THE WEST COAST
REGIONAL COUNCIL

29 May 2020

Ministry for the Environment
PO Box 10362
Wellington 6143

Dear Sir/Madam

West Coast Regional Council's submission on National Environmental Standards for Air Quality (2020) changes

The West Coast Regional Council appreciates the opportunity to submit on the proposed amendments to the National Environmental Standards for Air Quality (NESAQ). While we support in principle the improvement in air quality to benefit the health of our communities, we note our concerns regarding the proposed restrictions on multifuel burners, and the lack of provision for future technology that may enable coal burners to meet emission standards.

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Please contact us if you have any questions regarding the content of our submission.

Yours faithfully

Michael Meehan
Chief Executive

Introduction

The West Coast Regional Council (WCRC or the Council) supports in principle the intent of the proposed changes to the National Environmental Standards for Air Quality (NESAQ) to improve air quality where this is necessary for human health, particularly respiratory health. However, we are extremely concerned that the proposed changes to the standards for domestic burners will have perverse economic and social impacts on the people and communities of the West Coast through the inability to burn coal.

Over the past year, Government has proposed, and in some cases now implemented, significant changes to legislation. This includes the requirements of the proposed Freshwater Package, the whitebait refuges and fishing closures, and the National Policy Statement for Indigenous Biodiversity. The NESAQ, and other central government legislation, will financially impact West Coast communities and people, arguably some of the most deprived in New Zealand, further compromised through the impact of Covid-19.

Our submission on the proposed changes to the NESAQ is in two parts. Part 1 outlines the West Coast context, including the use of coal for heating on the West Coast and the Reefton Airshed. Part 2 of this submission outlines the Council's response to the questions in the Discussion Document that are relevant to the West Coast region.

Part 1: The West Coast Context

The West Coast is the wettest region in New Zealand with average yearly rainfall totals of between 1,746mm to 11,228mm[1]. This makes the West Coast a damp place to live. Efficient heating is extremely important to ensure that people are not living in damp, mouldy homes.

High deprivation is evident in areas that have lower population densities and no significant industry in the area. The history of the West Coast has been based on extractive industries including mining (coal and gold) as well as forestry and saw milling. Communities throughout the region have struggled as these sectors, and others, have contracted in recent times. The Buller District, including Reefton, is an example of such an area. With less disposable income, people have challenging decisions to make on how to spend this with improving insulation in their homes often foregone due to other pressing day to day expenses and priorities.

Mean income, and income growth, lags behind the national average at $54,000 and 2.9%, compared with $60,000 and 3.7%, as of 2018. Housing affordability is three times better than the national average. Rental affordability, while a third better, is closer to the rest of New Zealand when compared with house prices.[2]

Deprivation indices for the West Coast indicate moderate to low deprivation in areas where there is significant agricultural activity. This is particularly apparent in the Hokitika and Grey Valley areas.

Use of coal for heating on the West Coast

A large proportion of West Coasters use coal for heating because it is cheap and easily accessible. The West Coast has approximately 10 active coal mines, and another half a dozen that are currently being rehabilitated.

Local people often prefer the use of coal over wood, especially the older demographic, as once the coal has been delivered it can be immediately used on the burner. In comparison, wood often needs to be cut into smaller pieces and dried before it can be used properly. Coal burns hotter than wood

[1] West Coast State of Environment Report 2018 - https://www.wcrc.govt.nz/environment/state-of-environment

[2] https://ecoprofile.infometrics.co.nz/

when a solid fuel burner is operated correctly, heating homes faster, and to a higher temperature, than other forms of heating. It is therefore the preferred fuel for many on the West Coast.

The Reefton Airshed

Reefton is the only West Coast town that has a gazetted airshed. The town is mostly surrounded by hills, causing an inversion layer on still nights whereby emissions are unable to disperse upwards. A map of the airshed is included at Appendix 1. Reefton is a sub-alpine town that has numerous days in winter where temperatures fall below 0 degrees Celsius[3]. Snow can on occasion fall in the town. Fog is also a major issue, with the town having 62 fog days per year, of which 42 days are between May and August[4]. Foggy conditions are indicative of high humidity, and when combined with cold, increase the need for home heating. It is over these winter months that air quality is at its worst because there are more people operating their fires for longer periods in order to reduce ill health and damage associated with damp homes. Prolonged exposure to mould results in major health impacts. Therefore, in Reefton, it is particularly important for people to be able to efficiently and effectively heat and dry their homes. Furthermore, Reefton can be subject to unplanned power outages over the winter months and it is important that people are able to heat their homes during these times.

