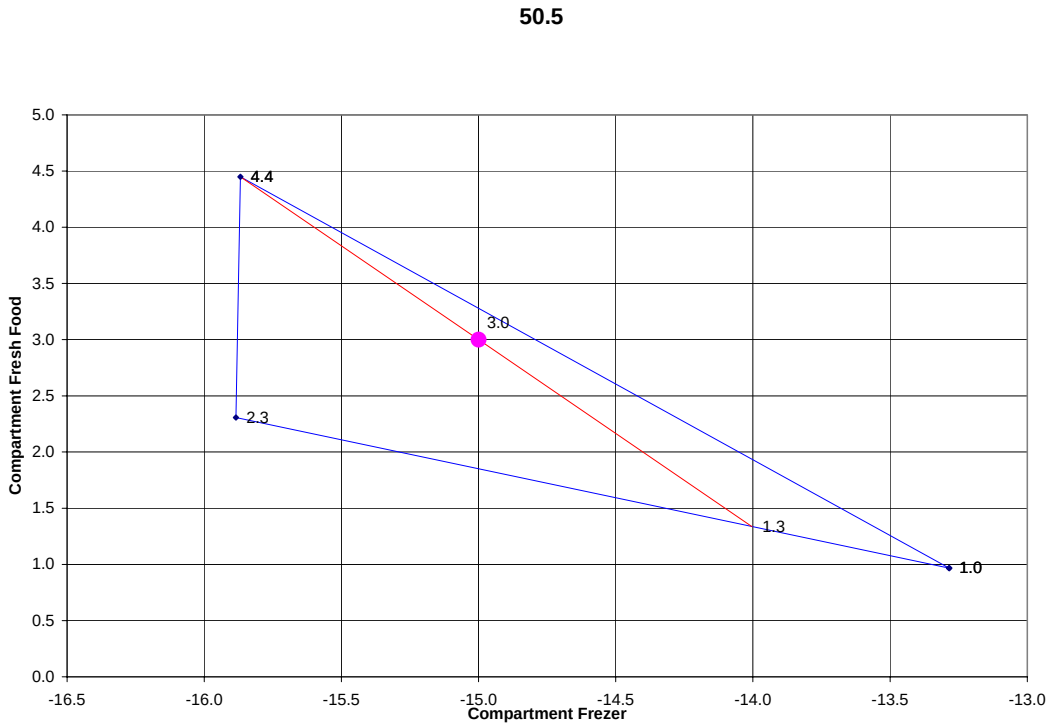
same test periods (the energy values were the same but the temperature determination periods and hence temperature values were different). An example of the temperature and energy analysis undertaken for each unit is provided below (data was separately analysed for old and new temperature values to determine energy impact of test method change). Products where only two point interpolation was possible were not included in this analysis.

The use of the triangulation approach also allows the energy sensitivity to be estimated for small changes in the internal temperatures for both the fresh food compartment and the freezer compartment[1]. This is of particular interest for this analysis but it is also of more general interest in terms of providing advice to consumers on the operation of their refrigerators.

It should also be noted that many of the points analysed closely surrounded the point Q, so the energy sensitivity over larger temperature changes as determined using this method and these points may not be as accurate as if they were determined using points that were more widely spaced. However, the results are generally consistent for most models, which indicates that the analysis is reasonably robust.

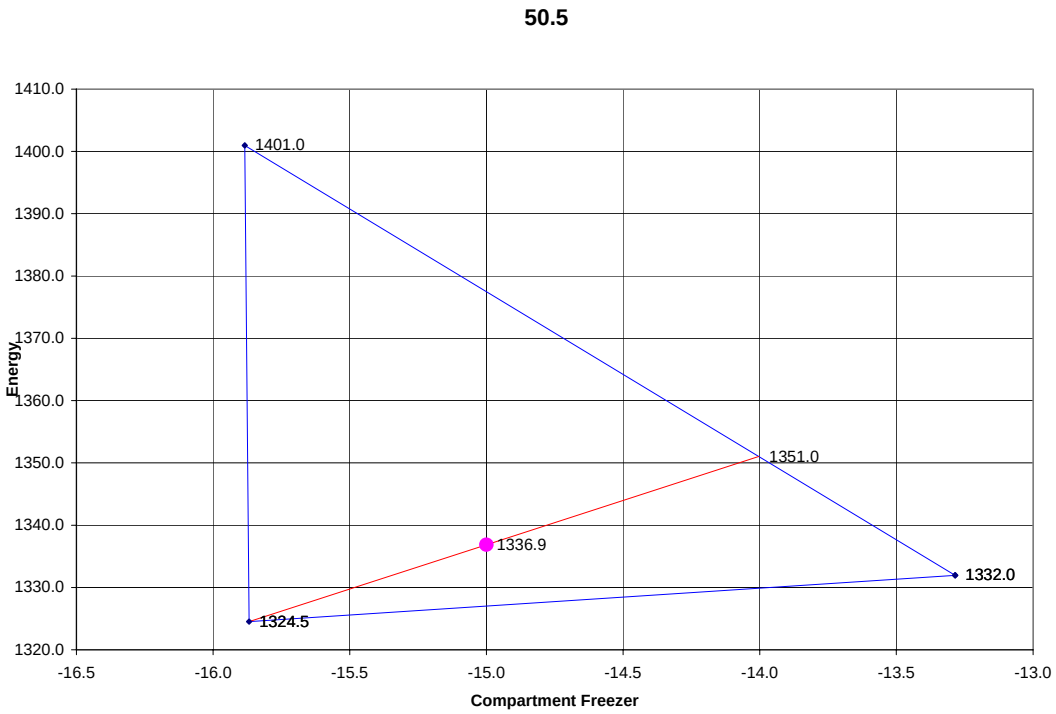
A summary of results for each model are included in Appendix A. The calculation for each model, including the three test points used and the triangulation calculations, are shown in Appendix B.

