NELSON CITY COUNCIL

Nelson Air Quality Plan

Proposed Plan Change A1

Section 32 Report

25 September 2010

Nelson City Council
te kaunihera ō whakatū

941089

1.0 Introduction

1.1 Purpose of report

Section 32 of the Resource Management Act (RMA) requires Council to consider alternatives and assess the benefits and costs of adopting any objective, policy, rule or method in a plan or policy statement prepared under the RMA. Before publicly notifying a proposed plan change, the Council is required to prepare a Section 32 report summarising these considerations.

The purpose of this report is to fulfil these Section 32 requirements for Proposed Plan Change A1 to the Nelson Air Quality Plan.

1.2 Steps followed in undertaking the Section 32 evaluations

The 6 broad steps which this section 32 evaluation follows are:

1. evaluating the extent to which any objective is the most appropriate way to achieve the purpose of the RMA
2. identifying alternative policies and methods of achieving the objective
3. assessing the effectiveness of alternative policies and methods
4. assessing the benefits and costs of the proposed and alternative policies, rules, or other methods
5. examining the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the policies, rules, or other methods
6. deciding which method or methods are the most appropriate given their likely effectiveness and their likely cost, relative to the benefit that they would be likely to deliver

1.3 Description of Proposed Changes

The Plan Change consists of six parts, as follows.

1.3.1 Plan Change A1.1 – Industrial combustion of wood pellet fuel

This change proposes inserting a new rule into the Air Quality Plan to deal with the use of wood pellet fuel in industrial-scale fuel burning appliances, and the insertion of a definition of wood pellet fuel. Wood pellets are about the size of a cigarette butt and are made from wood shavings and sawdust, compressed and held together by the wood's own resins. Wood pellets when burnt in appropriately designed boilers tend to produce significantly less particle matter (PM_{10}) than coal or other wood. This justifies a specific rule to deal with them.

1.3.2 Plan Change A1.2 – 'Urban Area' expansion – transition provisions

This change provides transitional or 'grandparenting' provisions for domestic open fires and enclosed burners in rural properties which, through change in land use, have or will become subject to the Air Quality Plan's 'Urban Area' controls. An open fire in a farmhouse in a rural area can be used as a permitted activity. If that property becomes part of the 'Urban Area' through rezoning or subdivision, use of the fire would be illegal (rule AQr.24 prohibits use beyond 1 Jan 2008). Nor could the open fire be replaced with a woodburner, leaving the person with limited heating options. Similar transitional issues apply to some woodburners depending on the 'airshed' the property is in. This plan change inserts a new rule to allow such fires to continue to be used (and replaced in the future with clean air approved burners if the owners wish). There are few such fires and this change is expected to have negligible effect on urban air quality.

1.3.3 Plan Change A1.3 – Update of Figure A2.1 'Extent of Nelson Urban Area'

'Urban Area' in the Air Quality Plan is the area where outdoor burning is not permitted and where use of open fires and burners is restricted. 'Urban Area' is defined both by a map (Figure A2.1) and by words (definition A2-86) to deal with new areas that become residential by changes to the Nelson Resource Management Plan and by resource consent (e.g. subdivision for residential use). This approach avoids the need to constantly change Figure A2.1 as the urban area expands. However, when other changes are being made to the Air Quality Plan, it is timely to update Figure A2.1, which is what Plan Change A1.3 does.

1.3.4 Plan Change A1.4 – Replacement of 'Jetmaster'-type domestic fireplaces

This plan change amends an error that prevents existing 'Jetmaster'-type fires within the Urban Area from being replaced with a complying woodburner. 'Jetmaster'-type fires are special inserts that fit into open fireplaces. They improve the efficiency of open fires, but under the Air Quality Plan they are still modified open fires. In response to submissions on the proposed plan the Council in 2005 agreed to give 'Jetmaster'-type fires a longer phase-out date than other open fires. This was because many were relatively new and because they had cleaner emissions than open fires. While the use of open fires has been banned since 1 January 2008, 'Jetmaster'-type fires are allowed to be used until 1 January 2013. When the rule was amended to permit longer use, the rule to allow their future replacement with a complying woodburner was not properly corrected. As the Plan currently reads, the right to replace a 'Jetmaster'-type fire disappeared on 1 January 2008, the same as it did for all other open fires.

1.3.5 Plan Change A1.5 – Outdoor burning of polyethylene agricultural wrap & plastic containers (rule AQr.55A)

This change proposes deleting rule AQr.55A which allows the burning of certain agricultural plastics. When the Air Quality Plan was drafted, AQr.55A.5 signalled that such burning was a temporary approach until recovery or recycling options became available for polyethylene agricultural wrap and polyethylene agrichemical containers. Two product stewardship programmes now operate in the region enabling the recycling of both bale wrap and agrichemical containers.

1.3.6 Plan Change A1.6 – Domestic Diesel burners – provision for different stack configurations

This change allows provision for other stack (flue) arrangements for domestic burners running on diesel. Under Appendix AQ4 of the Air Quality Plan domestic diesel burners are required to have an emission stack that discharges above roof level. Some newer models are designed with flues that end below the soffit of the building. Currently under the Plan their installation would require resource consent. This can discourage the uptake of these cleaner heating options.

2.0 Appropriateness in achieving the purpose of the RMA

2.1 Evaluation of the objective(s) – the environmental outcome to be achieved

Section 32 requires an evaluation of the extent to which the objective is the most appropriate way to achieve the purpose of the RMA.

No new objectives are being proposed, and none of the proposed changes amend the single operative objective of the Air Quality Plan. Objective A5-1 is *The maintenance, and the enhancement where it is degraded, of Nelson's air quality, and the avoidance, mitigation or remediation of any adverse effects on the environment of localised discharges into the air.*

No further assessment as regards the objective is considered necessary.

2.2 Whether the rules, or other methods are the most appropriate for achieving the objective in terms of their efficiency and effectiveness, benefits and costs, and in regards to the risk of acting or not acting

2.2.1 Introduction

The tables below provide an evaluation of the costs and benefits of each part of the proposed Plan Change and whether each is the most appropriate method for achieving the Plan's objective, having regard to their efficiency and effectiveness. The terms efficiency and effectiveness have not been defined in the legislation so the criteria set out in the introduction have been used to help focus the analysis.

Costs and benefits have largely been assessed subjectively and / or comparatively because of the great difficulty in assessing/quantifying intangible costs e.g. cultural costs. In some cases quantitative assessments of costs have been given.

The concept of risk has two dimensions, the probability of something adverse occurring and the consequence of it occurring. For example, if there is low risk associated with acting but high risk associated with not acting, then taking action is clearly the sensible thing to do. Risk is usually expressed as 'probability' multiplied by 'consequence' and associated with a cost – usually a severe economic, social or environmental cost. Assessing the risk of acting or not acting means assessing the probability of a cost occurring and the size of that potential cost.

2.2.2 Plan Change A1.1 – Industrial combustion of wood pellet fuel

The broad alternative options are:

1. Option 1 – Status Quo - do not proceed with the Plan Change – existing rule AQr.31 would continue to apply to use of wood pellet fuel.
2. Option 2 – Amend the Plan to make specific provision for wood pellet fuel.

These alternative options are assessed in Table 1.

The Council commissioned NIWA (National Institute of Water and Atmosphere) to collate and review available information on the industrial use of wood pellet fuel in New Zealand, and specifically on the emissions of particulate matter relative to combustion of coal or other wood. NIWA's report[1] (Appendix 1) concluded that there were clear and demonstrable air quality benefits to burning wood pellet fuel compared to coal or unprocessed by-product wood. For example, burning of wood-pellet fuel will discharge at least half of the particulate matter of a comparable coal boiler. Purpose-built (as opposed to retrofitted) pellet-fuelled boilers can produce up to two thirds less emissions[2]. NIWA concluded there was a case to support dealing with wood pellets as a specific fuel type (other than wood) within the Air Quality Plan – that is, Option 1.

Based on that, the Council asked NIWA to prepare an addendum[2] (Appendix 2) to their earlier report ALK202-037-R1 'Proposed Classification of Activities' to help with the development of a specific rule and to guide the establishment of thresholds for the proposed permitted, controlled and discretionary rule categories of pellet boilers. The proposed rule for burning wood pellets in Plan Change A1.1 is based on that addendum. But, as with the industrial combustion rules currently in the Air Quality Plan, adaptations have been made to take account of the existing high ambient PM_{10} levels in parts of Nelson[3]. In other words, for other than minor discharges, the Council needs to retain the ability to decline a consent application if necessary, to ensure pollution levels track down towards the air quality targets in the Plan and in the National Environmental Standard for air quality, and then remain under those levels.

Table 1 Plan Change A1.1 – Industrial combustion of wood pellet fuel

	Option 1 - Status Quo - do not proceed with the Plan Change	Option 2 – Specific rule for wood pellet fuel
Benefits	Economic Small financial saving from not having this Plan Change, and subsequent share of reporting, hearing etc costs.	Economic Currently any industrial-scale pellet boiler needs a discretionary resource consent. A less onerous consent procedure to install pellet-fuelled boilers will have economic benefits to applicants. Environmental Boilers retrofitted to run on pellets can have half the particulate emissions of a boiler of similar output run on coal or wood. A coal boiler also has much higher sulphur dioxide emissions, and greenhouse gas emissions. A purpose-built pellet boiler can have particle emissions that are two thirds lower than coal or wood (see NIWA reports in Appendices 1 & 2). The rule structure provides (via the consent process) an incentive to change from more polluting fuels to pellets, with air quality benefits.
Costs	Economic Higher consenting cost under status quo	Economic Small financial cost of undertaking this part of the Plan Change, and subsequent share of reporting, hearing etc costs.
Benefit and Costs Summary	The status quo option has no economic or environmental benefit.	There are positive economic and environmental benefits from pursuing this

[1] NIWA report CHC2009-170-R1 'Review of industrial use of wood pellet fuel in New Zealand and recommendations for Nelson City Council.'
[2] NIWA report CHC2010-061 'Proposed classification of Wood Pellet Fuelled Boilers'
[3] Dispersion modelling of industrial air discharges is very useful in predicting likely ground level concentrations around a discharge site. It works best if the existing receiving air is relatively unpolluted. Such models are not so useful when an airshed is already breaching ambient guidelines. In other words, such modelling deals just with the individual discharge – it does not deal well with cumulative effects, where new discharges are added on top of existing high ambient levels. In such cases, the modelling results need to be used to guide the setting of consent categories.

	Option 1 - Status Quo - do not proceed with the Plan Change	Option 2 – Specific rule for wood pellet fuel
		plan change, and the benefits outweigh the costs.
Effectiveness and Efficiency	The status quo option is an inefficient and ineffective way to meet the objective of the Air Quality Plan. Efficiency Requiring discretionary consent in all cases for pellets is inefficient economically and time wise. Effectiveness It is effective in controlling new discharges of particle matter, but ineffective in that it provides a barrier to cleaner technology and fuel.	The Plan Change option is an efficient and effective way to address the operative issues and achieve the objectives. Efficiency More efficient process. Small new discharges are a permitted activity (no consent needed if they comply with conditions stated). Where the discharge from an existing wood or coal fired boiler is being replaced with a discharge from pellets (similar or smaller thermal output), the consent is controlled (cannot be declined, but conditions can be imposed). It is less costly as it is non-notified, and no hearing is needed. But it is still effective in achieving the environmental outcomes sought. Therefore it is an efficient way of achieving the Air Quality Plan's objective. Effectiveness This option effectively achieves the relevant operative objectives and implements the policies of the Plan.
Risk of Acting or Not Acting if there is uncertainty or insufficient information	Not applicable (No uncertainty or insufficiency of information)	Not applicable
Conclusion		**This option is the most appropriate for achieving the objective of the Air Quality Plan.**

2.2.3 Plan Change A1.2 – 'Urban Area' expansion – transition provisions

The broad alternative options are:

Option 1 – Status Quo - do not proceed with the Plan Change.
Option 2 – Amend plan so that a resource consent can be obtained for affected fires.
Option 3 – Amend plan to provide transitional provisions without having to obtain consent.

