NELSON CITY COUNCIL

Nelson Air Quality Plan

Proposed Plan Change A3

s42A Report – Appendix 3

Space Heating & Behaviour Change

Report Date
21 April 2016

Hearing Date
3 May 2016

Nelson City Council
te kaunihera ō whakatū

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Attachments

- **Attachment 1:** Eco Design Advisor Factsheet 7a Insulation: How effective is it? (A1317717)
- **Attachment 2:** Authorised ULEB details and NES performance range (A1525675)

Interpretation

This report utilises a number of abbreivations for brevity's sake as set out in the glossary below:

Abbreviation	Means...
"the Act"	Resource Management Act 1991
"BCP"	Behaviour Change Programme
"CM1"	Canterbury Method One Ultra Low Emission Woodburner Test Method
"the Council"	Nelson City Council
"NESAQ" or "NES"	Resource Management (National Environmental Standards for Air Quality) Regulations 2004
"PCA3"	Proposed Change 3 to the Nelson Air Quality Plan
"the Plan"	Operative Nelson Air Quality Plan 2008
"the Plan Change"	Proposed Change 3 to the Nelson Air Quality Plan
"RMA"	Resource Management Act 1991
"RPS"	Nelson Regional Policy Statement 1997
"s32"	Section 32 of the Resource Management Act 1991
"ULEB"	Small-scale Ultra-Low emission burning appliances

1.0 INTRODUCTION

Report Author

1.1 My name is Richard John Popenhagen. I am an Environmental Programmes Adviser employed by Nelson City Council.

1.2 I have been in the role as Eco Building Design Adviser since December 2008. Prior to that I was a Building Inspector for nearly eight years and have spent over 20 years working as an Architectural Draughtsman designing buildings. I now use that accumulated knowledge to assist people to improve the performance of their homes.

1.3 I have been asked by the Council to prepare this addendum to the s42A report on PCA3.

1.4 Along with contextual information and other matters of fact, this report includes my personal views and recommendations to accept or reject points made in submissions on PCA3. These views and recommendations are my own, except where I indicate otherwise.

1.5 Though not a requirement of Council plan change hearings, I have read and agree to abide by the Code of Conduct for Expert Witnesses, and have prepared this report in accordance with it. The report content is within my area of expertise except where stated otherwise. I have not omitted to consider the material facts known to me that might alter or detract from the opinion expressed in this report.

1.6 In some instances, I have specifically relied on the evidence, expertise and/or views of others, including:

a. various reports authored by Dr Emily Wilton of Environet, including her addendum report to the s42A report on PCA3;

b. Consumer New Zealand - Keep Warm for Less report June 2015; and

c. Eco Design Advisor Factsheet 7a - Insulation: How effective is it?

Report Scope and Structure

1.7 The matters this report relates to are space heating and the proposed BCP.

1.8 In relation to these matters, this report specifically covers the following:

a. **Section 2** provides a discussion of space heating options commonly used for domestic purposes, and an outline of Council's current and proposed measures to improve ambient air quality through behaviour change; and

b. **Section 3** includes a discussion of the submissions of relevance to my report.

1.9 Attached to the report are the following:

a. **Attachment 1** contains Eco Design Advisor Factsheet 7a Insulation: How effective is it? (A1317717)

b. **Attachment 2** contains Authorised ULEB details and NES performance range (A1525675)

2.0 SPACE HEATING OPTIONS AND BCP

Domestic Space Heating Options

2.1. Heating options that are currently available to Nelson residents are dictated by the fuel sources available locally, and include:

a. Wood – NES compliant wood burners and ULEB.

b. Manufactured wood products – Wood pellet burners

c. Electricity – Heat pumps and Electric heaters

d. Bottled LPG – Flued and un-flued gas heaters

e. Fuel oil – Diesel burners

2.2. The space heating efficiency varies considerably between fuel types and also due to the varying efficiency of different heaters using the same fuel source. Consumer New Zealand publish a report annually which shows the relative efficiency of different heating options - refer figure one.