Figure 4: Triangulation for temperature data (3 runs) – Unit 50.5 (temperature to 2007 standard)



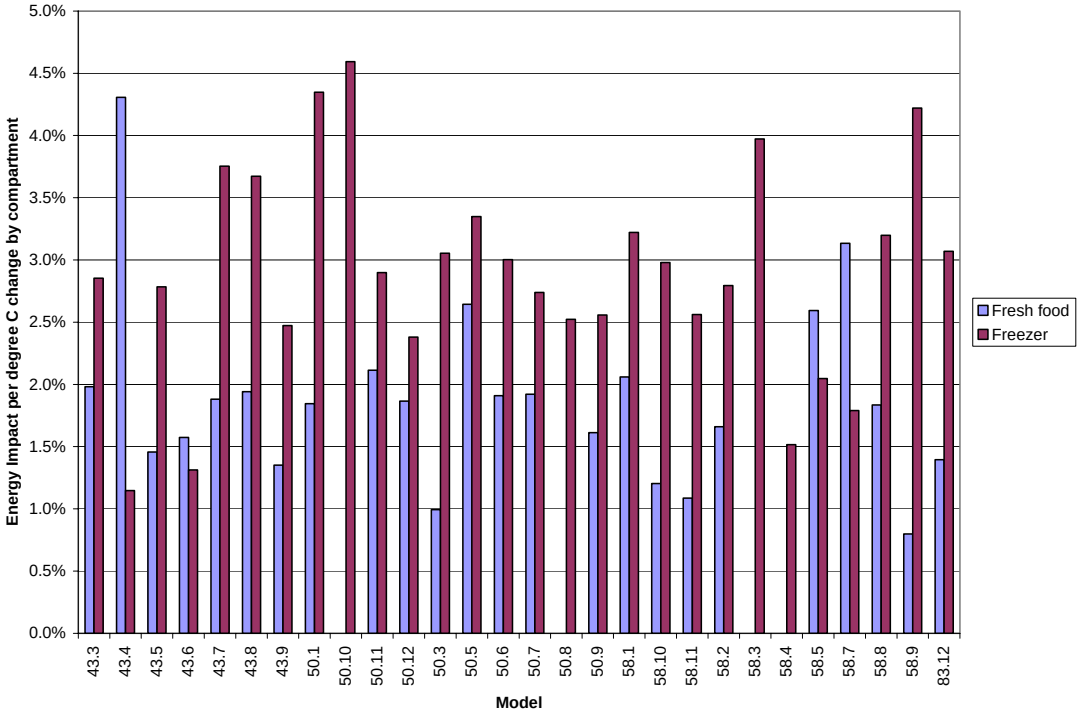
[1] The energy sensitivity of temperature changes in the fresh food and freezer compartment have been independently assessed for this study. The energy impacts for each compartment are roughly additive. These estimates may not be valid for large changes in compartment temperatures (eg freezers running at very cold temperatures) as other factors affect overall energy consumption in these cases.

Figure 5: Interpolation of energy data (3 runs) – 50.5 (temperature to 2007 standard)



The energy impact of temperature changes in the fresh food and freezer compartments is shown in Figure 6.

Figure 6: Energy impact of changes in compartment temperatures by model



Note: Some negative values for fresh food compartments not shown. Results are valid for small changes at the target temperature and could be influenced by the selection of points for triangulation.

Average Energy Impact of the Test Method Change

The overall average energy impact of the change in test method is set out by group in Table 2 below.