These alternative options are assessed in Table 2.

Table 2 Plan Change A1.2 – 'Urban Area' expansion – transition provisions

	Option 1 - Status Quo - do not proceed with the Plan Change	**Option 2 – Amend Plan so that affected fires can be used / replaced by resource consent**	**Option 3 - Amend Plan so that affected fires can continue to be used and replaced without resource consent.**
Benefits	Economic Small financial saving on not having this Plan Change, and subsequent share of reporting, hearing etc costs. Environmental Air quality benefit from fewer fires and burners that are able to discharge pollutants, but the effect would be close to negligible given the low density of existing residences in rural areas that change to urban use.	Social Benefit Allows fires and burners to continue to be used.	Social Benefit Allows fires and burners to continue to be used. No time, cost or inconvenience as do not have to go through consent process.
Costs	Social Cost Affected households immediately lose the right to continue using their open fire, and enclosed burner (subject to the airshed they are in). They also lose the right to replace that fire or burner with a compliant woodburner. This imposes considerable social costs, including potential health costs if the homeowner does not have alternative heating or cannot afford the cost of installing and running the alternative. Economic Costs As above – from the cost of installing alternatives and potentially for running costs.	Economic Financial cost in gaining consent (on top of the fire replacement costs in the Status Quo). Social Time and inconvenience of going through consent process. Environmental Small air quality disadvantage from these fires and burners being able to continue in use and be replaced. But the effect would be close to negligible given the low density of existing residences in rural areas that change to urban use.	Economic No consent costs. Fires and burners not subject to mandatory phase-out requirements, therefore no imposed replacement costs. Environmental Small air quality disadvantage from these fires and burners being able to continue in use and be replaced. But the effect would be close to negligible given the low density of existing residences in rural areas that change to urban use.
Benefit and Costs Summary	The social and economic costs of the Status Quo option would far outweigh the small financial savings in plan processing time if this plan change did not occur.	A net social benefit is expected from this option, but with a higher economic cost than Option 1.	A net social benefit and economic benefit.

	Option 1 - Status Quo - do not proceed with the Plan Change	Option 2 – Amend Plan so that affected fires can be used / replaced by resource consent	Option 3 - Amend Plan so that affected fires can continue to be used and replaced without resource consent.
Effectiveness and Efficiency	The status quo option is an efficient and effective way to achieve the objective of the Air Quality Plan of enhancing degraded air quality and maintaining good air quality. (But it does so at a social and economic cost because it disenfranchises users of existing fires and burners, for a very small environmental gain.)	This is an effective option, but not efficient in requiring people to go through the resource consent process.	This is an effective option, and efficient in that it does not require people to go through the resource consent process.
Risk of Acting or Not Acting if there is uncertainty or insufficient information	Not applicable	Not applicable	Not applicable
Conclusion			**This option is the most appropriate for achieving the objective of the Air Quality Plan.**

2.2.4 Plan Change A1.3 – Update of Figure A2.1 'Extent of Nelson Urban Area'

This is a simple procedural matter to update Figure A2.1 'Urban Area' so that is covers all new urban areas in accordance with Definition A2-86. No further assessment is necessary or appropriate.

2.2.5 Plan Change A1.4 – Replacement of 'Jetmaster'-type domestic fireplaces

The broad alternative options are:

Option 1 – Status Quo - do not proceed with the Plan Change.
Option 2 – Amend plan so that a resource consent can be obtained for affected fires.
Option 3– Amend plan to provide transitional provisions without having to obtain consent.

The same issues and arguments apply in this case as apply to fires and burners affected by expansion of the 'Urban Area'. The assessment in Table 2 also is relevant to this plan change.

Option 3 is the most appropriate for achieving the Air Plan's objective.

2.2.6 Plan Change A1.5 – Removal of rule AQr.55A – Outdoor burning of polyethylene agricultural wrap & plastic containers

The broad alternative options are:

Option 1 – Status Quo - do not proceed with the Plan Change (stay with burning polyethylene agricultural plastic being a permitted activity).
Option 2 – Amend Plan so that burning polyethylene agricultural plastic is not a permitted activity and that a discretionary resource consent has to be obtained if burning is to occur.
Option 3 – Amend Plan so that burning polyethylene agricultural plastic is a prohibited activity – it cannot be done and no resource consent application can be lodged or granted to allow it.

These alternative options are assessed in Table 3.

Table 3 Plan Change A1.5 – Removal of rule AQr.55A – Outdoor burning of polyethylene agricultural wrap & plastic containers

	Option 1 - Status Quo - do not proceed with the Plan Change	Option 2 – Amend Plan – burning not permitted, can apply for resource consent to burn	Option 3 - Amend Plan so that burning is prohibited activity
Benefits	Economic (landowner) Simple and no cost option for landowner.	Environmental Less contaminant discharged to air (assuming resource consent requirement would encourage alternative disposal such as use of the recycling schemes that are available for farm plastic). Less greenhouse gases from less combustion. Economic Currently two recycling schemes are available in the Top of the South. This Plan Change would support those schemes. If schemes stop operating, there is the option for farmers to apply for a consent to burn (with conditions to control adverse effects).	Environmental Less contaminant discharged to air than option 1 and 2 since no burning is allowed. Less greenhouse gases from less combustion. Economic Currently two recycling schemes are available in the Top of the South. Plan Change would support those schemes.
Costs	Economic (community) Community bears costs of any contaminants released. Environmental Environmental and potential health impacts of combustion, particularly if not done correctly and at high temperatures. (Note – the current rule only allows polyethylene plastic to be burnt – not plastics containing chlorine or other chemicals that can release hazardous contaminants when	Economic There is no cost in taking product to Richmond Transfer Station. In the Agrecovery scheme the cost of collection is included in the product purchase price, so it is cost neutral to the user. Financial cost in gaining consent if other disposal options are not available. Environmental Air quality impact or impact on neighbours if burning occurs by resource consent. Risk of illegal land disposal. Greenhouse gas emissions	Economic There is no cost in taking product to Richmond Transfer Station. In the Agrecovery scheme the cost of collection is included in the product purchase price, so it is cost neutral to the user. Inability to apply for a resource consent to burn, since it would be a prohibited activity in the Plan. If burning (even by resource consent) were wanted, a Plan Change would be needed, and this is

	Option 1 - Status Quo - do not proceed with the Plan Change	Option 2 – Amend Plan – burning not permitted, can apply for resource consent to burn	Option 3 - Amend Plan so that burning is prohibited activity
	combusted.)	from transporting/collecting waste plastic for recycling.	costly and takes considerable time (discussed further under Effectiveness & Efficiency). <u>Environmental</u> Risk of illegal land disposal or illegal burning. Greenhouse gas emissions from transporting/collecting waste plastic for recycling.
Benefit and Costs Summary	This option has private benefits for the landholder, but costs tend to be borne by neighbours and the environment.	This option has higher economic costs for the landholder, but lower community and environmental costs than Option 1.	This option has higher economic costs for the landholder, but lower community and environmental costs than Option 1. The environmental benefits are higher than in Options 1 and 2.
Effectiveness and Efficiency	The status quo option is <u>not</u> an efficient and effective way to achieve the objective of the Air Quality Plan.	This is an effective option since recycling options exist as an alternative to burning. It is less efficient economically than burning on-site, but that 'efficiency' has an environmental cost.	This is an effective option since recycling options exist as an alternative to burning. It is less efficient economically than burning on-site (Option 1, and by resource consent under Option 2), but that 'efficiency' has an environmental cost. If the recycling or other disposal options for the agricultural waste were to disappear, in order to allow burning, a Plan Change process would need to be gone through. That is a very inefficient option, given that the environmental effects of burning polyethylene are not so great as to impose an absolute prohibition.
Risk of Acting or Not Acting if there is uncertainty or insufficient information	Not applicable	Not applicable	Not applicable
Conclusion	**Option 2 is the most appropriate for achieving the objective of the Air Quality Plan. Option 3 – a total prohibition - is considered too high a threshold for this activity. This is not to endorse burning of agricultural plastics. That ought to be strongly discouraged by the Plan, but the <u>option</u> to apply for a resource consent should be provided where necessary because the adverse effects do not warrant total prohibition.**		

2.2.7 Plan Change A1.6 - Domestic Diesel burners – provision for different stack configurations

The broad alternative options are:

Option 1 – Status Quo - do not proceed with the Plan Change (stacks/flues that do not go above roof level would continue to need resource consent).
Option 2 – Amend plan so that stack configurations that meet the manufacturer's specifications are permitted.

These alternative options are assessed in Table 4.

Table 4 Plan Change A1.6 – Domestic Diesel burners – provision for different stack configurations

	Option 1 - Status Quo - do not proceed with the Plan Change	**Option 2 – Amend Plan – to make stack configurations that meet the manufacturer's specifications permitted**
Benefits	Economic Small financial saving from not having this Plan Change, and subsequent share of reporting, hearing etc costs.	Economic Currently any side venting diesel heater needs a discretionary resource consent. A less onerous consent procedure will have economic benefits to applicants. Environmental Diesel produces less particle emissions than a woodburner. This option removes a barrier to domestic heating choice. This will have a benefit in terms of reducing particle pollution. No adverse localised environmental effects are expected from flues which are installed in compliance with the manufacturer's specifications.
Costs	Economic High consenting cost under status quo, relative to the cost of the unit being installed (possibly 20-25%). Environmental Diesel produces less particle emissions than a woodburner. A homeowner frustrated by the need and cost of getting a resource consent to install a diesel burner with a different flue configuration, could instead opt for a woodburner, which would have an environmental cost in terms of particles (but less greenhouse gas emissions).	Economic Small financial cost of undertaking this part of the Plan Change, and subsequent share of reporting, hearing etc costs.
Benefit and Costs Summary	The status quo option has net environmental costs.	There are positive economic and environmental benefits from pursuing this plan change, and the benefits outweigh the costs.
Effectiveness and Efficiency	The status quo option is an inefficient and ineffective way to meet the objective of the Air Quality Plan. Efficiency Requiring discretionary consent in all cases for diesel burners with side venting flues is inefficient economically and time wise. Effectiveness Ineffective in that it provides a barrier to cleaner technology and fuel.	The Plan Change option is an efficient and effective way to address the operative issues and achieve the objective. Efficiency More efficient process. Therefore it is an efficient way of achieving the issues and objective. Effectiveness This option effectively achieves the relevant operative objective and implements the policies of the Plan.

	Option 1 - Status Quo - do not proceed with the Plan Change	**Option 2 – Amend Plan – to make stack configurations that meet the manufacturer's specifications permitted**
Risk of Acting or Not Acting if there is uncertainty or insufficient information	Not applicable	Not applicable
Conclusion		**This option is the most appropriate for achieving the objective of the Air Quality Plan.**

Appendix 1

Review of the industrial use of wood pellet fuel in New Zealand and recommendations to Nelson City Council.