Monitoring of PM_{10} in Reefton has been undertaken since the early 2000's as required by the current NESAQ. In 2019, air quality consulting firm Environet Limited completed an emissions inventory on air quality in the Reefton Airshed. The report found the following:

- PM_{10} concentrations exceeded the NESAQ of 50 µg/m^3 over a 24 hour period numerous times during the winters from 2006 to 2016.
- Domestic heating was the main source of winter PM_{10} and $PM_{2.5}$ emissions in Reefton accounting for 98% of the daily winter PM_{10}, 96% of the annual PM_{10}, 98% of the daily winter $PM_{2.5}$ and 97% of annual $PM_{2.5}$ emissions.
- Multi fuel burners were the most common method for heating the main living area in Reefton's dwellings, with 62% of households using this form of heating (57% of these using coal).
- Electricity was also common for home heating with 44% of households using this method.
- A further 23% of households used dedicated wood burners.
- Many households used more than one method to heat the main living area of their home.
- Other sources include outdoor burning, industry and motor vehicles at 1% of daily winter PM_{10}.
- On an average winter's night, around 145 kilograms of PM_{10} are discharged into the air.

Part 2: Consultation document on "Proposed amendments to the National Environmental Standards for Air Quality"

General comments

In general, Council supports in principle most of the proposed changes to the NESAQ as they contribute to improving air quality for the benefit of people's health. We have responded to Questions 1, 2, 4-6, and 21 on this matter.

Our key concern is that the proposed changes to burner standards, which effectively bans the use of coal for domestic heating, will have adverse economic, social and health impacts on low-income households within our communities. We also disagree with making the emission standard for

[3] The Climate and Weather of West Coast 2nd edition, NIWA, G. R. Macara, 2016
[4] The Climate and Weather of West Coast 2nd edition, NIWA, G. R. Macara, 2016

individual burner design more restrictive. These concerns are expanded on in reference to Questions 11, 13 and 14.

What is being proposed – particulate matter

Introduce $PM_{2.5}$ as the primary regulatory tool to manage ambient particulate matter

Questions

Q1. Do you agree the proposed $PM_{2.5}$ standard should replace the PM_{10} standard as the primary standard for managing particulate matter?

We **support** replacing the PM_{10} standard with the $PM_{2.5}$ standard as the primary standard for managing particulate matter in ambient air quality (outdoor air quality). This change aligns the NES with the World Health Organisation's review of health impacts of particulate matter. Research shows that particles in the air that are smaller than 2.5 micrometers in diameter ($PM_{2.5}$) are more hazardous to people's health than coarse, larger particles (PM_{10}). Our Council has already installed a new air quality monitoring machine in Reefton that measures both $PM_{2.5}$ and PM_{10}. This will allow us to continue our long term PM_{10} data set as well as establish a new $PM_{2.5}$ dataset. Once 5 years' worth of valid $PM_{2.5}$ data has been collected, Council will be able to transition to this as the primary standard.

Q2. Do you agree we should include both a daily and an annual standard for $PM_{2.5}$?

We **support** having a daily and an annual standard for $PM_{2.5}$ as they cover acute and chronic exposure to air quality pollutants which can be harmful to human health. Having said that, in Reefton, air quality is only an issue during the winter months and so the daily standard will be more relevant to ensure that air quality in Reefton is closely monitored over these months.

Q4. Do you consider your airshed would meet the proposed $PM_{2.5}$ standards? If not, what emissions sources do you expect to be most problematic?

We are unsure whether the Reefton Airshed will meet the proposed $PM_{2.5}$ standard of 25 $\mu g/m^3$, with three or fewer exceedances allowed in a 1-month period. We have only recently (October 2019) started monitoring $PM_{2.5}$ in the Reefton Airshed. Not enough data has been collected to understand $PM_{2.5}$ emissions in Reefton, especially as this data is yet to be collected over the winter months when emissions are higher. Until this has been collected we will not know whether the Reefton Airshed is likely to meet the proposed $PM_{2.5}$ standard.

Retain the PM_{10} standard with reduced mitigation requirements for breaches

Questions

Q5. Do you agree councils should be required to keep monitoring and managing PM_{10}?