Table 2: Energy Impact of Test Method Change - AS/NZS4474.1 1997 vs 2007

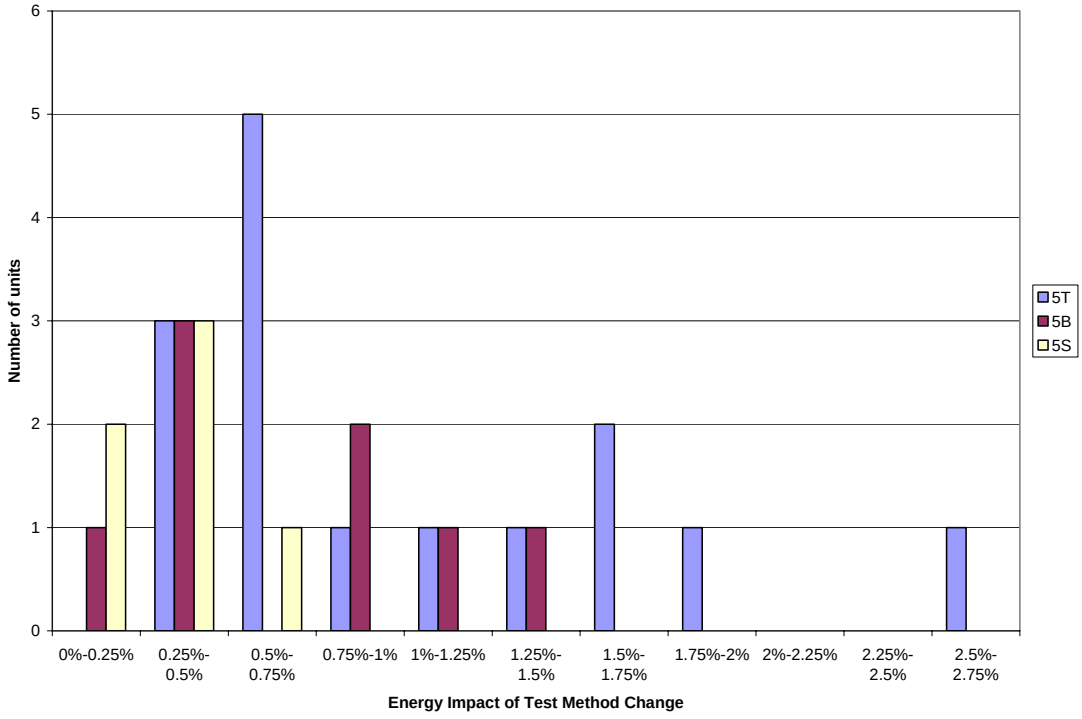
Group	No of units	Fresh av diff K	Freezer av diff K	Energy Impact %/deg K Fresh Food	Energy Impact %/deg K Freezer	Test Method Impact (average)	Test Method Impact (max)
5T	15	0.05	0.33	1.8%	2.8%	1.0%	2.7%
5B *	8	0.06	0.19	1.4%	3.2%	0.5%	1.4%
5S	6	0.02	0.18	2.1%	3.4%	0.3%	0.7%

Notes: The results for Group 5B exclude the two units noted in Appendix A.

On average, the change in the test method appears to have an impact of about 1% average on energy consumption, although the maximum impact on any individual Group 5T model was 2.7% (this unit had a temperature difference at the high end and an energy sensitivity at the high end as well). The impact on Group 5B seemed to be smaller at about 0.5% and the impact for side by side models was low at 0.3% (noting that only data for 6 different models was available).

The energy impact for Group 7 units is comparable to that for freezer impact of Group 5 units, that is of the order of 3% to 4% per degree temperature change. This would put the energy impact for Group 7 in the range of 1%, which is comparable to Group 5T. The distribution of the energy impact by group is shown in the following figure.

Figure 7: Distribution of Energy Impact for 29 Refrigerators Analysed by Group



The energy impact of changes in internal temperatures appears to be consistent across groups. This is typically 1% to 2% energy increase per degree decrease in temperature for the fresh food compartment and typically 2% to 4% energy increase per degree decrease in temperature for the freezer compartment (this factor appears to increase slightly as the freezer compartment becomes larger from 5T to 5B to 5S). Of course the values for individual models vary somewhat, but most conventional models seem to be in this broad range.

Conclusion

Although there are a significant number of changes in AS/NZS4474.1-2007, the only one that will have any significant impact on energy consumption is the change in energy determination period from 3 hours to the whole defrost control cycle. The impact of the test method on temperatures in the fresh food compartment is negligible. The impact of the test method on temperatures in the freezer compartment varies from zero to as much as 0.5K in some cases. The energy impact in most cases is small and for a large number of models, the energy impact is less than 0.5%.

The energy impact is largest for Group 5T, averaging 1%, mostly because the temperature changes in the freezer from the change in test method are largest for this group. The overall energy sensitivity of changes in freezer temperatures seems to be comparable for all groups, but as expected, is slightly higher for products with larger freezers (as a share of total volume). The energy impact for other groups is lower as the temperature impacts are generally lower.