NIWA Client Report: CHC2009-170-R1,
April 2010

(RAD 919019)

Review of the industrial use of wood pellet fuel in New Zealand and recommendations for Nelson City Council

NIWA Client Report: CHC2009-170-R1
April 2010

NIWA Project: NCC09502

Review of the industrial use of wood pellet fuel in New Zealand and recommendations for Nelson City Council

Jeff Bluett

Prepared for

Nelson City Council

NIWA Client Report: CHC2009-170-R1
April 2010
NIWA Project: NCC09502

National Institute of Water & Atmospheric Research Ltd
10 Kyle Street, Riccarton, Christchurch 8011
P O Box 8602, Christchurch 8440, New Zealand
Phone +64-3-348 8987, Fax +64-3-348 5548
www.niwa.co.nz

Contents

Reviewed by:

Guy Coulson

Approved for release by:

Charles Pearson

Executive Summary

The primary objective of this report is to collate and review the information that is available on the industrial use of wood pellet fuel in New Zealand with a focus on the emissions of particulate matter. The scale of this review was matched to the resources available to conduct the review. While every effort has been made to provide a comprehensive review, it is unlikely that all available NZ information has been included. It is acknowledged that the review would benefit from considering additional information as it becomes available. However, the review as it stands should, at least, provide a representative snapshot of the current industrial wood pellet fuel use in New Zealand.

Six mills are operating within New Zealand to produce a total of approximately 100,000 tonnes of wood pellet fuel per annum. New plants are planned that will approximately double the total production. Appropriate quality assurance processes should ensure that wood pellets provide a consistent and good quality high Gross Caloric Value (GCV) and low moisture content fuel when compared to un-dried sawmill wood by-products and fuel merchant firewood. The industrial use of wood pellet fuel is growing and currently there are at least 27 Schools and four industries burning pellet wood fuel. Some estimates put the total number of schools converted to pellet fuel at 39, with another 67 conversions being progressed (*Pers. Comm*. Steven Pearce, Solid Energy, 09/03/10)

A very limited number of New Zealand industrial emission test results have been considered in this review. The three tests considered suggest that concentrations of particulate discharged from boilers burning wood pellet fuel are on average around 100 mg/m^3. Two overseas emission test results considered in this review qualitatively support the possibility that particulate emissions with a concentration of less than 100 mg/m^3 may realistically be achieved by boilers burning wood pellet fuel.

Canterbury Natural Resources Regional Plan (Chapter 3 - Air Quality), contains rules which deal specifically with large scale wood pellet fired boilers. The activity classification defined in these rules are based on the maximum allowable emissions from new wood pellet boilers being 80 milligrams per cubic metre (approximately 0.8 g/kg) and from boilers retro fitted to burn wood pellets being 125 milligrams per cubic metre (approximately 1.4 g/kg).

Environment Canterbury (ECan) and Auckland Regional Council (ARC) have a number of consents to discharge contaminants from wood pellet fuelled boilers. The conditions attached to the pellet fuel consents include ensuring the pellets consist of only untreated wood and meet quality control criteria such as moisture and energy content. On a number of consents, conditions are included that define the maximum allowable concentration of particulate within the flue gas as between 100 to 125 mg/m^3. The information supplied for and accepted by ECan and ARC for the consent applications suggest that using pellet fuel could result in a reduction in particulate concentrations of approximately one third compared to an equivalent unit burning coal. Beyond the potential reduction in particulate emissions there are other potential environmental benefits with switching from coal to wood pellets such as significant reductions in SO_2 emissions.

Despite the limited amount of information and data considered for this review, there appear to be clear and demonstrable air quality benefits to burning wood pellet fuel compared to coal or unprocessed by-product wood. Using the data considered in this review, it is concluded that the burning of wood pellet fuel will discharge at least half of the particulate matter of a comparable coal boiler. With the review of a more comprehensive database of emission test results this estimate of particulate reductions could be refined and possibly show an even greater difference in emissions between the two fuel types.

Based on the available data and subsequent findings it is concluded that there is a case to support Nelson City Council (NCC) considering treating wood pellets as a specific fuel type (other than wood) within NCC's Air Quality Plan (AQP). It is therefore recommended that an addendum to NCC's report, External and Stationary Internal Combustion Rules (NIWA, ALK2002-037-R1, August 2004) be prepared regarding a new rule which would govern the industrial use of wood pellet fuel.

1. Introduction

1.1. Background

Nelson City Council's (NCC) Air Quality Plan (AQP) became operative on 3 November 2008. The process by which the AQP became operative included settling a number of Environment Court appeals. As part of the settlement of Solid Energy Ltd's appeal on NCC's AQP, the Council agreed to revisit how the combustion of wood pellets in industrial scale combustion appliances was categorised within the AQP, relative to other fuels such as diesel, oil, coal and other wood.

Currently within NCC's AQP wood pellet fuel falls under the definition of wood fuel and as such its use is governed by Rule AQr.31. AQr.31.3 defines the discharge of contaminants into air from the combustion of wood or coal in a large scale fuel burning appliance (provided no prohibited fuels are used) as:

(a) a restricted discretionary activity (non-notified) if the combined heat output from all the appliances on the site burning wood or coal is less than 200 kW, or

(b) a discretionary activity if the combined heat output from all the appliances on the site burning wood or coal exceeds 200 kW.

1.2. Objective

The objectives of this report are to:

(a) Collate and review of the information that is available on the industrial use of wood pellet fuel in New Zealand with a focus on the emissions of particulate matter.

(b) Consider how combustion of wood pellets within industrial scale plants was categorised in the Air Plan, relative to other fuels like diesel, oil, coal and other wood.

(c) Draw a conclusion as to whether or not there is a case to treat wood pellets as a specific fuel type (other than wood) within NCC's AQP.

If this report's recommendation is that NCC's AQP treat wood pellets as:

- Wood (i.e status quo), then the process to implement this potential change to the AQP will not be progressed.

- A specific fuel type, then NCC's report External and Stationary Internal Combustion Rules (NIWA, ALK2002-037-R1, August 2004) will be revised to include a recommendation for a new rule which would govern the industrial use of wood pellet fuel.

2. Wood pellet fuel

2.1. Manufacture process

Wood pellets are made from dry, natural wood which is a by-product of the wood processing industry. This wood by-product is compressed into small cylinders. The pellets are 6mm in diameter and typically range in length between 1-2 cm (Scion, 2009). The pellets are produced using by-product wood material, typically untreated Pinus radiata sawdust and/or shavings. The first step in the manufacture process is to collect the by-product wood material and dry it so it contains around 13% moisture by weight. Next the dried by-product wood is ground into a powder and then compressed under very high pressure and extruded into pellet form. The natural lignin contained in the wood is the agent that binds the by-product wood together into the pellet form (Eng, Bywater and Hendtlass, 2008). The grinding, compression and extrusion processes result in the end product pellet having a moisture content of less than 10% by weight.

Currently there are eight wood pellet mills operating in New Zealand. Solid Energy is a significant player in the NZ market. Solid Energy's subsidiary, Nature's Flame has mills operating in Rolleston (near Christchurch) and Rotorua with respective outputs of approximately 15,000 and 30,000 tonnes per annum. Solid Energy has built a new plant near Taupo which opened in March 2010. Currently this plant produces approximately 40,000 tonnes per annum, but capable of manufacturing up to 150,000 tonnes of pellets per year. Other companies involved in this industry include Wood Pellet Fuels Limited (Huntly), Southern Wood Pellets (Invercargill), The Green Lucifer Company (West Auckland) and Insert Firelongs Limited (Hastings). Recently Waste and Energy Solutions established a pellet-making plant in Brightwater near Nelson.

2.2. Fuel specifications

Most wood fuel pellets manufactured in New Zealand meet the specifications defined by the Australia and New Zealand Standard AS/NZS 4014.6. 2007 – Domestic solid fuel burning appliances-Test fuels Part 6: Wood pellets. The specifications defined by AS/NZS 4014.6:2007 are summarised in Table 2:1.

Appendix AQA2 of NCC's AQP defines the standards that wood pellets burned in small scale burning appliances in Nelson must meet. This appendix was written in 2005, when AS/NZS 4014.6 was still in draft form. There are two small differences between the standards set in Appendix AQA2 and AS/NZS 4014.6:2007. The Gross Calorific Value (GCV) standard specified in Appendix AQA2 varies slightly from that defined in AS/NZS 4014.6:2007 with the upper limit being set at 20 rather than 21 MJ/kg. Appendix AQA2 sets no limit on fines content. NCC are considering a change to the plan to bring AQA2 in to line with AS/NZS 4014.6:2007 and to expand the scope of the appendix to include pellets burned in industrial boilers.

Table 2:1: Wood Pellet fuel specifications of AS/NZS 4014.6.2007

Variable	Value
Moisture	4-8 % by weight
Bulk density	Minimum 640 kg/m^3
Ash content	Maximum 0.5% by weight (oven dry basis)
Gross calorific value	18 to 21 MJ/kg
Diameter	Maximum 10 mm
Length	Maximum 38 mm
Fines content	Maximum 1 % by weight

The Bio-energy Association of New Zealand (BANZ) has produced a Wood Fuel Classification Guide (BANZ, 2009) which aims to provide a common methodology for classifying, specifying and declaring the quality and properties of traded wood fuel (including pellets) in New Zealand. The BANZ guide specifies parameters for four categories of wood pellets:

- A1 - Premium pellets– based on AS/NZS 4014.62007 (see Table 2:1 above).
- A2 - Premium pellets – aligns with the European wood pellet standard CEN/TS 14962:2005,
- B - Large premium pellets
- C - Industrial grade pellets

Category A1 or A2 are the highest grade pellets and can be used in any residential heater or commercial boiler. They are manufactured from virgin wood fibre, untreated and free from contamination. Category B pellets also represent high quality pellets differing only in physical qualities (e.g. diameter) from Category A pellets. Category B pellets are designed to be used in selected boilers. Category C pellets are designed to be used in boilers subject to resource consents. Category C pellets may contain additives, either added or already within the pellet production material, and these must be stated on the specification list. Category C pellets do not offer the advantages associated with Category A and B pellets or low ash and low emission levels.

Wood pellet fuels manufactured in Austria, Germany, Sweden and the rest of Europe are required to meet the specifications defined by the respective standards, O-NORM M 7135, DIN 51731, SS 18 71 20 and CENT/TS 14961. Within the New Zealand wood pellet manufacturing sector there appears to be some concerns associated with CENT/TS 14961 (*pers. com*. Steve Pearce, Solid Energy 09/03/10). These concerns relate to the standard being voluntary, non-specific and does not have the support of all European boiler manufacturers. A new European Union standard has been developed and is under trial in Germany before rollout. The specifications set by AS/NZS 4014.6 compare well with the current equivalent European standards which typically set moisture content at 10-12% and the minimum gross calorific value 15-18 MJ/kg.

Solid Energy Renewable Fuels have independent analyses of batches of wood pellet fuels undertaken each fortnight. The results of one of these the analyses (CRL, 2006) showed that that particular batch of pellets contained:

- 6 % moisture by weight - as measured under AS/NZS 4014.2
- 0.4 % ash by weight – as measured under ASTM D1 102
- 19.1 KJ/kg gross calorific value – as measured under ISO 1928

Typically un-dried sawmill wood by-products and fuel merchant firewood have a moisture content of around 40% and a gross calorific value of 12 MJ/kg (Eng, Bywater and Hendtlass, 2008).

A survey of the quality of wood pellet fuel available in New Zealand has not been undertaken for this report. However, there is anecdotal evidence that some of the wood pellet fuel being sold may not be particularly good quality. (*Pers. Comm*. Steven Pearce, Solid Energy, 09/03/10) In an attempt to address this issue stakeholders in the NZ wood pellet fuel industry have developed or are developing quality assurance processes and targets that, if complied with, should ensure wood pellet fuel is of consistently good quality. Quality assured wood pellet fuel would have high GCV and low moisture content when compared to un-dried sawmill wood by-products and fuel merchant firewood.