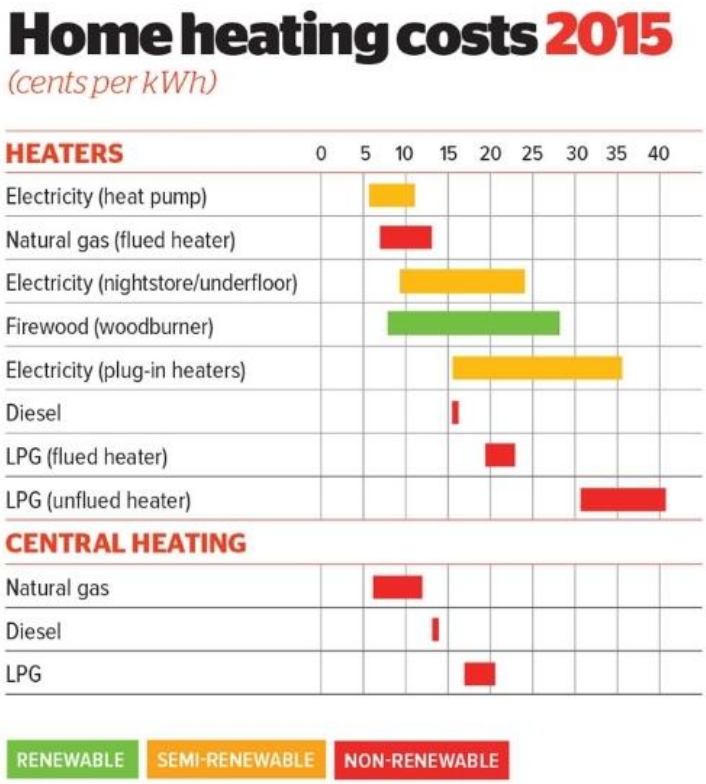

Figure 1: Relative Efficiency of Heat Sources (*Source: Consumer New Zealand)*

2.3. Despite similar operating costs, wood burners may be a preferred heating method in poorly insulated homes because they provide a mixture of

radiant heat (heats objects) and convective heat (heats air). A heat pump provides convective heat. Both methods result in energy wastage if a home is not adequately insulated, and retrofitting insulation can result in significantly improved home energy efficiency and comfort.

2.4. The perception that wood provides better heat is likely to come from the difference in the type of heat provided with wood burners providing a mix of radiant and convection heating whereas heat pumps only provide convection heating.

2.5. Convection heaters increase the household temperature by warming the air in a room. In contrast radiant heaters heat objects not air. In a house with a high air exchange rate (i.e. air leaky and draughty) the air is regularly replaced so the heating of the air through convective heating (heat pumps and wood burners) is perceived as less efficient.

2.6. In contrast, the radiant heating aspect of wood burners means a person can stand by the fire and feel the heat (on the side of their body close to the fire). In addition objects close to the fire can absorb the heat and slowly release it creating an additional perception of warmth.

2.7. The overall efficiency of space heating options refers to the ability of the appliance to convert energy in the fuel to usable energy for space heating. Wood burners have efficiencies ranging from around 65-80%. In contrast, a heat pump can convert a kW of electricity to produce more than one kW of heat and therefore has an efficiency greater than 100% (values of around 300 to 400% are common).

2.8. Another issue for home heating, and especially those homes with high air exchange rates, is the role of insulation for heat retention. Retrofitting insulation and draught proofing is an important tool for increasing warmth within these households.

Behaviour Change Programme

2.9. The Council's approach to reducing particulate emissions to date has included:

a. capping the number of solid fuel burners in the urban area;

b. banning open fires and phasing out older more polluting solid fuel appliances and encouraging replacement with cleaner forms of heating;

c. improving the operation of burners used to reduce particulate emissions; and

d. financial assistance to help homeowners install insulation and upgrade to more efficient and less polluting forms of heating.

2.10. To alleviate the effects of previous phase outs and prohibitions on domestic burners, the Council provided a financial assistance programme (Clean Heat Warm Homes) to upgrade insulation and change to more modern, lower emitting fires or other non-polluting appliances such as heat pumps or gas. Under this scheme, which ran from 2004 until 2012, 433 open fires and 1546 enclosed burners were replaced and 1370 homes insulated.