Appendix A: Result Summary by Model – Temperature and Energy Impacts

Unit	Group	Volume litres (gross)	Control	Fresh Food difference degrees K	Freezer difference degrees K	Energy Impact % per deg K Fresh Food	Energy Impact % per deg K Freezer	Test Method Impact	Notes
43.1 *	5B	600	C	0.01	0.29	-	-	-	(1)
43.3	5T	360	C	0.08	0.52	2.0%	2.9%	1.6%	
43.4	5T	390	E	0.04	0.43	4.3%	1.1%	0.6%	
43.5	5T	420	C	0.04	0.27	1.5%	2.8%	0.8%	
43.6	5T	420	E	0.04	0.46	1.6%	1.3%	0.7%	(2)
43.7	5T	440	C	0.07	0.47	1.9%	3.8%	1.9%	(2)
43.8	5T	520	C	0.07	0.45	1.9%	3.7%	1.7%	(3)
43.9	5T	400	E	0.05	0.47	1.4%	2.5%	1.3%	
50.1	5T	300	C	0.13	0.55	1.8%	4.3%	2.7%	(4)
50.10	5B	320	E	-0.06	-0.13	-0.7%	4.6%	-1.2%	(5)
50.11	5B	430	C	0.09	0.40	2.1%	2.9%	1.4%	(4)
50.12	5B	430	C	0.04	0.34	1.9%	2.4%	0.9%	
50.2 *	5B	380	C	0.08	0.44	-	-	-	(1)
50.3	5B	510	C	0.09	0.38	1.0%	3.1%	1.2%	
50.5	5B	370	E	0.04	0.12	2.6%	3.3%	0.5%	
50.6	5T	450	E	0.02	0.10	1.9%	3.0%	0.3%	
50.7	5B	442	E	0.04	0.13	1.9%	2.7%	0.4%	
50.8	5T	517	E	0.02	0.17	-0.1%	2.5%	0.5%	(2)
50.9	5B	519	E	0.04	0.13	1.6%	2.6%	0.4%	
58.1	5S	580	E	0.04	0.09	2.1%	3.2%	0.4%	
58.10	5T	500	E	0.02	0.16	1.2%	3.0%	0.5%	
58.11	5T	350	CE	0.00	0.11	1.1%	2.6%	0.4%	(2)
58.2	5S	650	E	0.03	-0.09	1.7%	2.8%	-0.2%	
58.3	5S	540	E	-0.01	-0.01	-1.6%	4.0%	0.0%	
58.4	5S	600	E	0.06	0.22	-1.1%	1.5%	0.3%	
58.5	5S	610	E	-0.06	0.22	2.6%	2.0%	0.3%	
58.7	5T	330	E	0.04	0.26	3.1%	1.8%	0.5%	
58.8	5T	440	CE	0.06	0.28	1.8%	3.2%	1.0%	(2)
58.9	5B	380	CE	0.19	0.14	0.8%	4.2%	0.8%	(6)
74.12	5S	640	C	0.06	0.67	8.8%	6.6%	0.7%	(7)
83.12	5T	530	CE	0.02	0.20	1.4%	3.1%	0.6%	(8)

Positive difference mean 2007 warmer than 1997. Results are average of 3 tests.

Controls: C – conventional, E – electronic, CE – looks to be conventional but with electronic elements.

Units marked * were not used in energy analysis (two point interpolation – triangulation not possible)

Notes:

(1) Points do not form a triangle – these lie on a straight line so cannot determine energy impact.
(2) Not in the triangle, only small extrapolation, probably OK
(3) Not really valid as none of the freezer temperatures are warm enough - extrapolation in wrong direction.
(4) Old temperatures not quite valid (Q not inside triangle).
(5) Unclear whether freezer can reach -15C, not really valid, one point very cold. Treat with caution.
(6) Point 3 fresh food may not be stable for this run, old points outside triangle.
(7) Not valid run as fresh food too cold, target not in triangle, one freezer point very cold (-24C) – need to treat this result with caution.
(8) Fresh food run 3 does not meet stability.