3. Industrial use of wood pellet fuel in New Zealand

The purpose of this section is to provide a brief review of the number and scale of industrial wood pellet fuel consumers in New Zealand. The scale of this review was matched to the resources available to conduct this review. While every effort has been made to provide a comprehensive review, the information below may not include every school or industry that is currently using wood pellet fuel. However, the following information should, at least, provide a representative snapshot of the current industrial wood pellet fuel use in New Zealand.

3.1. Schools

The Energy Efficiency and Conservation Authority (EECA) run a Renewable Heating for Schools program which provides capital grants (of 40% of the capital cost of the project, with a minimum of $10,000 and maximum of $200,000) to assist with conversions of coal boilers to wood pellet fuel. Over the last 5 years or so a number of schools have replaced or converted their coal boilers to run on wood pellet fuel. Table 3.1 shows the 27 schools which have converted their coal boilers to wood pellet fuel with assistance from the Renewable Heating for Schools programme. Some estimates put the total number of schools converted to pellet fuel at 39, with another 67 conversions being progressed (*pers. com*. Steve Pearce, Solid Energy 09/03/10). In addition to the schools listed in Table 3.1 there are a small number of other schools which have made the conversion to wood pellet fuel without the assistance from the Renewable Heating for Schools programme. (Pers. Com. Kirk Archibald, EECA, 07/09/2009).

3.2. Other industry

EECA run a Wood Energy for Business (WEB) program which provides grants of 40% of the capital cost of the project, with a minimum of $10,000 and maximum of $200,000. Table 3.2 shows the three industries which have converted their coal boilers to wood pellet fuel with assistance from the Wood Energy for Business programme. In addition to those businesses noted in Table 3.2 there are at least five others which have converted to wood pellet fuels, (Rangipo Prison, Mt Algidus Logde, Otago University, Agresearch and Hohepa Trust) and another 23 conversions in progress (*pers. com*. Steve Pearce, Solid Energy 09/03/10).

Radford Yarns (Christchurch) are also operating a wood pellet boiler but installed this without EECA assistance.

Table 3:1: Schools operating wood pellet fuels boilers

School	Boiler Size (kW)
Cashmere High School	1460
Mairehau High School	1220
Taieri College	1460
Balmacewen Intermediate	530
Menzies College Trust	800
Te Puke Intermediate	700
Edgecumbe College	645
Otumoetai Intermediate	400
Galatea Primary	175
Otago Boys High	1640
Logan Park High School	1460
Katikati Primary School	150
Glenmoor School	150
Aorangi School	150
Tokoroa High School	200
Papanui High School	1025
Firth School	300
Matamata Intermediate	TBC
Te Aroha Primary School	200
Ellesmere College	430
Avonside Girls High School	1000
Timaru Boys High School	1295
Matamata College	1400
Shirley Intermediate School	TBC
Kaiapoi High School	1000
Macleans College	533
Paekakariki School	200

Table 3:2: Industries operating wood pellet fuelled boilers

Industry	Boiler capacity (kW)	Process
Titoki Healing Centre – Bay of Plenty	50	Commercial building heating
AgResearch - Mosgiel	1280	Office heating
Wigram Lodge - Christchurch	800	Heating and hot water for accommodation

4. Particulate matter emissions from industrial boilers burning wood pellet fuel

The purpose of this section is to provide a summary of the particulate emission test data that has been collected from industrial scale boilers burning wood pellet fuel in New Zealand and overseas. As mentioned earlier, the scale of this review was matched to the resources available to undertake the review. While every effort has been made to provide a comprehensive review, the information below is unlikely to include every school or industry that has pellet fuel emission testing undertaken. The readily available emission test data is limited to three NZ and two overseas test results. However, the following information should, at least, provide a representative snapshot of the particulate emissions from boilers using wood pellet fuel in New Zealand.

4.1. New Zealand test data

Table 4.1 details the three particulate emission tests that have been reviewed for this report. Given the number of wood pellet fuel boilers currently operating in NZ (see Section 3) there are likely to have been additional emission tests undertaken but those results (if they exist) have proved not to be readily available for use in this review. It is acknowledged that this review could be improved with the incorporation of additional emission test results.

Table 4:1: Wood pellet boiler emission tests.

Site	Test Date	Testing Company	Test Report Reference
Rotorua Girls' High School	19 September 2006	CRL Energy Ltd.	Ermens 2006
Cashmere High School*	13 August 2008	K2 Environmental Ltd.	Keer-Keer 2008
Central New Brighton School	28 September 2006	K2 Environmental Ltd.	Keer-Keer 2006

*City Firewood, John Harris and Roger Best are acknowledged for funding the Cashmere High School tests.

Table 4.2 presents a summary of the particulate emission test results obtained from the three schools.

In summary, the pellet fuel emission test data from the three boilers considered in this review indicates that the average concentrations of particulate matter range from 42 to 120 mg/dsm^3. It should be noted that these emission results were obtained from underfed stoker boilers that have been converted from operating on coal. These boilers were not specifically designed to burn wood pellet fuel and therefore may have emissions that are higher than those that could be expected from boilers specifically designed for wood pellet fuel.

Table 4:2: Summary of the particulate emission test results.

Site	Boiler output (KW)	Test 1 TSP *(mg/dsm³)	Test 2 TSP *(mg/dsm³)	Test 3 TSP *(mg/dsm³)	Average (mg/dsm³)
Rotorua Girls' High School	1000	101	98	NA	100
Cashmere High School	750	129	46	38	Tests 1-3, 71 #Test 2-3, 42
Central New Brighton School	300	200	73	82	Tests 1-3, 120 #Test 2-3, 78

*mg/dsm³: milligrams of particulate per cubic metre of air adjusted to 101.3 kPa, 0 degrees Celsius, 12% CO_2.

#The two test average (Test numbers 2 and 3) is provided for Cashmere High and Central New Brighton Schools as a comparison against the three test average. This is done on the recommendation of K2 Environmental who noted that Test 1 at both schools included start up emissions which are not characteristic of normal operation.

The variation within the particulate emissions samples taken from Cashmere High and Central New Brighton Schools is relatively large, with the highest test sample being well over twice that of the other two samples. Test 1 at Cashmere was taken during boiler start up. While the operating conditions of the Central New Brighton are not noted in the report, a discussion with K2 Environmental staff suggests that it is likely that sample 1 from Central New Brighton School included start up emissions.

The testing at Central New Brighton School included emissions samples taken while the boiler was also being fired with coal. Table 4.3 compares the emission test results taken from the Central New Brighton School boiler when it was burning wood pellets and coal.

Table 4:3: Comparison of particulate emissions from the Central New Brighton School boiler while burning wood pellet fuel and coal

Fuel	Test 1 TSP (mg/dsm³)	Test 2 TSP (mg/dsm³)	Test 3 TSP (mg/dsm³)	Average (mg/dsm³)
Wood Pellets	200	73	82	120
Coal	360	290	180	280

The data displayed in Table 4.3 show that the concentration of particulate matter discharged from the Central New Brighton School boiler while burning wood pellet fuel is, on average, less than half of that when the boiler is burning coal. It may be helpful to note that the pellet fuel results were obtained from tests carried out on older coal burning technology, which is likely to be less efficient than boilers specifically designed for wood pellet fuel.

4.2. Overseas test data

A frequently used reference on sources of air pollution emission data is the United States Environmental Protection Authority's Compilation of Air Pollution Emission Factors AP-42 (http://www.epa.gov/ttn/chief/ap42/index.html). A review of AP-42's Section 1.6, Wood Residue Combustion in Boilers, reveals the document details particulate emissions from boilers burning bark, dry wood and wet wood. Emissions from the burning of wood pellet fuel are not provided by this source of information.

Two reports have been obtained on emission testing undertaken on wood pellet fuelled boilers outside of New Zealand. The source and authenticity of these reports has not been verified, however, on face value the reports appear to be genuine. These reports have been evaluated as suitable for the purpose of providing a qualitative comparison to the emission test results obtained in New Zealand.

A small (149 kW) boiler burning wood pellet fuel located in Grabenwarth, Austria, was tested by the Testing Institution for Air Pollution Prevention (TIAPP) (www.nua.at) in early February 2005. The TIAPP claim to be an accredited laboratory by the Federal Ministry of Economics and Labour (accreditation number GZ92714/404-IX/2/98). A series of three tests were carried out using the method detailed in ONORM M 5861, determination of the dust contents of a flowing gas: gravimetric procedure. The results of these tests show that the particulate concentrations in the flue gas ranged between two and five mg/m^3.

A small (200 kW) boiler burning wood pellet fuel located in Massing, Germany, was tested by the TUV SUD Industrie Service (www.tuev-sued.de) between July and September 2007. A series of three tests were carried out using the method detailed in DIN EN 303-5:199-06 for which the laboratory claims to be accredited. The results of the tests are presented in TUD SUD Industrie Service report no H-C# 1232-00/07. The results of these tests show that the particulate concentrations in the flue gas averaged 36 mg/m^3.

4.3. A comparison of particulate emissions from different fuel types

The physical state (solid, liquid or gas) and chemical composition of a fuel are two important factors which determine the amount of particulate discharged when that fuel is burned. Table 4.4 compares the relative PM_{10} emissions from a typical 0.5MW boiler burning different fuels. The relative emission rates are presented using diesel as the reference fuel.

The information in table Table 4.4 suggests that the PM_{10} emissions from a boiler burning wood pellet fuel are approximately:

- 10 times greater than that from burning diesel.
- Similar those generated from burning heavy fuel oil.
- One-third of those generated from burning coal or by-product wood.

Table 4:4: Relative emission rates of PM_{10} from 0.5 MW boiler.

Fuel type	Source of emission factor	Relative PM_{10} emission rates*
Natural Gas/LPG	USEPA-42	0.5
Kerosene	USEPA-42	<1
Diesel	**USEPA-42**	**1**
Light fuel oil (LFO)	USEPA-42	5
Heavy fuel oil (HFO)	USEPA-42	7
Wood pellet fuel	NZ emission test data (1 g/kg)**	10
Coal (sub-bituminous)	USEPA-42	30-50
Waste Wood	USEPA-42	30-50

*Calculated using the method and assumptions detailed in Bluett, 2004.

**Emission results from underfed stoker boilers that have been converted from operating on coal

The information on particulate emissions from burning coal and waste wood presented in Table 4.4 is based on generic USEPA AP-42 emission factors. Measurements of particulate emissions have been undertaken for the boilers operated by South Pine and Waimea Sawmills in Nelson. The South Pine boilers burn a combination of coal, wood shavings and sawdust. The Waimea Sawmills boilers burn a combination of wood shavings and sawdust. The South Pine (Pilgrim, 2008a) and Waimea (Pilgrim, 2008b) emission data was recently presented at the NCC hearings which considered their applications for resource consent to discharge contaminants to air. Table 4.5 compares the relative PM_{10} emissions from a typical 0.5MW boiler burning wood pellets, sawdust, shavings and coal. The emissions from sawdust, shavings and coal were calculated using data measured at the Waimea and South Pine Sawmill plants. The relative emission rates are presented using wood pellets as the reference fuel.

The information in table Table 4:5 suggests that the PM_{10} emissions from a boiler burning wood pellet fuel are approximately:

- One-half of those generated burning wood shavings.
- Between one-half and one-third of those generated burning semi-dried sawdust.
- One-half of those generated burning coal.