2.11. In 2004, the Council also established an education programme with wood merchants (Good Wood scheme) to encourage dry wood use and make it more accessible. This initiative aims to improve the quality of wood sold through a voluntary code of practice that merchants sign up to and recommit to every year. There are currently 7 Good Wood suppliers on the scheme.

2.12. The Council also provides a free Eco Building Design Adviser service offering home assessments and advice on energy efficiency and home heating.

2.13. Comprehensive information is available on the Council's website and information has been extensively distributed (including to doctor's surgeries and real estate agents). The Council has developed a brochure of tips for using woodburners more efficiently, as well as tips for reducing power bills, which is sent to every building consent applicant when burners are installed; provided to homes assessed by the Council Eco Building

Design adviser; as well as being left with people following any complaints about excessive smoke from their burners. The tips are also widely available through burner retailers, the Council's website and as part of air quality promotion (e.g. advertising, displays, and educational events). The Council's website also features a link to NZ Home Heating Association video on how to light and operate a woodburner so that it burns efficiently and as cleanly as possible.

2.14. In addition to this, the Council has run an extensive media campaign since 2004 including regular features in its fortnightly *Live Nelson* newspaper, which goes to every household in Nelson (19,200 homes).*The Nelson Mail* newspaper features have covered the Clean Heat Warm Homes scheme, Good Wood scheme (including the health effects of burning treated wood), tips mentioned above and air quality monitoring.

2.15. Following the last burner phase-out in 2012, the Council increased its enforcement of domestic controls embarking on a programme over several years and staring with the most polluted area of the city (Airshed A) to progressively check every property and confirm whether it complies with the Plan. This resulted in over 100 abatement notices being issued to people using illegal burners. All of these abatement notices have been complied with.

2.16. The measures outlined above have complemented the controls on domestic burning in the Plan. It is difficult to isolate the particular contribution to reducing emissions made by the Council's behaviour change efforts to date as all elements are essential – i.e. rules limiting the number and standard for burners supplemented by non-regulatory methods to help people change their burner type/behaviour and enforcement to rely on as a last recourse.

2.17. However, the combined result of the Council's air quality management efforts to date has been one of the most spectacular success stories in the country as the Council has achieved the most rapid and largest reductions in PM_{10} levels of any municipality in New Zealand. In its most polluted airshed (Airshed A) exceedances of the National Environmental Standard for air quality have fallen from 81 in 2001, to 1 in 2015. This success has been recognised with two Green Ribbon Awards being received by Council in 2012 for its air quality programme.

2.18. Building on its work to date, the Council is presently involved in a 2-year national behaviour change project with other regional councils - and led by ECan - which aims to reduce emissions from domestic woodburners. This project started in 2015 and will address practical elements of woodburner operation and develop effective interventions that can be developed locally by Councils and other organisations.

2.19. So far, the national behaviour change project has identified the following key elements for a successful programme:

a. Tell the story (raise awareness that smoky fires/poor burner operation cause emissions/contribute to Nelson's air pollution problem);

b. Individual contact (e.g. targeted letters to smoky burner operators, with instructions on better burning and offering support);

c. A disrupter (e.g. using 'spotters' to identify ongoing smoky burners/monitor progress); and

d. Feedback (follow-up with households letting them know how they are going).

2.20. To date, the Council's initiatives outlined above have largely been reactive. Some people still feel they are burning properly and others are causing the problem, or they do not know what they can do to improve the operation and performance of their burner. Key factors that influence emissions from burners and that people operating their burners need to be aware of are fuel quality (moisture content, type and size), starting and loading of burners, oxygen supply/air flow settings, and regular maintenance (including flue cleaning).

2.21. The Council can be more proactive by developing a more targeted and supportive approach with households using burners. Planned actions to increase behaviour change to achieve a 10% reduction in domestic emissions include:

a. extending the Good Wood scheme to include chimney sweeps and burner retailers to promote regular flue cleaning and burner maintenance;

b. surveying woodburner users to determine current attitudes and practice around woodburner use and identify any barriers to efficient burner operation. This information will be used to develop an effective strategy to support households to improve the performance of their burners;

c. identifying and targeting excessive and smoky burners and reviewing why (e.g. considering the key factors above) and support people to change. Directly working with households, and monitoring their burner operation and analysing the Council's ambient air quality information, will result in a better understanding of the effectiveness of this behaviour change programme; and

d. enforcement will be used as last resort to ensure General Conditions in rule NAQP rule AQr.22 are met (i.e. smoke from burners do not result in offensive or objectionable odour, or dispersal or deposition of smoke particles, to the extent it causes offensive or objectionable effect beyond the boundary of the discharge).