We **generally support** councils being required to keep monitoring and managing PM_{10}. In the shorter term, continuing to collect PM_{10} data will enable us to report if there is a breach of the PM_{10} standard until there is adequate and meaningful $PM_{2.5}$ data to accurately and reliably identify if there is a breach of the $PM_{2.5}$ air quality standard. It will also provide for a transition period over which we can investigate the possibility of carrying out further work to determine the accuracy of the new Teledyne T640x air quality monitoring machine which measures both $PM_{2.5}$ and PM_{10}.

Q6. What would be the additional costs involved in retaining PM_{10} monitoring alongside $PM_{2.5}$ monitoring, versus the potential loss of valuable monitoring information?

Beyond the adoption of $PM_{2.5}$ monitoring and standards, there will be an additional cost to councils in order to operate equipment that can measure PM_{10}, including factors such as instrument maintenance, calibration, and processing data to a high standard.

What is being proposed – domestic solid-fuel burner standards

Tighten the emissions standard

Questions

Q11. Do you agree with the proposal to reduce the emissions standard to no more than 1.0g/kg? If not, what do you think the standard should be?

We **strongly disagree** with this proposal as we question how much improvement in air quality the proposed standard will achieve. The reason provided in the Discussion Document for making the emissions standard for individual burners at the design stage more restrictive than the current 1.5g/kg appears to be because there is improved wood burner technology that can meet the new standard, rather than for any other reason. This is akin to 'let's do it because we can', which is not a robust or valid reason for making the standard more restrictive. The supporting documents, such as the cost benefit analysis, do not provide any additional justification for reducing the standard to 1.0g/kg.

Although it seems logical that a lower standard for individual burner emissions will improve air quality, before a decision is made, clear evidence that the change will have a considerable impact on improving air quality should be provided, in order to justify the costs. If the evidence does not show major air quality improvement, or that the costs substantially outweigh the benefits, then we **oppose** changing the standard to 1.0g/kg, and **support** maintaining the current standard of 1.5g/kg.

In addition, making the emissions standard for the design of burners more restrictive makes it even harder for future multi-fuel burner design to meet it. The new standard inhibits innovation and advancements in multi-fuel burner technology.

The new standard will not provide for innovative devices that can be attached to multi-fuel burner flues to reduce emissions to meet the national standard. This is discussed further in our response to Questions 13 and 14 below.

All domestic, solid-fuel burners to meet the emissions standard

Proposal

*8. Include all types of solid-fuel burners under the existing burner regulations that prohibit discharges from newly installed, domestic burners unless they meet the emissions limit and thermal efficiency standards. This would include **all** types of domestic, solid-fuel burners such as wood burners, coal burners, multi-fuel burners, pellet burners, open fires, space heaters, cookers and water boilers.*

Question

Q13. Do you agree the new emissions standard should apply to all domestic, solid-fuel burners newly installed in properties less than two hectares in size?

We **agree in principle** that the emissions standard should apply to all domestic, solid-fuel burners newly installed on properties less than two hectares in size. This will contribute to improving air quality and the health of people in built-up areas in our region. However, we are **extremely concerned** that the standard, as proposed, will effectively ban the use of coal for the heating of homes. There are currently no burners on the market that can burn coal and meet the proposed standard. This is concerning given the quantity of low-income West Coast homes burning coal for their heating. The costs of burning coal vary among the community depending on contacts, and the ability to collect and

store wood. However, it has high value to a significant part of the community. Without this fuel source, those on low incomes may be unable to heat their homes without considerable financial assistance to install other forms of heating such as heat pumps, as well as insulation, both of which cannot heat such places as effectively. The versatility of multifuel burners are important in allowing people to maximise the availability and price of coal and wood, given that availability and price will vary.

We **strongly support** the proposal that the emissions standard for individual coal and multi-fuel burners will only apply when someone is replacing their burner, or they are building a new house. See our further comments under Question 21.

Q14. Do the current methods to measure emissions and thermal efficiency need updating or changing? For example, to address any trade-off between thermal efficiency and emissions, or to test other types of burners or burner modifications that seek to reduce emissions?

The emissions standard, and possibly the methods to measure emissions and thermal efficiency for burner design, need amending to provide for the use of devices that help reduce emissions to meet the design standard. There are burner devices that can help reduce emissions from solid-fuel burners, including multi-fuel burners where coal is used. Our Council has investigated the option of using OekoTubes to reduce emissions from burners in Reefton homes that burn coal. The OekoTube technology employs a steel rod attached to an electrical circuit box at the top of the flue with the rod inserted inside the flue. A low electrical current travels through the rod and charges the particulate matter so it clusters together into larger particles. These particles either attach to the flue wall or drop down into the firebox resulting in fewer emissions discharging out the top of the flue. Appendix 2 shows a diagram of the OekoTube and photos of the device attached to a burner flue on a roof.