Table 4:5: Relative emission rates of PM_{10} from 0.5 MW boiler.

Fuel type	Source of emission factor	Approximate Relative PM_{10} emission rates*
Wood pellet fuel	**NZ emission test data**	**1**
Wood shavings	South Pine hearing evidence	2
Semi-dried sawdust	Waimea and South Pine hearing evidence	2-3
Coal (sub-bituminous)	South Pine hearing evidence	2

*Calculated using the method and assumptions detailed in Bluett, 2004.

4.4. Summary

A well tuned and well operated coal fired boiler fitted with grit arrestors should be capable of achieving particulate emission concentrations of 250 mg/m^3. Coal fired boilers fitted with emission control technology such as electrostatic precipitators, cloth bag or ceramic filters can be expected to achieve particulate emission concentrations lower than 100 and 50 mg/m^3 respectively. It is important to note that emission control technology such as electrostatic precipitators and bag filters have high capital and operating costs.

A very limited number of New Zealand emission test results have been considered in this review. The three tests considered suggest that concentrations of particulate discharged from boilers burning wood pellet fuel are on average around 100 mg/m^3. Individual test results (rather than a three test average) for two of the three boilers suggest that when the boilers are operated at a steady load within the normal output range of the units, concentrations of particulate of less than 100 mg/m^3 may be achieved.

The two overseas emission test results considered in this review qualitatively support the possibility that particulate emissions with a concentration of less than 100 mg/m^3 may realistically be achieved by boilers burning wood pellet fuel.

A comparison of particulate matter discharged from the Central New Brighton School boiler suggests that PM emissions while burning wood pellet fuel is, on average, less than half of that when the boiler is burning coal.

Two additional comparisons of particulate emissions from boilers burning wood pellet fuel, coal and other forms of by-product wood fuel have been undertaken. The first comparison (Table 4:4) used USEPA AP-42 emission factors and the second comparison (Table 4:5) used emission data measured at the Waimea and South Pine Sawmill plants. Both comparisons indicate that the burning of wood pellet fuel results in a significant reduction (50-70%) in PM_{10} emissions compared to coal and other forms of by-product wood fuel such as shavings and sawdust.

5. Air plan classification of wood pellet fired boilers

This section provides a brief overview of the Canterbury Natural Resources Regional Plan, Air Quality Rules (Chapter 3), which deal with large scale wood pellet fired boilers. These rules became operative after being approved at a meeting of the Canterbury Regional Council on 24 September 2009. Air Quality Rule 18 deals with the discharges of contaminants to air from large scale fuel burning devices with a heat output of less than 1 MW. AQL18B, 18C and 18D specifically deal with large scale wood pellet fired boilers and are listed below:

- **Rule AQL18B:** Replacement of existing large scale fuel burning devices burning solid fuel with a combined heat output of greater than 40kW and less than or equal to 500 kW with large scale wood pellet burning devices burning wood pellet fuel with a combined heat output of greater than 40kW and less than or equal to 500 kW in the Christchurch Clean Air Zones 1 and 2 is a controlled activity.
- **Rule AQL18C:** Replacement of existing large scale fuel burning devices burning solid fuel with a combined heat output of greater than 500kW and less than or equal to 1MW with large scale wood pellet burning devices burning wood pellet fuel with a combined heat output of greater than 500kW and less than or equal to 1MW in the Christchurch Clean Air Zones 1 and 2 is a restricted discretionary activity.
- **Rule AQL18D:** New large scale wood pellet burning devices with a combined heat output of less than or equal to 500kW, or large scale wood pellet burning devices with a combined heat output of less than or equal to 500kW replacing existing large scale fuel burning devices not burning solid fuel, in the Christchurch Clean Air Zones 1 and 2 is a restricted discretionary activity.

These three air plan rules resulted from an Environment Court mediation process between Solid Energy Ltd. and ECan. They are based upon a technical agreement reached between the two parties on the maximum allowable emissions from large scale wood pellet burning appliances to meet the defined activity classification.

For existing boilers retrofitted to burn wood pellets to meet the activity classification defined in AQL18B and AQL18C, ECan and Solid Energy accepted that the concentration of total suspended particulate in combustion gas discharged should not exceed 125 milligrams per cubic metre. (*pers com.* Steve Pearce - Solid Energy and Tim Mallet - ECan, email 23/04/10). This equates to an emission factor of approximately 1.4 g TSP per kg of wood pellet fuel burned.

For new wood pellet boilers to meet the activity classification defined in AQL18D, ECan and Solid Energy accepted that the concentration of total suspended particulate in combustion gas discharged should not exceed 80 milligrams per cubic metre. (*pers com.* Steve Pearce - Solid Energy and Tim Mallet - ECan, email 23/04/10). This equates to an emission factor of approximately 0.8 g TSP per kg of wood pellet fuel burned.

6. Council consents to operate wood pellet fired boilers

This section provides a brief overview of resource consents which other Councils have granted to operate wood pellet fired boilers. While an effort has been made to provide a reasonably comprehensive review, it transpires that readily available council reports are limited to four, three from Environment Canterbury and one from Auckland Regional Council. Given the number of wood pellet fuel boilers currently operating in New Zealand there are likely to be additional Council consents that have not been considered as part of this review. It is acknowledged that this review would benefit from considering a greater number of Council consents. However, given that the issues associated with the operation of wood pellet fired boilers are quite generic between Councils, it is anticipated that the consents that have been reviewed will provide a representative overview.

6.1. Environment Canterbury

Radford Yarn Technologies Limited operate a 150 kW wood pellet fired boiler which burns a maximum of 32 kg of fuel per hour. Radford Yarn Technologies Ltd was granted a resource consent to discharge contaminants to air for this activity by Environment Canterbury in September 2006. The consent was granted via the non-notified pathway for a duration of 35 years (consent number CRC064377).

Radford Yarn Technologies' Assessment of Environmental Effects (AEE) was prepared by Kingett Mitchell. The key points from the AEE can be summarised as follows. The emissions from the Radford Yarn Technologies boiler were estimated using the data from the emission test certificate for the unit which was supplied by the German manufacturer of the unit (HDG Bavaria). The data from the emission test certificate showed that the concentration of particulate discharged from this type of burner was 50 mg/m^3. The applicant calculated an emission rate of 0.6 grams of particulate discharged from every kilogram of fuel burned. The applicant noted that the particulate emissions from the pellet fuel were similar to those of a diesel burner of the same heat output rating. The maximum predicted 24-hour concentration of PM_{10} was modelled to be less than 0.2 $\mu g/m^3$. The applicant concluded that any adverse environmental effects caused by the discharge of contaminants from this activity would be less than minor. The audit of the AEE, undertaken by Environment Canterbury staff, agreed with the key points and conclusion of the AEE.

Central New Brighton School operate a 300 kW wood pellet fired boiler which burns a maximum of 72 kg of fuel per hour and a total of 288 kg/day. Central New Brighton School was granted a resource consent to discharge contaminants to air for this activity by Environment Canterbury in March 2007. The consent was granted via the non-notified pathway for a duration of 35 years (consent number CRC071606).

Rangiora High School operate two 640 kW wood pellet fired boilers which burn a maximum of 307 kg of fuel per hour and a total of 2150 kg/day. Rangiora High School was granted a resource consent to discharge contaminants to air for this activity by Environment Canterbury in October 2008. The consent was granted via the non-notified pathway for a duration of 35 years (consent number CRC090979).

Both the Central New Brighton and Rangiora High School AEEs were prepared by Specialist Environmental Services. The key points from the AEEs of these two applications can be summarised as follows. The emissions from both the Central New Brighton School and Rangiora High School boilers were estimated using the emission test data from Central New Brighton School (See Section 4.1). The applicant calculated an emission rate of 1.08 grams of particulate discharged from every kilogram of fuel burned. The applicant compared particulate emissions from pellet fuel and coal and estimated that using pellet fuel would result in a reduction in particulate emissions of approximately 66% over coal. The maximum predicted 24-hour concentration of PM_{10} was modelled to be around 2 $\mu g/m^3$. The applicant also noted that the fuel switch would provide a reduction in emissions of SO_2 by a factor of approximately 1000. The applicant concluded that any adverse environmental effects caused by the discharge of contaminants from this activity would be less than minor. The audit of the AEE, undertaken by Environment Canterbury staff, agreed with the key points and conclusion of the AEE.

Environment Canterbury has developed a standard set of conditions that are attached to each of the consents to discharge contaminants from wood pellet fuelled boilers. These conditions are similar in form and content to those used for industrial boilers burning other solid fuels, but have a number of conditions which deal with the specifics of wood pellet fuelled boilers. The condition dealing with the composition of the pellets require that the fuel shall only be made up of sawdust and shavings that have not been treated with any chemicals, except for non-chlorinated anti-sap stains. The condition addressing the quality of the fuel defines specifications and criteria similar to those used in AS/NZS 4014.6:2007 (See Section 2.2). The Rangiora High School consent also has a conditions that define the maximum allowable concentration of particulate within the flue gas as 125 mg/m^3 and require a standard test within 12 months of installation and then again at least every five years after the initial test.

6.2. Auckland Regional Council

The Energy Efficiency and Conservation Authority (EECA) applied to the Auckland Regional Council (ARC) for generic consent to replace up to forty school coal fired boilers with biomass fuelled (wood pellets or wood chips) boilers. SKM produced the AEE for EECA. The key points from the AEE can be summarised as follows. The emissions from the pellet fired boilers were estimated using the data from the emission test certificate for the type of units which are most likely to be installed in Auckland. The data from the emission test certificates showed that the concentration of particulate within the flue gases were around 50 mg/m^3. The applicant calculated an emission rate of approximately 0.8 grams of particulate discharged from every kilogram of pellet fuel burned. The maximum predicted 24-hour concentration of PM_{10} was modelled to be between 4 µg/m^3 (12 metre high stack) and 7 µg/m^3 (9 m high stack). The applicant compared particulate emissions from pellet fuel and coal and estimated that using pellet fuel could result in a reduction in particulate concentrations of between three and four times. The applicant also noted that the fuel switch would provide a significant reduction in emissions of SO_2. The applicant concluded that any adverse environmental effects caused by the discharge of contaminants from bio-mass boilers will be significantly less than the coal fired boiler that they replace.

The ARC approved EECA's generic consent to replace or convert up to forty school coal fired boilers within the Auckland urban airshed (ARC consent number 36188, 10 October 2008). In due course, EECA will transfer this consent to the Ministry of Education. The conditions of this consent are similar in form and content to those used for industrial boilers burning other solid fuels, but have a number of specific conditions which deal with biomass (wood pellets or wood chips) fuelled boilers. Theses conditions require that the biomass boilers shall:

- Be capable of achieving a maximum PM emission concentration of 100 mg/m^3 during maximum normal operating conditions

- Discharge less than 1.5 gram of particulate for every kilogram of dry wood burned

- Achieve a thermal efficiency of greater than or equal to 85%

- Have a maximum heat output rating of 1 MW

- Discharge a maximum of 640 kg/year of PM_{10}

- Burn only untreated wood pellets or chips

- Burn pellets with a moisture content of less than 10%

- Have a standard emissions test within three months of and ten years after commissioning

Currently only one school coal-fired boiler has been converted to pellet fuel in Auckland. EECA anticipate that at least another eight will be converted in the near future.

7. Summary and recommendations

The primary objective of this report is to collate and review the information that is available on the industrial use of wood pellet fuel in New Zealand with a focus on the emissions of particulate matter. As noted earlier, the scale of this review was matched to the resources available. While every effort has been made to provide a comprehensive review, it is unlikely that all available NZ information has been included. It is acknowledged that the review would benefit from considering additional information as it becomes available. However, the review as it stands should, at least, provide a representative snapshot of the current industrial wood pellet fuel use in New Zealand.