2.22. Dr Wilton's addendum report also discusses elements of the BCP, and specifically the significant impact on ambient PM_{10} levels that can be achieved by halving the emissions of the 500 worst polluting domestic woodburners.

3.0 SUBMISSIONS

Introduction

3.1. Submitters have raised a number of issues regarding the efficiency and effectiveness of different heating devices and the likely effectiveness of the BCP. This section addresses those issues.

Issues

3.2. This report adopts the issue-based approach from the main s42A report, and covers the following matters raised by submitters:

a. better monitoring, enforcement, education, and/or burning practice should be applied;

b. NES burners should be enabled instead of, or in addition to, ULEB;

c. wood burners are better, more effective and/or more efficient than heat pumps;

d. opposition to the plan change due to the effect of new burners on ambient air quality;

e. burners should only be authorised for five years;

f. ULEB models with wetbacks should be authorised;

g. other methods should be explored outside of the AQP; and

h. proposed amendments to the rules and methods in PCA3.

3.3. Each of these matters is discussed in turn below.

Better monitoring, enforcement, education and/or burning practice

3.4. Twelve submissions[1] raised the role of monitoring, enforcement, education and/or burning practice as important methods for managing ambient air quality.

3.5. Enforcement to date has relied on complaints which are followed up to determine source of excessive smoke, including type and quality of wood/other materials burnt and advice on burner operation being provided. The Council plans to achieve further improvement by increasing its behaviour change programme as outlined above, including more targeted education, supported by monitoring and enforcement.

3.6. **Submission 87** sought additional detail on funding, effectiveness monitoring and methodology for behaviour change programme.

3.7. This has been addressed in section 2 above.

3.8. **Submission 103** has questioned the effectiveness of the BCP and the ability to achieve 10% improvement in ambient air quality. The submission recommends targeting 5% instead and adjusting burner numbers accordingly.

3.9. Based on the science provided by Dr Emily Wilton, along with my experience and collaborative discussions I have held with other Council Officers who will involved in the design and delivery of the BCP, I believe that a 10% improvement in domestic PM10 emissions can be achieved as proposed.

3.10. The BCP will draw on the Council's considerable experience and knowledge of factors influencing woodburner emissions and also its good working relationships with the burner sector (i.e. wood merchants, chimney sweeps and burner retailers). Involvement in the national burner behaviour change project to develop effective methods will also inform the Council's programme.

3.11. The Council has demonstrated its commitment to improving air quality and will continue to provide resources to reduce emissions as much as possible from woodburner operation. Monitoring of changes in burner operation, of

[1] Submissions 1, 16, 22, 29, 53, 61, 75, 85, 87, 89, 103 and 107

the number and extent of smoky burners, and of ambient air quality will be used to determine the effectiveness of this programme.

NES burners should be enabled instead of, or in addition to, ULEB

3.12. Twenty-three[2] submissions sought that NES burners should be enabled by the plan change, either instead of or in addition to ULEB. One of the main reasons cited in submissions for this proposed change is the suggestion that NES burners are more effective and/or efficient at space heating than ULEB.

3.13. One way to compare NES & ULEBs directly is through the NES test method. The space heating efficiencies range from 65% to 76% for NES burners and 68% to 79% for ULEBs. The pollution emitted varies from 0.3 to 1.5 g/kg for NES, and 0.1 to 0.98 g/kg for ULEB's[3]. This indicates that ULEB's are as efficient, if not more so in converting 1 kg of wood into heat into the room and produce less emissions in the process than NES burners.

3.14. The effectiveness of appliances depends on the output. ULEB's range in output from 3.9kW to 15.1 kW, while NES wood burners range from 4.0kW to 26kW output.