Appendix B: Analysis of the Impact of AS/NZS4474.1-2007 on Energy Consumption																				
Unit	Group	Volume	Control	Energy diff	FF diff	FZ diff	E%/ FF K	E%/ FZ K	Offset	Comment										
43.1	5B	600	C	52.45%	0.01	0.29	23.2%	-25.3%	0	Do not form triangle - lie on a straight line so invalid										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1615.75	3.93	-15.14		3.88	-15.43	0.05	0.29			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1781.40	2.10	-16.52		2.16	-16.74	-0.06	0.23			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1786.73	2.18	-16.42		2.14	-16.77	0.04	0.35	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	2154	3	-15	1413	3	-15	Energy	52.45%	WARNING POINTS D		786				WARNING POINTS D		516			
Point 4	1793	2.1	-16.5	1786	2.1	-16.8			-12.4639	0.756807	1	1	0	0	-13.6356	0.813421	1	1	0	1
43.3	5T	360	C	1.60%	0.08	0.52	2.0%	2.9%	8											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1391.21	3.29	-15.86		3.17	-16.48	0.12	0.62			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1290.66	5.03	-14.49		4.96	-15.00	0.07	0.51			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1334.16	2.31	-13.72		2.28	-14.16	0.04	0.44	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1365	3	-15	1344	3	-15	Energy	1.60%	Points enclose Q		498				Points enclose Q		491			
Point 4	1369	2.9	-15.0	1355	2.6	-15.0			66.66138	-4.43723	1	0	1	0	6194.385	-412.932	1	0	1	0
43.4	5T	390	E	0.62%	0.04	0.43	4.3%	1.1%	16											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1526.56	2.33	-13.66		2.28	-14.05	0.05	0.39			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1463.26	3.34	-13.77		3.32	-14.13	0.02	0.36			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1542.67	2.99	-17.05		2.94	-17.59	0.05	0.54	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1506	3	-15	1497	3	-15	Energy	0.62%	Points enclose Q		550				Points enclose Q		546			
Point 4	1537	2.8	-15.9	1535	2.6	-16.0			7.430503	-0.468	1	0	0	1	8.822661	-0.55181	1	0	0	1
43.5	5T	420	C	0.78%	0.04	0.27	1.5%	2.8%	24											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1317.80	2.81	-15.09		2.79	-15.34	0.02	0.25			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1242.89	2.10	-12.67		2.06	-12.90	0.05	0.23			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1301.56	4.65	-15.61		4.60	-15.93	0.05	0.33	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1311	3	-15	1301	3	-15	Energy	0.78%	Points enclose Q		479				Points enclose Q		475			
Point 4	1316	3.1	-15.2	1314	3.2	-15.5			47.93429	-3.16232	1	0	0	1	39.95122	-2.58137	1	0	0	1
43.6	5T	420	E	0.68%	0.04	0.46	1.6%	1.3%	32	Only small extrapolation, probably OK										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1459.94	2.58	-15.18		2.55	-15.67	0.03	0.49			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1394.54	4.55	-14.09		4.53	-14.56	0.02	0.47			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1442.19	2.04	-13.59		1.98	-14.03	0.06	0.44	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1447	3	-15	1437	3	-15	Energy	0.68%	WARNING POINTS D		528				Points enclose Q		525			
Point 4	1461	2.6	-15.2	1455	2.4	-15.2			31.21391	-2.04884	1	0	0	0	58.10157	-3.82778	1	0	1	0
43.7	5T	440	C	1.94%	0.07	0.47	1.9%	3.8%	40	Only small extrapolation, probably OK										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1421.19	3.59	-15.66		3.48	-16.23	0.10	0.57			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1289.64	5.70	-14.22		5.66	-14.64	0.04	0.42			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1343.49	2.97	-13.87		2.90	-14.28	0.06	0.41	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1402	3	-15	1375	3	-15	Energy	1.94%	WARNING POINTS D		512				WARNING POINTS D		502			
Point 4	1389	3.3	-14.9	1372	3.1	-15.0			56.46502	-3.78817	0	0	1	0	113.9009	-7.6012	0	0	1	0
43.8	5T	520	C	1.66%	0.07	0.45	1.9%	3.7%	48	Not really valid as none of the freezer temperatures are warm enough - extrapolation in wrong direction										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1663.24	1.66	-16.34		1.55	-16.83	0.11	0.49			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1532.51	3.50	-15.01		3.43	-15.42	0.07	0.41			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1623.22	4.52	-17.15		4.48	-17.60	0.05	0.45	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1547	3	-15	1522	3	-15	Energy	1.66%	WARNING POINTS D		565				WARNING POINTS D		555			
Point 4	1739	-3.8	-14.8	1601	6.1	-18.0			-477.995	32.27224	0	1	1	1	50.24339	-2.78618	1	1	0	0