Six mills are operating within New Zealand to produce a total of approximately 100,000 tonnes of wood pellet fuel per annum. New plants are planned that will approximately double the total production. Appropriate quality assurance processes should ensure that wood pellets provide a consistent and good quality (high GCV and low moisture content) fuel when compared to un-dried sawmill wood by-products and fuel merchant firewood. The industrial use of wood pellet fuel is growing and currently there at least 27 Schools and four industries burning pellet wood fuel.

A very limited number of New Zealand industrial emission test results have been considered in this review. The three tests considered suggest that concentrations of particulate discharged from boilers burning wood pellet fuel are on average around 100 mg/m^3. Individual test results (rather than a three test average) for two of the three boilers suggest that when the boilers are operated at a steady load within the normal output range of the units, concentrations of particulate of less than 100 mg/m^3 may be achieved.

Two overseas emission test results considered in this review qualitatively support the possibility that particulate emissions with a concentration of less than 100 mg/m^3 may realistically be achieved by boilers burning wood pellet fuel.

Canterbury Natural Resources Regional Plan (Chapter 3 - Air Quality), contains rules which deal specifically with large scale wood pellet fired boilers. The activity classification defined in these rules are based on the maximum allowable emissions from new wood pellet boilers being 80 milligrams per cubic metre (approximately 0.8 g/kg) and from boilers retro fitted to burn wood pellets being 125 milligrams per cubic metre (approximately 1.4 g/kg).

Environment Canterbury and Auckland Regional Council have issued a number of consents to discharge contaminants from wood pellet fuelled boilers. The conditions attached to the pellet fuel consents are similar in form and content to those used for industrial boilers burning other solid fuels, but have a number of conditions which deal with the specifics of wood pellet fuelled boilers. ECan's conditions dealing with the composition of wood fuel pellets require that they shall only be made up of sawdust and shavings that have not been treated with any chemicals, except for non-chlorinated anti-sap stains. The equivalent ARC condition requires that only untreated wood pellets or chips are burned. Conditions addressing the quality of the fuel defines specifications and criteria similar to those used in AS/NZS 4014.6:2007 (See Section 2.2). Conditions that define the maximum allowable concentration of particulate within the flue gas as between 100 to 125 mg/m^3 and require a standard emission test to be conducted within 3-12 months of commissioning and then again every five to ten years after the initial test.

The information supplied for and accepted by ECan and ARC for the consent applications suggest the emission rate of PM from burning wood pellet fuel is between 0.8 and 1.2 g/kg. As a comparison, the emission rate that NCC used for generic wood fuel in their air quality planning process was approximately 3 g/kg. ECan's and ARC's applicants compared particulate emissions from pellet fuel and coal and estimated that using pellet fuel could result in a reduction in particulate concentrations of approximately 66%. A comparison of particulate matter discharged from the Central New Brighton School boiler suggests that PM emissions while burning wood pellet fuel is, on average, less than half of that when the boiler is burning coal. Beyond the potential reduction in particulate emissions there are other potential environmental benefits with switching from coal to wood pellets such as significant reductions in SO_2 emissions.

Despite the limited amount of information and data considered for this review, there appears to be clear and demonstrable air quality benefits to burning wood pellet fuel compared to coal or unprocessed by-product wood. Using the data considered in this review, it is concluded that the burning of wood pellet fuel will discharge at least half of the particulate matter of a comparable coal boiler. With the review of a more comprehensive database of emission test results this estimate of particulate reductions could be refined and possibly show an even greater difference in emissions between the two fuel types.

Based on the available data and subsequent findings it is concluded that there is a case to support NCC considering treating wood pellets as a specific fuel type (other than wood) within NCC's AQP. It is therefore recommended that an addendum to NCC's report, External and Stationary Internal Combustion Rules (NIWA, ALK2002-037-R1, August 2004) be prepared regarding a new rule which would govern the industrial use of wood pellet fuel.

8. References

Bio-energy Association of New Zealand (BANZ) (2009). Wood Fuel Classification Guide. http://www.bioenergy.org.nz/documents/Homepage/Forthcoming_Events/WoodFuelClassificationGuidelines_draft090928-version4.pdf
or
http://www.woodpellets.org.nz/docs/Wood%20Fuel%20Classification%20Guidelines_draft%20090928%20-%20version%204.pdf)

Bluett, J. (2004). Nelson City Air Quality Provisions, External and Stationary Internal Combustion Rules, Proposed Classification of Activities, Revised Background Report. *NIWA Client Report ALK2002-037-R1*.

CRL. (2006). CRL Energy Limited – Report of Analysis, Wood Pellet Sample supplied by Nature's Flame Limited. *CL Report number 78/743*.

Eng, Bywater and Hendtlass (2008). New Zealand Energy Information Handbook (Third Edition). New Zealand Centre for Advanced Engineering, University of Canterbury. ISBN 978-00908993-44-4/

Ermens, R. (2006). Particulate Emission Report Rotorua Girls High Boiler Plant. *Coal Research Report Number 06-31271-06-3172*.

Keer-Keer, S. (2008). City Firewood-Cashmere High School - Emissions Assessment of Wood Chips and Wood Pellets. *K2 Environmental Report number J98.*

Keer-Keer, S. (2006). Central New Brighton School – Emission Assessment of Boiler. *K2 Environmental Report number H130*.

Pilgrim, R. (2008a). South Pine (Nelson) Limited: Application for an Air Discharge Permit – August 2008.

Pilgrim, R. (2008b). Waimea Sawmillers Limited: Application for an Air Discharge Permit – August 2008.

Scion. (2009). Scion Next Generation Biomaterials – Wood Pellets. http://www.scionresearch.com/bioenergy.aspx?PageContentID=99

Appendix 2

Nelson Air Quality Provisions: External and Stationary Internal Combustion Rules – Proposed Classification of Wood Pellet Fuelled Boilers.

NIWA Client Report: CHC2010-061,
May 2010.

(RAD 931901)

NELSON CITY
AIR QUALITY PROVISIONS:
External and Stationary Internal Combustion Rules-

Proposed Classification of Wood Pellet Fuelled Boilers

NIWA Client Report: CHC2010-061
May 2010

NIWA Project: NCC09502

NELSON CITY
AIR QUALITY PROVISIONS: External and Stationary Internal Combustion Rules-

Proposed Classification of Wood Pellet Fuelled Boilers

Jeff Bluett

Prepared for

Nelson City Council

NIWA Client Report: CHC20109-061
May 2010
NIWA Project: NCC09502

National Institute of Water & Atmospheric Research Ltd
10 Kyle Street, Riccarton, Christchurch 8011
P O Box 8602, Christchurch 8440, New Zealand
Phone +64-3-348 8987, Fax +64-3-348 5548
www.niwa.co.nz

Contents

Reviewed by:

Guy Coulson

Approved for release by:

Charles Pearson

Executive Summary

This report is prepared as an addendum to NIWA report, ALK2002-037 R1 (August 2004) which proposed the classification of industrial external combustion activities for the Nelson City Air Quality Provisions. ALK2002-037-R1 proposed the classification of activities for external combustion devices burning; CNG, LPG, diesel, kerosene, LFO, HFO, coal and unprocessed by-product wood. The objective of this report is to recommend the thresholds that may apply to any new rule/s within the NCC air quality plan that govern the industrial use of wood pellet fuel.

The wood pellet fuel thresholds proposed within this report considered two types of devices:

- Existing boilers converted to burn pellets
- New purpose designed and built pellet boilers

The potential adverse effects from the key contaminant (PM_{10}) have been assessed using atmospheric dispersion modelling. The maximum predicted ground level concentrations (GLC) have been compared to the activity classification criteria defined in ALK2002-037-R1.

Using this method and these classification criteria, wood pellet fuelled combustion activities fall into the classifications shown in Table ES-1. For comparison the activity classification of burning unprocessed by-product wood and coal as defined in ALK2002-037-R1 have been included.

Table ES-1 Proposed classification of external combustion activities according to fuel type and heat output of device.

Activity Class	Permitted	Controlled	Discretionary
Fuel			
Coal		<200kW	>200kW
Unprocessed by-product wood		<200kW	>200kW
Wood pellet fuel – converted boilers	**<150kW**	**150-450kW**	**>450kW**
Wood pellet fuel - purpose built boilers	**<220kW**	**220-650kW**	**>650kW**

To ensure that the effects of contaminants discharged from any device do not exceed those predicted in this study the wood pellet fuel must meet the quality assurance specifications defined in either AS/NZS 40146.2007 or Bio-Energy Association of New Zealand (BANZ) wood fuel classification category A1 or A2 pellets.

1. Introduction

1.1. Background

Nelson City Council's (NCC) Air Quality Plan (AQP) became operative on 3 November 2008. The process by which the AQP became operative included settling a number of Environment Court appeals. As part of the settlement of Solid Energy Ltd's appeal on NCC's AQP, the Council agreed to revisit how the combustion of wood pellets in industrial scale combustion appliances was categorised within the AQP, relative to other fuels such as diesel, oil, coal and other wood. To this end NCC engaged NIWA to produce a report with the objectives of:

(a) Collating and reviewing of the information that is available on the industrial use of wood pellet fuel in New Zealand with a focus on the emissions of particulate matter.

(b) Considering how combustion of wood pellets in industrial scale plants was categorised in the Air Plan, relative to other fuels like diesel, oil, coal and other wood.

(c) Drawing a conclusion as to whether or not there is a case to treat wood pellets as a specific fuel type (other than wood) within NCC's AQP

The outcomes of this investigation are presented in "*Review of the industrial use of wood pellet fuel in New Zealand and recommendations for Nelson City Council*" (NIWA, CHC2009-170-R1, April 2010). Based on the available data and subsequent findings the report concluded that there was a case to support Nelson City Council (NCC) considering treating wood pellets as a specific fuel type (other than wood) within NCC's Air Quality Plan (AQP). It was therefore recommended that an addendum to NCC's report, External and Stationary Internal Combustion Rules (NIWA, ALK2002-037-R1, August 2004) be prepared regarding new rules which would govern the industrial use of wood pellet fuel.

1.2. Objective

This report is prepared as an addendum to NIWA report, ALK2002-037 R1 (August 2004) which proposed the classification of industrial external combustion activities for the Nelson City Air Quality Provisions. ALK2002-037 proposed the classification of activities for the burning of; CNG, LPG, diesel, kerosene, LFO, HFO, coal and unprocessed by-product wood. The objective of this report is to recommend the thresholds that may apply to any new rules within the NCC air quality plan that govern the industrial use of wood pellet fuel.

The wood pellet fuel thresholds proposed within this report will consider two types of devices:

- Existing boilers converted to burn pellets
- New purpose designed and built pellet boilers

2. Method

The method used to assess the potential adverse effects of contaminants from industrial external combustion devices burning wood pellet fuel is identical to that used for the other fuels considered in the Nelson City Council Air quality Plan. The four stage assessment process is detailed in (NIWA, ALK2002-037-R1). There is one point of difference between the input data used in ALK2002-037-R1 and this report, as discussed in the next section.

2.1. PM_{10} contaminant source data

The only significant difference in the method used to assess the potential adverse effects of contaminants from burning wood pellet fuel and other fuels is the source of data used to calculate the PM_{10} emission rate. In ALK2002-037-R1, which considers all fuels except wood pellets, the emission rates were calculated using emission factors provided by USEPA, (1998). These emission factors, known as AP-42 factors, are based on tests and trials performed in the USA and are accepted internationally. However, even the most recent updates of AP-42 do not include emission factors for wood pellet fuel.