3.15. Some submissions suggest that older houses provide justification for favouring NES burners over ULEB. While older un-insulated homes certainly have greater space heating challenges than their modern counterparts, I do not agree that this favours NES burners for the reasons stated above.

3.16. Moreover, if the house is old, large and un-insulated then the heat losses from the house may exceed the maximum output of the heating device used. In those cases it may be possible to heat some rooms at an acceptable temperature, but it will not be possible to keep the whole house at the recommended minimum temperatures.

3.17. This underscores the importance of providing solutions for minimising the heat loss from the home when considering home heating options, and not simply the appliance preferred. There is little point in pouring huge

[2] Submissions 5, 7, 8, 22, 29, 35, 38, 42, 43, 53, 57, 61, 77, 80, 81, 84, 89, 93, 94, 99, 104, 106 and 107
[3] Authorised ULEB details and NES performance range (A1525675)

amounts of energy into heating a home if that heat is quickly being lost back out of the home.

3.18. Among the many solutions for addressing heat loss from homes one of the most effective is insulation[4]. Nelson City Council is currently investing $100,000 per annum into the Warmer Healthier Homes Nelson-Marlborough programme. This is discussed in more detail under submission 32 below.

3.19. To illustrate the importance of insulation by way of practical example, a typical 1960s/70s three bedroom un-insulated house of around 120m^2 will require a massive 17 kW of heat input every hour to keep the house at 20^{o}C when the outside temperature is 5^{o}C[5]. This is why old houses require a large wood burner blazing away all night to try and keep warm. Often it will not manage to heat the whole house.

3.20. If that same house is insulated to the levels required by the current building code for new houses, the required heat input drops to 6.0kW (4.6kW if double glazing included) and if it was insulated to higher levels this figure drops below 3 kW.

3.21. In short, while the efficiency and effectiveness of appliances is an important consideration for purchasers, it is only part of the overall home heating 'equation'; and in any event, there is little to separate ULEB and NES burners in terms of efficiency and effectiveness based on the information currently available about these appliances.

3.22. For these reasons, I see no compelling case for favouring NES burners over ULEB from an overall space heating perspective, notwithstanding the difference in capital cost.

3.23. **Submitter 29** has requested that a specific model of burner – Pyroclassic IV – be authorised.

3.24. The Pyroclassic IV is already currently authorised as a NES compliant woodburner. To my knowledge it has not been tested to the CM1 ULEB test method to date. The responsibility for having woodburners tested and obtaining authorisation sits with the manufacturer. Council can't force the

[4] Cost Benefit Analysis of the Warm Up New Zealand: Heat Smart Programme
[5] Eco Design Advisor Factsheet 7a Insulation: How effective is it?

manufacturer to have their fire tested to either standard. If the manufacturer of the Pyroclassic has it tested to the CM1 ULEB test method (or similar), and it passes all the requirements, then it could be authorised as a ULEB.

Wood burners are better, more effective or more efficient than heat pumps

3.25. Seven submissions[6] cite the shortcomings of heat pumps as a reason to liberalise the proposed plan change provisions. Of relevance to my report, several of these submitters provide the view that heat pumps are not as effective at domestic space heating as wood burners.

3.26. Independent research[7] shows that heat pumps have a similar or greater efficiency to wood burners when comparing how much money is spent on the fuel source compared to the amount of heat provided per dollar spent. However, the effectiveness can vary widely. Broadly, it comes down to having a heat source that provides equal or greater heat into the house, to compensate for heat loss from the house in cold conditions. This is further detailed in **Attachment 1**, including a comparison between an insulated and an un-insulated house.

3.27. An additional suggestion made by submitters is that there are special characteristics of Nelson's environment and typical housing stock that further emphasises the superiority of wood burners as a domestic heat source relative to heat pumps.

3.28. I have not been able to find any evidence that Nelson houses are different in age, condition or typology to houses in other regions around New Zealand.

3.29. As discussed in Section Two, the perception that woodburners provide better heat is likely to come from two aspects:

a. the first one being the difference in the type of heat provided, with wood burners providing a mix of radiant and convection heating, and heat pumps only providing convection heating; and

[6] Submissions 5, 8, 11, 14, 16, 17 and 29
[7] Consumer New Zealand Keep warm for Less report June 2015

b. secondly in regard to the sheer volume of heat that most woodburners can deliver compared to the output of a typical heat pump.