A laboratory trial was undertaken in January 2014 to determine the percentage reduction of PM_{10} by the OekoTube on a coal, and coal and wood (50:50), fire. Attached as Appendix 3 is a copy of the lab trial report. The results indicated a 90-97% reduction when the fire was operated at low burn setting, and approximately 58% reduction in total emissions across all the trialed burn cycles,[5] although the actual reduction could be higher in the colder Reefton air temperatures. The lab trial results give a positive indication that the ESP filter on domestic burners may be sufficient to achieve the NES for PM_{10} in Reefton, in tandem with other methods. We are not aware of any trials of the OekoTube on coal burning for PM2.5.

An independent review of the lab trial results identified that *"the OekoTube was most effective at reducing particulate emissions when the fire was operated at low burn setting (90-97%)….(it) had reduced effectiveness…. when bituminous coal was used,….and if the use of an ESP device such as the OekoTube is included as a regulatory tool for managing PM_{10},….Council would need to be satisfied that the OekoTube can be adequately operated and maintained such that its effectiveness in reducing PM_{10} is perpetual."* A copy of this evaluation is attached as Appendix 4. It may be the case that devices attached to coal burners can reduce $PM_{2.5}$ to be near the emissions standard, and this, in conjunction with other regulatory provisions such as prohibiting certain types of coal, and proper burner operation, will together meet the standard. We **strongly seek** the NES to provide for this.

A trial was also undertaken to check the operation and maintenance of an OekoTube filter on two household burners in Reefton in May 2014. The purpose of this trial was to identify how well the OekoTube runs mechanically in live conditions. The trial identified that: *"The ESP filter has clearly retained soot dust containing PM_{10} within the flue almost continually over winter without any major malfunctions, confirming that it does operate well in real life conditions on coal and coal-wood fires. The minor buildup of soot dust on the flue wall did not interfere with the safe operation of the burners…..On-site testing has proved to be very valuable in identifying some minor maintenance and*

[5] Wilton, E. February 2014. Evaluation of the effectiveness of the OekoTube ESP in the management of PM_{10} in Reefton.

operational matters that will improve use of the ESP device." The report on the field trial is attached as Appendix 5.

Although the lab trial measured the reduction of PM_{10} emissions, given the potential social and health impacts on West Coast people of the new emissions standard for individual burners, central government should support and encourage the use of innovative burner modifications and devices that reduce emissions, in combination with using other tools in regional plans. As a starting point, Government should provide funding for further trials on devices such as the OekoTube on coal, and coal and wood burners, to determine how much $PM_{2.5}$ is reduced, and how much other tools can help reduce emissions to meet the national standard. Over time, technology may be developed that will allow people to burn coal and still meet the standard. Government policy and regulation should not stifle future innovation in solid fuel burner design to the detriment of the most vulnerable within our communities.

Outcomes sought:

1. Central government to provide funding for further trials on devices that can be added to solid fuel burners that burn coal, to determine whether the use of these will result in the burner meeting the emissions standard.
2. Amend the standard to allow approved devices to be fitted to solid fuel burners. These approved devices would be tested to confirm that fitting them to a burner that is burning coal will ensure the burner meets the required standard.
3. Maintain the current emissions standard of 1.5g/kg.

Timing, implementation and transitional provisions

Questions

Q21. Do you agree that lead-in times are required for starting to monitor $PM_{2.5}$ and for burners that will no longer be compliant? What lead-in times would you suggest and why?

We **strongly support** lead-in times for monitoring $PM_{2.5}$. In 2019 we purchased a new machine that measures both $PM_{2.5}$ and PM_{10}. Monitoring of $PM_{2.5}$ only began in October 2019, and so more time will be needed to collect enough data to ensure it is accurate before Council starts notifying breaches. The proposals do not provide clear direction on lead-in times. However, paragraph 4 on page 27 of the Discussion Document suggests that a minimum of 12 months of data for $PM_{2.5}$ would need to be collected before the Council could notify any breach. Since we already monitor, and can continue monitoring PM_{10}, we can use this data to manage air quality in Reefton until we have 12 months of data for $PM_{2.5}$ for breaches, and five years' worth of $PM_{2.5}$ data to determine whether Reefton remains a polluted airshed.