The review of industrial use of wood pellet fuel in NZ (NIWA, CHC2009-170-R1) identified five sources of data for PM_{10} emission factors:

- Emission tests undertaken on boilers being operated in NZ
- Emission tests undertaken on boilers being operated in Europe
- Auckland Regional Council resource consent applications and conditions
- Environment Canterbury resource consent applications and conditions
- Environment Canterbury Air Plan rules

Based on the data available from the five sources listed above, wood pellet fuel PM_{10} emission factors were developed for use within this assessment. Table 2-1 lists the PM_{10} emission factors used for this assessment.

Table 2-1: Wood pellet fuel TSP and PM_{10} emission factors

Type of Boiler	PM_{10} emission factor
Existing boiler converted to burn wood pellet fuel	1.5 g/kg TSP 1.4 g/kg PM_{10}
New Boiler designed and built to burn wood pellet fuel	1.0 g/kg TSP 0.95 g/kg PM_{10}

2.2. Calculation of PM_{10} and SO_2 mass emission rates

Using diesel as a reference fuel, the relative emission rates of SO_2 and PM_{10} from the different fuels used in external combustion sources are shown in Table 2-2. The relative emission rates of SO_2 and PM_{10} from the combustion of wood pellet fuel are shown in bold

Table 2-2: External combustion mass emission rates of SO_2 and PM_{10} relative to diesel (dimensionless)

Contaminant	Fuel type	Factor
SO_2	Natural Gas/LPG	0
	Diesel	**1**
	Kerosene	4
	Light fuel oil (LFO)	37
	Heavy fuel oil (HFO)	70
	Coal (1 % S by weight)	21
	Unprocessed by-product Wood	Neg.
	Wood pellet fuel	**Neg.**
PM_{10}	Natural Gas/LPG	0.5
	Kerosene	<1
	Diesel	**1**
	Light fuel oil (LFO)	5
	Heavy fuel oil (HFO)	7
	Wood pellet fuel - purpose built boilers	**10**
	Wood pellet fuel – converted boilers	**15**
	Coal (sub-bituminous)	30
	Unprocessed by-product Wood	30

Table 2-2 suggests that the emissions of SO_2 from the burning of wood pellet fuel are negligible. Table 2-2 also suggests that the PM_{10} emissions from a boiler burning wood pellet fuel are approximately:

- 10 to 15 times greater than that from burning diesel.
- One-half to one-third of those generated from burning coal or unprocessed by-product wood.

The calculations performed to estimate the emission rates of each contaminant from the different fuel types are contained in Appendix 1: Emission Rate Calculations.

3. Ground level concentrations of SO_2 and PM_{10}

The ground level concentrations of SO_2 and PM_{10} emitted from the burning of wood pellet fuel in industrial boilers were modelled using the method detailed in Section 2 of ALK2002-037-R1 and input data as described in Section 2 of this report. An example of the Ausplume model configuration and output can be found in Appendix 2. The modelling results of 1-hour SO_2 and 24-hour PM_{10} ground level concentrations for different sized devices burning coal, unprocessed by-product wood and wood pellet fuel presented in Table 3-1. The percentage of the relevant National Environmental Standard or guideline is shown in brackets. The predicted ground level concentrations of SO_2 and PM_{10} from the combustion of wood pellet fuel are highlighted in bold text. For comparison, the predicted GLCs of SO2 and PM_{10} generated by burning unprocessed by-product wood and coal have been included (ALK2002-037-R1).

Table 3-1 shows that the ground level concentrations of the SO_2 from the burning of wood pellet fuel are negligible. Table 3-1 also shows that the ground level concentrations of the PM_{10} from the burning of wood pellet fuel are lower than those burning either unprocessed by-product wood or coal. Ground level concentrations of PM_{10} from burning wood pellet fuel in converted boilers are approximately one half of those generated from burning unprocessed by-product wood. Ground level concentrations of PM_{10} from the burning of wood pellet fuel in purpose built boilers are approximately one third of those generated from burning unprocessed by-product wood.

Table 3-1: Predicted GLCs of SO_2 and PM_{10} for external combustion devices burning coal, unprocessed by-product wood and wood pellet fuel (The percentage of the relevant National Environmental Standard or guideline is shown in brackets.)

	100kW outputr	500kW output	1.0MW output
Fuel	**SO_2 (1-hr av -µg/m^3)**	**SO_2 (1-hr av -µg/m^3**	**SO_2 (1-hr av -µg/m^3**
Coal	54 (15%)	270 (77%)	540 (155%)
Unprocessed by-product wood	Negligible	Negligible	Negligible
Wood pellet fuel	**Negligible**	**Negligible**	**Negligible**
	PM_{10} (24-hr av -µg/m^3)	**PM_{10} (24-hr av -µg/m^3)**	**PM_{10} (24-hr av -µg/m^3)**
Coal	3 (6%)	14 (30%)	28 (56%)
Unprocessed by-product wood	3 (6%)	15 (30%)	30 (60%)
Wood pellet fuel – converted boilers	**1.7 (3.4%)**	**8.5 (17%)**	**17 (34%)**
Wood pellet fuel - purpose built boilers	**1.1 (2.2%)**	**5.7 (11.4%)**	**11.4 (22.8%)**

4. Proposed Classification of Wood Pellet Fired Boilers

In ALK2002-037-R1 effects based criteria were defined to assist with the classification of external combustion device activities. For sources that emit significant amounts of PM_{10} the following classification criteria were used:

- **Permitted activities:** PM_{10} Maximum GLCs less than 2.5 µgm^{-3} (less than 50 % of the standard deviation value of Nelson ambient PM_{10} concentrations).

- **Controlled activities:** PM_{10} Maximum GLCs between 2.5 µgm^{-3} and 7.5 µgm^{-3} (between 50 and 150 % of the standard deviation value of Nelson ambient PM_{10} concentrations).

- **Discretionary activities**: PM_{10} Maximum GLCs greater than 7.5 µgm^{-3} (greater than 150 % of the standard deviation value of Nelson ambient PM_{10} concentrations).

Under these criteria, external combustion activities fall into the classifications as shown in Table 4-1 according to the fuel type used and heat output (MCR) of the device under consideration. The activity classifications of boilers burning wood pellet fuel are highlighted in bold text. For comparison the activity classification of burning unprocessed by-product wood and coal as defined in ALK2002-037-R1 have been included.

Table 4-1: Proposed classification of external combustion activities according to fuel type and heat output of device.

Activity Class	Permitted	Controlled	Discretionary
Fuel			
Coal		<200kW	>200kW
Unprocessed by-product wood		<200kW	>200kW
Wood pellet fuel – converted boilers	**<150kW**	**150-450kW**	**>450kW**
Wood pellet fuel - purpose built boilers	**<220kW**	**220-650kW**	**>650kW**

To ensure that the effects of contaminants discharged from any device do not exceed those predicted in this study:

- The discharge point shall be at the greater height of 12.5 metres above ground level or 2.5 times higher than the apex of any building within a radius of 2.5 times the stack height; and
- The exhaust gases shall be directed vertically upward; and
- The exhaust gases shall not be impeded by any object that would lower the velocity of the exhaust gases; and
- The wood pellet fuel must meet the quality assurance specifications defined in either AS/NZS 4014.6:2007 or Bio-energy Association of New Zealand (BANZ) wood fuel classification (version 4) category A1 or A2 pellets.

5. References

Bio-energy Association of New Zealand (BANZ) (2009). Wood Fuel Classification Guide. http://www.bioenergy.org.nz/documents/Homepage/Forthcoming_Events/WoodFuelClassificationGuidelines_draft090928-version4.pdf
or
http://www.woodpellets.org.nz/docs/Wood%20Fuel%20Classification%20Guidelines_draft%20090928%20-%20version%204.pdf)

Bluett, J. (2004). Nelson City Air Quality Provisions, External and Stationary Internal Combustion Rules, Proposed Classification of Activities, Revised Background Report. *NIWA Client Report ALK2002-037-R1*.

Bluett, J., 2010. Review of the industrial use of wood pellet fuel in New Zealand and recommendations for Nelson City Council. *NIWA Client Report CHC2009-170-R1*

Appendix 1: Calculation of contaminant emission rates

Fuel Type	Name	References USEPA AP-42	Gross Calorific Value	Net Calorific Value	Specific Gravity	% sulphur maximum	Pollutant	AP-42 emission rate emperial	AP-42 emission rate metric	emission rate	Boiler rating	boiler efficiency	Total energy demand per hour	Total volume/mass of fuel needed	hourly emission rate	gram per second emission rate	
Solid	**Fuels**																
			MJ/kg	MJ/kg				lb/ton	kg/Mg	g/kg	MW	%	MJ/hr	kg/hr	g/hr	g/s	**coal**
	Coal		22.8	21.432	NA	1	Nox	9.5	4.75	4.75	0.5	70%	2571	119.98	569.91	0.158	**Nox**
	Subituminous	AP-42 Table 1.1-3	Typical values				NO2	9.5	4.75	4.75	0.5	70%	2571	119.98	56.99	0.016	**NO2**
		AP-42 Table 1.1-4					CO	11	5.5	5.5	0.5	70%	2571	119.98	659.89	0.183	**CO**
		highest of:					Filterable PM	6.6	3.3	3.3	0.5	70%	2571	119.98	395.94	0.110	**PM**
		Spreader stoker					PM10	6.2	3.1	3.1	0.5	70%	2571	119.98	371.94	0.103	**PM10**
		Overfeed stoker					SO2	Mass balance used	NA	20	0.5	70%	2571	119.98	2399.62	0.633	**SO2**
		Underfeed stoker						5 % ash retention of S									
			MJ/kg	MJ/kg				lb/ton	kg/Mg	g/kg	MW	%	MJ/hr	kg/hr	g/hr	g/s	**Wood**
	Wood			18.2	NA	NA	Nox	2	1	1	0.5	70%	2571	141.29	141.29	0.039	**Nox**
		AP-42 Table 1.6-1		Typical Hardwood			NO2	2	1	1	0.5	70%	2571	141.29	14.13	0.004	**NO2**
		AP-42 Table 1.6-2					CO	13.6	6.8	6.8	0.5	70%	2571	141.29	960.75	0.267	**CO**
		Highest of:					PM	6.4	3.2	3.2	0.5	70%	2571	141.29	452.12	0.126	**PM**
		Dutch Oven					PM10	5.8	2.9	2.9	0.5	70%	2571	141.29	409.73	0.114	**PM10**
		Stoker Boilers					SO2	0.2	0.1	0.1	0.5	70%	2571	141.29	14.13	0.004	**SO2**
		FBC Boilers															
																Wood Pellet fuel - convert. boiler	
			MJ/kg	MJ/kg				lb/ton	kg/Mg	g/kg	MW	%	MJ/hr	kg/hr	g/hr	g/s	
	Wood Pellet Fuel	AP-42 Table 1.6-1	18	16.2	NA	NA	Nox	2	1	1	0.5	70%	2571	158.73	158.73	0.044	**Nox**
	Converted boilers	AP-42 Table 1.6-2	AS/NZS 4014.6.2007				NO2	2	1	1	0.5	70%	2571	158.73	15.87	0.004	**NO2**
		Highest of:					CO	13.6	6.8	6.8	0.5	70%	2571	158.73	1079.37	0.300	**CO**
		Dutch Oven					PM	AP-42 not applicable		1.5	0.5	70%	2571	158.73	238.10	0.066	**PM**
		Stoker Boilers					PM10	Emission factors estimated from NZ data		1.425	0.5	70%	2571	158.73	226.19	0.063	**PM10**
		FBC Boilers					SO2	0.2	0.1	0.1	0.5	70%	2571	158.73	15.87	0.004	**SO2**
																Wood Pellet fuel - new boilers	
			MJ/kg	MJ/kg				lb/ton	kg/Mg	g/kg	MW	%	MJ/hr	kg/hr	g/hr	g/s	
	Wood Pellet Fuel	AP-42 Table 1.6-1	18	16.2	NA	NA	Nox	2	1	1	0.5	70%	2571	158.73	158.73	0.044	**Nox**
	New Boilers	AP-42 Table 1.6-2	AS/NZS 4014.6.2007				NO2	2	1	1	0.5	70%	2571	158.73	15.87	0.004	**NO2**
		Highest of:					CO	13.6	6.8	6.8	0.5	70%	2571	158.73	1079.37	0.300	**CO**
		Dutch Oven					PM	AP-42 not applicable		1	0.5	70%	2571	158.73	158.73	0.044	**PM**
		Stoker Boilers					PM10	Emission factors estimated from NZ data		0.95	0.5	70%	2571	158.73	150.79	0.042	**PM10**
		FBC Boilers					SO2	0.2	0.1	0.1	0.5	70%	2571	158.73	15.87	0.004	**SO2**