3.30. In conclusion, heat pumps are just as efficient as woodburners in regard to the amount of heat they provide for every dollar spent on fuel or energy. However the size and thermal performance of the building envelope will influence the effectiveness in regard to the volume of heat required to maintain acceptable comfort levels in the home.

Opposition to PCA3 due to impact on ambient air quality

3.31. Ten submissions[8] oppose the plan change due to concerns that the provisions will degrade ambient air quality levels.

3.32. The Council's approach with the Plan Change is to achieve continual improvement of ambient air quality. Provision for installation of ULEBs into homes without burners is based on a 10% improvement target through better operation of existing burners. Other factors will also contribute to improved air quality, including people opting to replace their existing burners with cleaner forms of heat.

3.33. As noted above, and drawing on the related expertise of Dr Wilton, I consider that the 10% improvement target is achievable. On that basis, the plan change should not result in any net reduction in ambient air quality.

Wood burners should only be authorised for 5 years

3.34. **Submission 24** proposes a 5 year maximum authorisation period for new burners to ensure that the most efficient and lowest emission burners were the standard stock in Nelson, providing ongoing protection of air quality

3.35. Given that the average life of a wood burner is 15 to 20 years, requiring people to replace them after 5 years would create a substantial imposition.

[8] Submissions 15, 19, 31, 32, 37, 56, 78, 92, 96 and 101

This would not be cost effective and would create an economic burden on home owners.

3.36. There would also be an added cost to Council in monitoring and enforcing such a requirement, and it would add administrative complexity with little or no benefit.

3.37. Accordingly, I do not support a five year maximum authorisation period for new burners.

ULEB models with wetback should be authorised

3.38. **Submission 24** seeks that Council's list of authorised burners include ULEB models with a wetback option.

3.39. Currently there is one ULEB with a wetback that has been authorised by ECan. As indicated in **Attachment 2**, this model has a recommended retail price of $5,999.

3.40. As a comparison, NES burners with a wetback range in price from $1,548 to $4,435.[9]

Consider other methods outside the AQP

3.41. **Submission 32** supports alternative methods to wood burners as a means of making homes warmer and drier overall. Specifically, the submission suggests that the following be considered:

a. programmes to encourage and subsidise insulation

b. warrants of fitness/minimum standards for rental accommodation

c. rates rebates for the installation of efficient electric heating systems

d. lobbying central government for regulatory alteration of electricity pricing mechanisms.

[9] Consumer New Zealand Woodburners – Reviews and ratings

3.42. Nelson City Council are a partner in the Warmer Healthier Homes Nelson-Marlborough. The programme was established to meet a need to improve the energy efficiency of homes in Nelson, Tasman and Marlborough. The programme has a health focus and has been targeted at low income households and Community Services Card Holders who also have high health needs.

3.43. Current funding for the programme is provided by the Energy Efficiency and Conservation Authority (EECA), Rata Foundation, Nelson City Council (NCC), Nelson Marlborough District Health Board (NMDHB), and Marlborough District Council.

3.44. There have been trials of a proposed rental warrant of fitness in some parts of the country; however the government has expressed disinterest in introducing a nation-wide warrant of fitness programme. In my understanding, Government is considering some minimum standards for rental properties.

3.45. It is considered a better spend of money to partner with other agencies and subsidise insulation upgrades, as opposed to providing rates rebates for heating systems. Rates rebates can be administration heavy and it can be difficult to ensure that the rebate is spent on the intended item.

3.46. There is merit in the submitter's suggestions, many of which the Council is actively engaged in presently. In my view, these and other solutions can continue to be developed in tandem to the plan change, but it is not necessary that they are considered as alternative or additional methods.

Proposed Rules and Methods

3.47. Nine submissions[10] have sought specific amendments to the proposed rules and methods in the plan change. Of particular relevance to my report are Submission 67 and Submission 88.

3.48. **Submission 67** seeks heat shield efficiency measures to be adopted in the plan change methods.