Appendix B: Analysis of the Impact of AS/NZS4474.1-2007 on Energy Consumption

Unit	Group	Volume	Control	Energy diff	FF diff	FZ diff	E%/ FF K	E%/ FZ K	Offset	Comment										
43.9	5T	520	E	1.27%	0.05	0.47	1.4%	2.5%	56											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1691.37	2.53	-16.00		2.52	-16.45	0.01	0.45			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1634.00	3.54	-15.14		3.46	-15.69	0.08	0.54			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1586.16	2.69	-13.49		2.64	-13.90	0.05	0.40	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1640	3	-15	1620	3	-15	Energy	1.27%	Points enclose Q		599				Points enclose Q		591			
Point 4	1645	2.6	-14.9	1608	2.6	-14.4			-57.5273	3.862274	0	1	1	0	-10.3891	0.720161	0	1	1	0
50.1	5T	300	C	2.70%	0.13	0.55	1.8%	4.3%	64	Old temperatures not quite valid (Q not inside triangle)										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1324.90	3.43	-15.32		3.28	-15.92	0.15	0.61			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1253.14	2.71	-13.75		2.57	-14.23	0.13	0.47			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1455.17	2.16	-17.05		2.05	-17.63	0.11	0.58	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1317	3	-15	1283	3	-15	Energy	2.70%	Points enclose Q		481				WARNING POINTS D		468			
Point 4	1353	3.2	-15.7	1311	3.4	-15.7			-15.2805	0.974194	1	0	0	1	-20.0577	1.274044	1	0	1	1
50.10	5B	320	E	-1.16%	-0.06	-0.13	-0.7%	4.6%	72	Unclear whether freezer can reach -15C, not really valid, one point very cold										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1632.25	1.72	-23.56		1.75	-23.64	-0.03	0.08			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1244.68	2.84	-16.24		2.92	-16.01	-0.08	-0.23			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1243.97	3.13	-16.18		3.20	-15.94	-0.07	-0.24	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1179	3	-15	1193	3	-15	Energy	-1.16%	WARNING POINTS D		430				WARNING POINTS D		435			
Point 4	1472	2.3	-20.5	1369	2.7	-18.4			-1.33854	0.065269	1	1	1	0	-2.01913	0.109594	1	1	1	0
50.11	5B	430	C	1.40%	0.09	0.40	2.1%	2.9%	80	Old temperatures not quite valid (Q not inside triangle)										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1513.87	2.33	-15.18		2.24	-15.58	0.09	0.39			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1510.02	3.28	-15.79		3.21	-16.19	0.07	0.40			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1367.72	4.63	-13.47		4.51	-13.88	0.12	0.41	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1485	3	-15	1465	3	-15	Energy	1.40%	Points enclose Q		542				WARNING POINTS D		535			
Point 4	1477	2.9	-14.7	1465	3.0	-15.0			-25.0484	1.698475	0	1	1	0	-22.7617	1.516994	1	1	1	0
50.12	5B	430	C	0.88%	0.04	0.34	1.9%	2.4%	88											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1598.66	1.98	-13.76		1.95	-14.05	0.03	0.29			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1656.05	2.86	-15.94		2.79	-16.35	0.06	0.41			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1570.32	3.85	-14.49		3.83	-14.83	0.02	0.34	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1615	3	-15	1601	3	-15	Energy	0.88%	Points enclose Q		590				Points enclose Q		584			
Point 4	1581	3.1	-14.2	1582	3.1	-14.5			38.68786	-2.72331	0	1	0	1	37.34623	-2.57308	0	1	0	1
50.2	5B	380	C	-366.63%	0.08	0.44	31.6%	-37.3%	96	Not valid - appears to effectively have only one control										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1530.40	2.70	-16.41		2.66	-16.80	0.04	0.39			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1553.51	3.83	-15.43		3.69	-16.01	0.14	0.58			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1198.92	9.36	-11.09		9.29	-11.44	0.07	0.34	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	2691	3	-15	-1009	3	-15	Energy	-366.63%	WARNING POINTS D		982				WARNING POINTS D		-368			
Point 4	1471	3.9	-15.5	1480	3.7	-16.0			-49.4484	3.198643	1	1	1	0	-30.6388	1.916897	1	1	1	0
50.3	5B	510	C	1.18%	0.09	0.38	1.0%	3.1%	104											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1534.42	4.90	-12.77		4.83	-13.08	0.07	0.31			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1787.28	3.44	-17.22		3.32	-17.72	0.11	0.50			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1686.09	2.06	-14.80		1.99	-15.14	0.08	0.33	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1680	3	-15	1661	3	-15	Energy	1.18%	Points enclose Q		613				Points enclose Q		606			
Point 4	1644	2.9	-14.2	1635	2.9	-14.5			-22.6898	1.593299	0	1	0	1	-21.6792	1.500124	0	1	0	1