Appendix 2: Ausplume model configuration and output

NELSON: 500KW, WOOD PELLETS, PM10, 12.5M STK

Concentration or deposition	Concentration
Emission rate units	grams/second
Concentration units	microgram/m^3
Units conversion factor	1.00E+06
Constant background concentration	00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.400m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	Schulman-Scire method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES

Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS:

"Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES

24 hours

NELSON: 500KW, WOOD PELLETS, PM10, 12.5M STK
SOURCE CHARACTERISTICS
STACK SOURCE: 1

X (m)	Y (m)	Ground elevation	Stack height	Diameter	Temperature	Speed
0	0	0 m	13 m	0.20 m	100°C	3.0 m/s

Effective building dimensions (in metres)

Flow direction	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
Effective width	30	30	30	30	30	30	30	30	30	30	30	30
Effective height	5	5	5	5	5	5	5	5	5	5	5	5
Flow direction	130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°
Effective width	30	30	30	30	30	30	30	30	30	30	30	30
Effective height	5	5	5	5	5	5	5	5	5	5	5	5
Flow direction	250°	260°	270°	280°	290°	300°	310°	320°	330°	340°	350°	360°
Effective width	30	30	30	30	30	30	30	30	30	30	30	30
Effective height	5	5	5	5	5	5	5	5	5	5	5	5

(Constant) emission rate = 4.20E-02 grams/second
No gravitational settling or scavenging.

NELSON: 500KW, WOOD PELLETS, PM10, 12.5M STK
RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

-500.m	-450.m	400.m	350.m	-300.m	-250.m	-200.m
-150.m	-100.m	-90.m	-80.m	70.m	-60.m	-50.m
-40.m	-30.m	-20.m	-10.m	0.m	10.m	20.m
30.m	40.m	50.m	60.m	70.m	80.m	90.m
100.m	150.m	200.m	250.m	300.m	350.m	400.m
450.m	500.m					

and these y-values (or northings):

-500.m	-450.m	400.m	350.m	-300.m	-250.m	-200.m
-150.m	-100.m	-90.m	-80.m	70.m	-60.m	-50.m
-40.m	-30.m	-20.m	-10.m	0.m	10.m	20.m
30.m	40.m	50.m	60.m	70.m	80.m	90.m
100.m	150.m	200.m	250.m	300.m	350.m	400.m
450.m	500.m					

METEOROLOGICAL DATA : CALMET NELSON: AUSPLUME VS2 :NIWA (17 AUG 04)

Peak values for the 100 worst cases (in microgram/m^3)
Averaging time = 24 hours

Rank	Value	Time Recorded Hour	Date	Coordinates (* denotes polar)		
1	5.66E+00	24	01/12/01	(-30,	-60,	0.0)
2	5.66E+00	24	01/12/01	(-30,	-60,	0.0)
3	4.72E+00	24	23/11/01	(70,	0,	0.0)
4	4.72E+00	24	23/11/01	(70,	0,	0.0)
5	4.72E+00	24	09/04/00	(50,	-40,	0.0)
6	4.12E+00	24	21/11/01	(-30,	-60,	0.0)
7	4.12E+00	24	21/11/01	(-30,	-60,	0.0)
8	4.03E+00	24	28/11/01	(-20,	-70,	0.0)
9	4.03E+00	24	28/11/01	(-20,	-70,	0.0)
10	3.90E+00	24	31/10/00	(50,	-40,	0.0)
11	3.83E+00	24	21/12/01	(-10,	-70,	0.0)
12	3.83E+00	24	21/12/01	(-10,	-70,	0.0)
13	3.81E+00	24	07/05/01	(-10,	-70,	0.0)
14	3.81E+00	24	07/05/01	(-10,	-70,	0.0)
15	3.77E+00	24	02/12/01	(20,	-80,	0.0)
16	3.77E+00	24	02/12/01	(20,	-80,	0.0)
17	3.77E+00	24	29/06/00	(40,	60,	0.0)
18	3.76E+00	24	16/12/01	(10,	-60,	0.0)
19	3.76E+00	24	16/12/01	(10,	-60,	0.0)
20	3.76E+00	24	23/03/00	(0,	-70,	0.0)
21	3.76E+00	24	25/10/00	(20,	-60,	0.0)
22	3.74E+00	24	17/12/01	(10,	-70,	0.0)
23	3.74E+00	24	17/12/01	(10,	-70,	0.0)
24	3.65E+00	24	13/11/01	(-30,	-60,	0.0)
25	3.65E+00	24	13/11/01	(-30,	-60,	0.0)
26	3.65E+00	24	14/01/01	(-20,	-80,	0.0)
27	3.65E+00	24	14/01/01	(-20,	-80,	0.0)
28	3.63E+00	24	20/03/01	(-30,	-60,	0.0)
29	3.63E+00	24	20/03/01	(-30,	-60,	0.0)
30	3.63E+00	24	14/02/00	(-0,	-60,	0.0)
31	3.63E+00	24	08/10/00	(20,	-60,	0.0)

Rank	Value	Time Recorded Hour	Date	Coordinates (* denotes polar)		
32	3.59E+00	24	08/08/01	(-20,	-60,	0.0)
33	3.59E+00	24	08/08/01	(-20,	-60,	0.0)
34	3.57E+00	24	18/12/0	(10,	60,	0.0)
35	3.57E+00	24	18/12/0	(10,	60,	0.0)
36	3.56E+00	24	19/12/01	(-10,	-60,	0.0)
37	3.56E+00	24	19/12/01	(-10,	-60,	0.0)
38	3.49E+00	24	06/11/00	(10,	-60,	0.0)
39	3.47E+00	24	30/11/01	(-40,	-60,	0.0)
40	3.47E+00	24	30/11/01	(-40,	-60,	0.0)
41	3.46E+00	24	11/02/00	(-70,	10,	0.0)
42	3.46E+00	24	08/04/00	(30,	-60,	0.0)
43	3.40E+00	24	22/11/01	(-20,	-70,	0.0)
44	3.40E+00	24	22/11/01	(-20,	-70,	0.0)
45	3.40E+00	24	10/04/00	(70,	-10,	0.0)
46	3.39E+00	24	08/01/01	(-10,	-50,	0.0)
47	3.39E+00	24	08/01/01	(-10,	-50,	0.0)
48	3.37E+00	24	29/07/01	(-50,	-50,	0.0)
49	3.37E+00	24	29/07/01	(-50,	-50,	0.0)
50	3.35E+00	24	10/12/01	(20,	70,	0.0)
51	3.35E+00	24	10/12/01	(20,	70,	0.0)
52	3.32E+00	24	19/10/01	(30,	-80,	0.0)
53	3.32E+00	24	19/10/01	(30,	-80,	0.0)
54	3.31E+00	24	06/08/01	(-30,	-60,	0.0)
55	3.31E+00	24	06/08/01	(-30,	-60,	0.0)
56	3.28E+00	24	30/09/01	(-20,	-60,	0.0)
57	3.28E+00	24	30/09/01	(-20,	-60,	0.0)
58	3.20E+00	24	21/05/01	(0,	60,	0.0)
59	3.20E+00	24	21/05/01	(0,	60,	0.0)
60	3.20E+00	24	11/07/00	(40,	-60,	0.0)
61	3.20E+00	24	27/12/01	(0,	-60,	0.0)
62	3.20E+00	24	27/12/01	(0,	-60,	0.0)
63	3.18E+00	24	08/12/01	(-20,	-70,	0.0)
64	3.18E+00	24	08/12/01	(-20,	-70,	0.0)
65	3.18E+00	24	03/12/01	(-30,	-80,	0.0)
66	3.18E+00	24	03/12/01	(-30,	-80,	0.0)

Rank	Value	Time Recorded Hour	Date	Coordinates (* denotes polar)		
67	3.14E+00	24	28/07/01	(-20,	-70,	0.0)
68	3.14E+00	24	28/07/01	(-20,	-70,	0.0)
69	3.14E+00	24	12/03//01	(20,	-60,	0.0)
70	3.14E+00	24	12/03/01	(20,	-60,	0.0)
71	3.12E+00	24	29/10/00	(0,	-80,	0.0)
72	3.11E+00	24	12/09/00	(-10,	-60,	0.0)
73	3.09E+00	24	29/01/01	(0,	-50,	0.0)
74	3.09E+00	24	29/01/01	(0,	-50,	0.0)
75	3.08E+00	24	11/08/01	(0,	-70,	0.0)
76	3.08E+00	24	11/08/01	(0,	-70,	0.0)
77	3.06E+00	24	20/10/01	(-20,	-80,	0.0)
78	3.06E+00	24	20/10/01	(-20,	-80,	0.0)
79	3.06E+00	24	20/10/01	(-20,	-80,	0.0)
80	3.06E+00	24	20/10/01	(-20,	-80,	0.0)
81	3.05E+00	24	11/02/01	(-20,	-70,	0.0)
82	3.05E+00	24	11/02/01	(-20,	-70,	0.0)
83	3.05E+00	24	30/01/00	(-10,	-70,	0.0)
84	3.04E+00	24	04/09/01	(70,	10,	0.0)
85	3.04E+00	24	04/09/01	(70,	10,	0.0)
86	3.02E+00	24	04/08/00	(0,	-60,	0.0)
87	3.00E+00	24	21/06/00	(30,	-60,	0.0)
88	3.00E+00	24	30/04/00	(-40,	-50,	0.0)
89	3.00E+00	24	10/05/00	(0,	-60,	0.0)
90	2.99E+00	24	12/02/01	(-10,	-60,	0.0)
91	2.99E+00	24	12/02/01	(-10,	-60,	0.0)
92	2.99E+00	24	07/01/01	(-20,	-60,	0.0)
93	2.99E+00	24	07/01/01	(-20,	-60,	0.0)
94	2.99E+00	24	24/06/00	(40,	-60,	0.0)
95	2.98E+00	24	14/07/01	(-70,	-10,	0.0)
96	2.98E+00	24	14/07/01	(-70,	-10,	0.0)
97	2.97E+00	24	26/10/00	(10,	-60,	0.0)
98	2.97E+00	24	12/11/01	(-10,	-60,	0.0)
99	2.97E+00	24	12/11/01	(-10,	-60,	0.0)
100	2.96E+00	24	05/11/01	(-10,	-60,	0.0)