[10] Submissions 63-67, 87, 88, 92 and 95

3.49. This submission falls into the category of reducing heat loss from homes and improving space heating efficiency. I agree with the submission that conventional flues contribute to substantial heat loss from homes; not just when the fire is operating, but at all times during winter. Reducing this heat loss has merit and the additional cost relative to conventional flues is minimal in most cases.

3.50. Encouraging or requiring people to install "heat saver" type flues when replacing or installing new wood burners could deliver substantial benefits in improving the thermal performance of homes.

3.51. PCA3 does not prevent heat saver type flues from being installed to authorised woodburners including ULEBs. The definition for ULEB requires minimum efficiencies to be met, and this technology can be one of many specifications adopted to achieve the efficiency required.

3.52. In my view, this submission has considerable merit; however implementation of this submission requires further consultation with wood burner manufacturers, suppliers, installers, and certified testing laboratories. I consider this issue would be better addressed and considered through the wider Air Plan review scheduled to be undertaken in 2017.

3.53. **Submission 88** seeks that the plan change stipulates that ULEB must be capable of operating the down draft fully automatically without any manual interaction by human beings.

3.54. In my view, this would add an additional requirement unique to Nelson and could create confusion in the market place where ULEBs acceptable in other parts of New Zealand may not be acceptable in Nelson. It would be more appropriate if this issue was addressed as part of the testing and authorisation process.

3.55. There is only one ULEB currently on the market that operates in this mode, being the 'Bionic Fire'. However, even this burner requires the door to be left ajar for the first five to ten minutes of operation. It must then be manually closed, so manual interaction is still required by human beings to operate this appliance. This issue could also apply to any NES compliant fire.

3.56. Accordingly, I do not support introducing a requirement that all ULEB must be capable of operating the down draft fully automatically without any manual interaction by human beings.

Attachment 1

Eco Design Advisor Factsheet 7a Insulation: How effective is it?

Comparing Insulation

ECO-DESIGN ADVISOR SERIES NO.7A (ZONE THREE - SOUTH ISLAND AND CENTRAL NORTH ISLAND)

• INSULATION – HOW EFFECTIVE IS IT?

Two of the most common questions asked of eco design advisors are how much insulation should be installed, and how do you know what difference it will make. To answer these questions there are a few basic concepts to understand.

- Heat always tries to flow from a warmer place to a colder place.
- Insulation reduces this heat flow by slowing it down.
- The unit used to measure resistance to heat flow is the R-value ($m^{2o}C/W$). The bigger the number, the better the resistance to heat flow.

All insulation products sold in New Zealand are required to be labelled with the R-value, and when building new you need to demonstrate you can meet the insulation requirements of the New Zealand Building Code (NZBC). To give you a feel for the levels required here are some typical R-values:

Construction (Note 1)	**NZBC minimum** (Note 2)	**Better** (Note 3)	**Best** (Note 3)
Floor	R1.3	R1.9	R3.1
Wall	R2.0	R2.6	R3.3
Ceiling	R3.3	R4.0	R5.0
Windows (Note 4)			
Standard double glazing (aluminium frame)	R0.26		
Minimum WEERS Rated 3 Stars, or Energy Star endorsed		R0.32	
Minimum WEERS Rated 5 Stars			R0.50

Note 1: For non solid construction.
Note 2: R values stated are total construction R-value, taking into account heat losses through framing members. Note NZBC minimum figures are for Zone 3 (South Island and Central North Island) – refer to Factsheet 7 for Zones 1 & 2.
Note 3: Refer to BRANZ House Insulation Guide – Fifth Edition, for options on achieving these desired construction R-values.
Note 4: Consult with your window supplier to ascertain what Rw value different options will give, or refer to BRANZ Bulletin 579 for guidance.

What can we learn from the above table?

- Insulation is your friend, the more the better, especially in the ceiling, as warm air rises (replacing the cold air that sinks).
- Windows perform really poorly thermally; even double glazed windows lose 10 times as much heat as a well-insulated wall, hence there's still a need for good curtains (see fact sheet no. 2).
- Avoid too much glazing, especially on south sides and via skylights.
- Insulation works in both directions, slowing heat from entering in summer, and will reduce overheating, provided windows are well shaded.