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Unit	Group	Volume	Control	Energy diff	FF diff	FZ diff	E%/ FF K	E%/ FZ K	Offset	Comment										
50.5	5B	370	E	0.47%	0.04	0.12	2.6%	3.3%	112											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1331.95	0.97	-13.28		0.93	-13.37	0.04	0.09			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1324.52	4.45	-15.87		4.41	-15.99	0.03	0.13			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1400.97	2.31	-15.88		2.25	-16.02	0.06	0.14	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1337	3	-15	1331	3	-15	Energy	0.47%	Points enclose Q		488				Points enclose Q		486			
Point 4	1351	1.3	-14.0	1339	1.1	-13.6			-16.1473	1.153134	0	1	0	1	-12.6156	0.925079	0	1	0	1
50.6	5T	450	E	0.34%	0.02	0.10	1.9%	3.0%	120											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1162.30	2.51	-13.40		2.50	-13.48	0.01	0.08			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1154.60	5.03	-14.79		5.02	-14.89	0.01	0.10			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1256.84	3.08	-16.37		3.06	-16.49	0.02	0.12	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1209	3	-15	1205	3	-15	Energy	0.34%	Points enclose Q		441				Points enclose Q		440			
Point 4	1214	2.8	-15.0	1210	2.8	-15.0			149.1406	-9.93079	1	0	0	1	274.3682	-18.2768	1	0	0	1
50.7	5B	442	E	0.44%	0.04	0.13	1.9%	2.7%	128											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1458.87	1.07	-12.77		1.04	-12.87	0.03	0.09			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1550.73	2.96	-16.34		2.91	-16.51	0.05	0.17			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1440.45	4.64	-14.83		4.61	-14.95	0.03	0.12	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1495	3	-15	1488	3	-15	Energy	0.44%	Points enclose Q		546				Points enclose Q		543			
Point 4	1449	3.0	-13.9	1448	3.1	-14.0			24.55937	-1.76655	0	1	0	1	24.984	-1.77936	0	1	0	1
50.8	5T	517	E	0.47%	0.02	0.17	-0.1%	2.5%	136	Not in the triangle, small extrapolation										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1391.06	2.69	-16.24		2.66	-16.46	0.03	0.22			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1339.62	1.97	-14.75		1.95	-14.89	0.02	0.14			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1322.89	2.94	-14.23		2.93	-14.40	0.01	0.16	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1349	3	-15	1343	3	-15	Energy	0.47%	WARNING POINTS D		492				WARNING POINTS D		490			
Point 4	1348	2.9	-15.0	1342	2.9	-15.0			-63.7718	4.26171	0	0	1	0	-143.61	9.583927	0	0	1	0
50.9	5B	519	E	0.35%	0.04	0.13	1.6%	2.6%	144											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1719.68	0.58	-15.00		0.55	-15.09	0.03	0.09			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1565.82	4.44	-13.80		4.42	-13.91	0.03	0.11			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1780.97	3.58	-18.34		3.52	-18.52	0.06	0.19	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1655	3	-15	1649	3	-15	Energy	0.35%	Points enclose Q		604				Points enclose Q		602			
Point 4	1741	1.6	-16.2	1739	1.5	-16.2			33.89315	-2.09844	1	0	0	1	34.99167	-2.16441	1	0	0	1
58.1	5S	580	E	0.36%	0.04	0.09	2.1%	3.2%	152											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1961.41	2.15	-16.16		2.11	-16.25	0.04	0.09			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1717.77	2.54	-12.34		2.51	-12.39	0.03	0.04			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1856.09	4.75	-16.07		4.71	-16.21	0.04	0.14	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1859	3	-15	1853	3	-15	Energy	0.36%	Points enclose Q		679				Points enclose Q		676			
Point 4	1919	3.2	-16.1	1916	3.2	-16.2			-441.783	27.39969	1	0	1	0	-1026.02	63.21562	1	0	1	0
58.10	5T	500	E	0.54%	0.02	0.16	1.2%	3.0%	160											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1536.75	1.86	-17.99		1.86	-18.27	0.00	0.28			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1340.93	5.40	-14.71		5.41	-14.67	-0.01	-0.03			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1358.98	2.07	-13.80		1.99	-14.04	0.09	0.24	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1393	3	-15	1386	3	-15	Energy	0.54%	Points enclose Q		509				Points enclose Q		506			
Point 4	1415	2.0	-15.1	1405	2.0	-15.1			122.7055	-8.1144	1	0	1	0	111.0187	-7.33178	1	0	1	0

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Unit	Group	Volume	Control	Energy diff	FF diff	FZ diff	E%/ FF K	E%/ FZ K	Offset	Comment										
58.11	5T	350	CE	0.37%	0.00	0.11	1.1%	2.6%	168	Not in the triangle, small extrapolation										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1071.04	2.83	-16.42		2.82	-16.57	0.01	0.15			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1047.47	4.88	-16.40		4.88	-16.49	-0.01	0.09			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	964.90	4.88	-13.27		4.87	-13.36	0.01	0.09	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1032	3	-15	1028	3	-15	Energy	0.37%	WARNING POINTS D		377				WARNING POINTS D		375			
Point 4	1036	3.5	-15.4	1033	3.5	-15.4			-30.6261	1.991552	1	1	1	0	-29.3361	1.900975	1	1	1	0
58.2	5S	650	E	-0.15%	0.03	-0.09	1.7%	2.8%	176											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1804.35	2.22	-13.00		2.19	-12.79	0.03	-0.20			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1839.87	4.16	-14.82		4.14	-14.75	0.02	-0.07			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	2000.05	2.32	-16.77		2.27	-16.78	0.05	0.01	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1886	3	-15	1888	3	-15	Energy	-0.15%	Points enclose Q		688				Points enclose Q		689			
Point 4	1914	2.3	-15.1	1921	2.2	-15.2			98.04187	-6.4876	1	0	0	1	69.33153	-4.57108	1	0	0	1
58.3	5S	540	E	-0.02%	-0.01	-0.01	-1.6%	4.0%	184											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	2131.76	3.22	-18.31		3.23	-18.29	-0.01	-0.02			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1694.07	2.16	-12.86		2.16	-12.85	0.00	-0.01			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1898.59	4.18	-14.80		4.19	-14.81	-0.01	0.01	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1878	3	-15	1879	3	-15	Energy	-0.02%	Points enclose Q		686				Points enclose Q		686			
Point 4	2024	3.7	-16.7	2026	3.7	-16.7			-11.149	0.66794	1	0	1	0	-11.1346	0.66638	1	0	1	0
58.4	5S	600	E	0.33%	0.06	0.22	-1.1%	1.5%	192											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1802.89	2.06	-12.98		1.99	-13.20	0.08	0.22			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1907.20	2.05	-16.65		2.03	-16.68	0.02	0.02			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1910.58	4.23	-15.12		4.13	-15.54	0.10	0.42	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1881	3	-15	1875	3	-15	Energy	0.33%	Points enclose Q		686				Points enclose Q		684			
Point 4	1869	3.4	-14.3	1866	3.2	-14.6			22.73019	-1.58908	0	1	0	1	21.78933	-1.49484	0	1	0	1
58.5	5S	610	E	0.32%	-0.06	0.22	2.6%	2.0%	200											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1991.11	3.43	-16.41		3.49	-16.56	-0.06	0.15			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1868.20	3.47	-13.39		3.49	-13.57	-0.02	0.18			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	2108.31	1.53	-16.93		1.61	-17.25	-0.08	0.32	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1956	3	-15	1950	3	-15	Energy	0.32%	Points enclose Q		714				Points enclose Q		712			
Point 4	2047	2.5	-16.7	2064	2.3	-17.0			-55.992	3.361019	1	0	0	1	-40.577	2.387915	1	0	0	1
58.7	5T	330	E	0.53%	0.04	0.26	3.1%	1.8%	208											
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1158.21	1.96	-17.27		1.93	-17.53	0.03	0.26			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1023.50	4.23	-14.27		4.15	-14.57	0.08	0.30			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1014.96	3.68	-12.86		3.66	-13.08	0.02	0.21	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1079	3	-15	1074	3	-15	Energy	0.53%	Points enclose Q		394				Points enclose Q		392			
Point 4	1088	2.8	-15.1	1078	2.9	-15.0			19.6089	-1.29698	1	0	1	0	34.65681	-2.30457	1	0	1	0
58.8	5T	440	CE	1.05%	0.06	0.28	1.8%	3.2%	216	Not in the triangle, small extrapolation										
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1477.50	1.11	-16.92		1.03	-17.23	0.08	0.30			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1411.12	3.01	-16.48		2.97	-16.75	0.04	0.27			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1272.35	4.50	-14.11		4.43	-14.36	0.07	0.25	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1348	3	-15	1334	3	-15	Energy	1.05%	WARNING POINTS D		492				WARNING POINTS D		487			
Point 4	1363	3.0	-15.4	1359	3.0	-15.6			-18.6104	1.212281	1	1	1	0	-18.2595	1.172289	1	1	1	0