Heating savings

Let's look at a typical 1960s/ 70s house and what insulation can do to improve the occupants' comfort and reduce the heat requirements and running costs of the house.

Reduce heating requirement through more insulation (from no insulation to best levels)

	Existing house with no insulation	Heat Load (Watts)	Insulated to NZBC minimum	Heat Load (Watts)	Insulated to better level	Heat Load (Watts)	Insulated to best levels	Heat Load (Watts)
Floor 120m^2	R0.4	4,500	R1.3	1,385	R1.9	950	R3.1	580
Walls 92m^2	R0.44	3,140	R2.0	690	R2.6	530	R3.3	420
Ceiling 120m^2	R0.3	6,000	R3.3	545	R4.0	450	R5.0	360
Windows 34m^2	R0.15	3,400	R0.26	1960	R0.32	1595	R0.50	1020
Total		**17,040**		**4,580**		**3525**		**2380**

The house with no insulation requires a massive 17kW of heat to keep the temperature at 20^{o}C when it is 5^{o}C outside. The biggest heat loss is through the ceiling, followed by the floor, with the walls and the glazing losing similar amounts. That equates to $4.25 an hour (at 2014 prices, ~25c/kWh).

Once insulated to the NZBC minimum the heating requirement drops to 4.6kW, to maintain a comfortable 20^{o}C. Now the biggest heat loss is through the glazing even though the house has been double glazed. The heating cost drops to $1.15 an hour, a saving of over $3 per hour. If you can build to the better levels, the cost drops to only 88 cents an hour to heat the whole house!

If the house was able to be insulated to best levels, including installing minimum 5 star rated windows, and higher spec insulation, savings will be even greater. Best levels may require a deeper ceiling cavity and wider than normal wall framing to accommodate thicker insulation, an insulated floor slab (including around the perimeter of the slab). In a well-oriented, solar designed house, it is possible in the more temperate parts of New Zealand to achieve a good level of thermal comfort with no need for space heating at all.

More information

For further information, contact your nearest Eco Design Advisor– a source of free, independent advice on how to include sustainable features in your building or renovation project, or visit www.ecodesignadvisor.org.nz.
www.level.org.nz/

Attachment 2

Authorised ULEB details and NES performance range

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Ultra-Low Emission Wood Burners

Name	Date authorised	Cost (RRP)	Heat output	Require electricity?	Wetback?	NES PEF (g/kg)	NES SHE	CM1 PEF (g/kg)	CM1 SHE
RAIS Bionic Fire		$7,870	3.9 – 4.6kW	No	No	0.7	72%	0.5	76%
Jayline Walltherm	January 2015	$10,999	14.9kW	Yes	No	0.3	78%	0.47	67%
Xeeoos Twinfire X8	May 2015	$5,950	8kW	No	No	0.98	68%	0.45	69%
Tropicair Duo	December 2015	$5,490	15.1kW (peak); 13.6kW (max); 10.4kW (min)	No	No	0.1	79%	0.35	74%
Tropicair Duo Wet	March 2016	$5,990		No	Yes			0.48	73%
Bionic Fire Studio	March 2016			No	No	0.7	72%	0.5	76%
Masport Mystique	March 2016	$4,999	12.8kW (peak)	?	No	0.17	75.7%	0.3	78%
	2017	$3,000	12kW	?	?	TBA	TBA	TBA	TBA

PEF = Particulate Emission Factor
SHE = Space Heating Efficiency

NES compliant Low Emission Wood Burners (highest and lowest rated)

Name	Date authorised	Cost (RRP)	Heat output	Require electricity?	Wetback?	NES PEF (g/kg)	NES SHE
Pyroclassic IV		$3,389	15kW (max) 4kW average	No	No	0.3	74%
Pyroclassic IV Wetback		$3,814	15kW (max) 4kW average	No	Yes	0.3	65%
Bosca Limit 380		$1,645	17kW max 9.4kW average	No	No	0.9	76%
Warmington McKenzie		$4,577	18.5kW max	No	No	1.5	65%

PEF = Particulate Emission Factor
SHE = Space Heating Efficiency