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Unit	Group	Volume	Control	Energy diff	FF diff	FZ diff	E%/ FF K	E%/ FZ K	Offset	Comment									
58.9	5B	380	CE	0.77%	0.19	0.14	0.8%	4.2%	224	Point 3 fresh food may not be stable for this run, old points outside triangle									
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1934.97	3.58	-17.58		3.39	-17.77	0.18	0.19			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1912.82	2.32	-17.05		2.18	-17.17	0.14	0.12			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1635.45	2.90	-13.41		2.67	-13.51	0.24	0.10	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1752	3	-15	1739	3	-15	Energy	0.77%	Points enclose Q		639				WARNING POINTS D		635			
Point 4	1726	3.1	-14.7	1750	2.9	-15.1			7.209183	-0.4913	0	1	1	0	8.31015	-0.54875	1	1	1	0
74.12	5S	640	C	0.67%	0.06	0.67	8.8%	6.6%	232	Not valid run as fresh food too cold, not in triangle									
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1769.10	2.09	-16.74		2.04	-17.16	0.06	0.42			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1697.15	0.92	-14.45		0.80	-14.84	0.11	0.39			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	2527.42	2.51	-24.99		2.51	-26.18	0.00	1.19	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1481	3	-15	1471	3	-15	Energy	0.67%	WARNING POINTS D		540				WARNING POINTS D		537			
Point 4	1585	2.0	-14.7	1582	1.9	-14.9			-55.2638	3.750509	0	0	1	1	-210.38	14.09688	0	0	1	1
83.12	5T	530	CE	0.63%	0.02	0.20	1.4%	3.1%	240	Fresh food run 3 does not meet stability									
	Energy new	FF new	Z new W4	Energy old	FF old	FZ old W4	Impact FF	Impact FZ	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4	T4 top	T4 bott	P4<Q	P2<Q	P1 <P4	P3<P4
Run1	1839.89	4.35	-15.73	-15.98	4.34	-15.93	0.01	0.20			Checks Q is between		Checks P4 is between				Checks Q is between		Checks P4 is between	
Run 2	1729.20	3.24	-13.26	-13.48	3.23	-13.42	0.01	0.17			P2 and P4		P1 and P3				P2 and P4		P1 and P3	
Run 3	1914.58	1.61	-15.81	-16.04	1.58	-16.04	0.03	0.23	New	New	New CEC	New	New	New	Old	Old	Old CEC	Old	Old	Old
Target	1833	3	-15	1822	3	-15	Energy	0.63%	Points enclose Q		669				Points enclose Q		665			
Point 4	1880	2.9	-15.8	1880	2.9	-16.0			-548.344	34.76554	1	0	0	1	-425.1	26.58677	1	0	0	1