We **strongly oppose** adding lead-in times to the NES to replace non-compliant burners with low-emission burners. A lead-in time will place significant financial burden on low income households to replace their burner earlier than anticipated, meaning they have less time to save up to pay for the new burner.

We **strongly support** requiring burners to only be replaced when they need replacing. This will mean that the standard will not apply for some West Coasters for a number of years, given that the average lifespan of a multi-fuel, or coal burner is 20-25 years. People who have just replaced their burners should not be unreasonably required to replace their 'newish' burner. Replacing burners is a substantial financial undertaking by the landowner. Having no lead-in times to replace burners in the NES also allows Councils the ability to set their own timeframes to replace burners if air quality is a significant issue in particular parts of their region.

Part 3: Non-regulatory tools

The NESAQ should not be implemented in isolation. There are other non-regulatory tools which the Government needs to action as a whole of Government approach to improving air quality and the health of our population, as well as minimising the economic and social impacts on low-income households. We **strongly recommend** that MfE and EECA visit low-income communities throughout the West Coast, including the Reefton Airshed, to educate communities about the NESAQ changes regarding replacing burners, and the Warmer Kiwi Homes Scheme.

We **strongly support** the Scheme which provides 90% of the cost of insulation and/or cleaner heating appliances. This Scheme is available to low-income households until 2023, but this timeframe could be too short for low-income households to save up for the remaining 10% of the cost. The Scheme should be extended until at least 2025.

While we support the use of 'clean heating', such as low-emission wood burners and heat pumps, we are concerned that the high price of electricity on the West Coast makes these options potentially more expensive than in other regions.[6] A large percentage of electricity consumed on the West Coast is imported from outside the region, and the distance to transmit this electricity to the region adds significant cost in comparison to that of other regions. There are robust potential hydro electricity generation opportunities on the West Coast. In tandem with the NESAQ changes and the climate change response legislation, the Government needs to reconsider allowing the generation of cleaner hydro electricity within the region, to make 'cleaner heating' for West Coast households more viable.

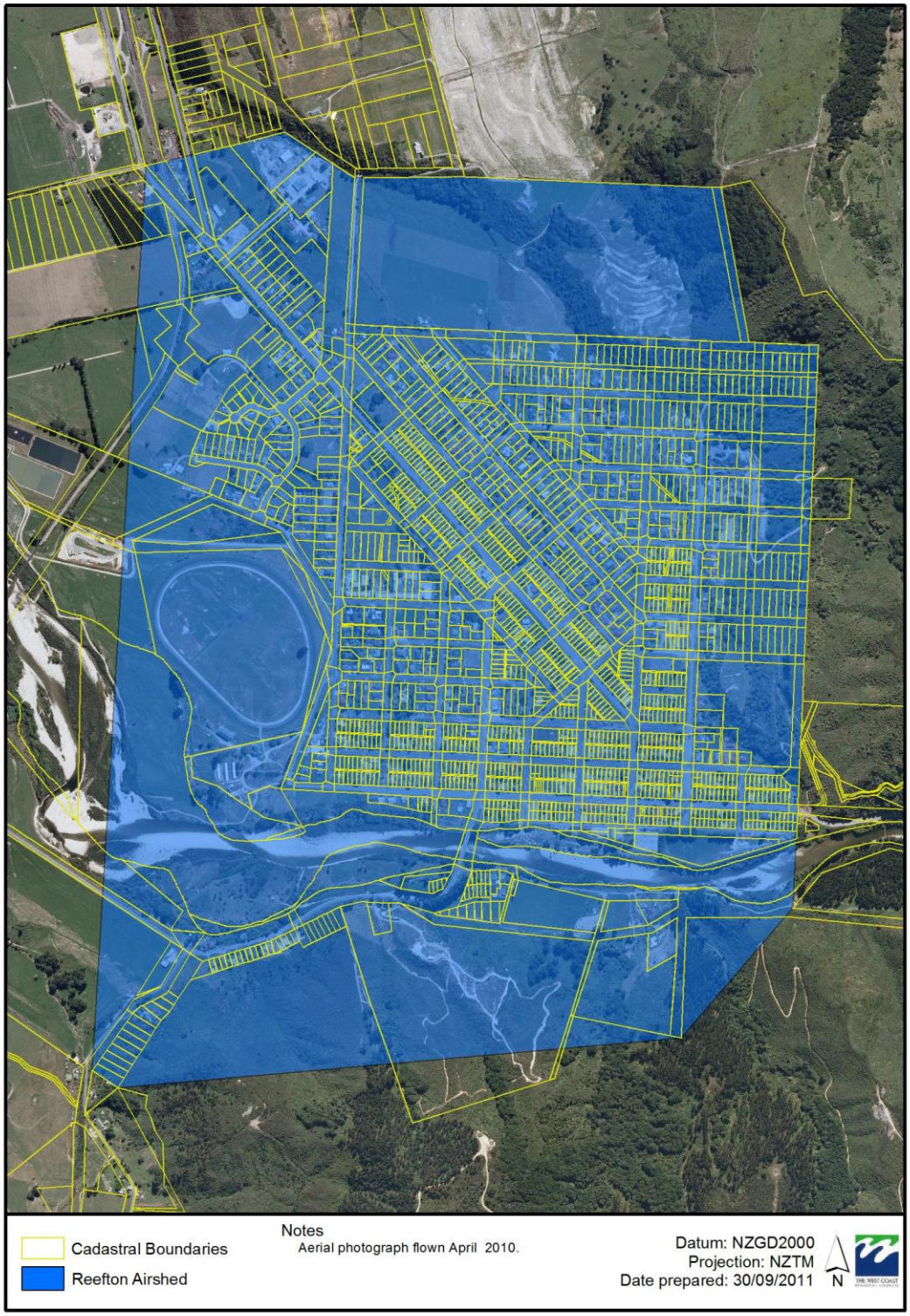
Outcomes sought:

1. MfE and EECA visit low-income communities throughout the West Coast, including the Reefton Airshed, to educate communities about the NESAQ changes regarding replacing burners, and the Warmer Kiwi Homes Scheme.
2. Extend the Warmer Kiwi Homes Scheme to 2025.
3. Provide for increased hydro electricity generation within the West Coast.

This ends our submission.

[6] The figures indicate a potential annual additional cost for an average West Coast household in the Westpower area of $110.53 (pers comm, M Kennedy, Consultant Planner for Westpower, 1/4/2020). For averaging on a regional basis, go to this link: https://www.emi.ea.govt.nz/Wholesale/Reports/4GS02J?DateFrom=20200318&DateTo=20200318&_rsdr=D1&_si=_dr_Date From|20190319,_dr_DateTo|20200318,_dr__rsdr|L364D,v|4

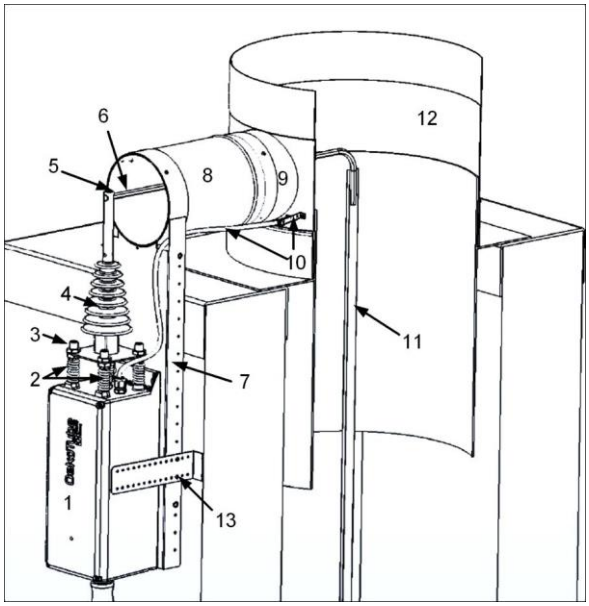
Appendix 1: Map of Reefton Airshed



Appendix 2: Diagram and photos of OekoTube

DIAGRAM OF THE OEKOTUBE ELECTROSTATIC PRECIPITATION FILTER

1. Electronic box
2. Springs
3. Adjusting nuts
4. Insulator
5. Grub screw to fix the hexagonal electrode
6. Holder (6)
7. Hexagonal electrode holder (steel rod)
8. Electronic box mounting bracket
9. Extension pipe
10. T-piece connecting piece
11. Temperature sensor and cable holder
12. Flexible electrode
13. T-piece
14. Mounting bracket



The OekoTube ESP filter

OekoTube circuit box on chimney

Light at bottom of circuit cover

Appendix 3: Report on lab trial of OekoTube on a coal burner

Appendix 4: Report on Evaluation of effectiveness of OekoTube in reducing Reefton PM^{10} emissions

Appendix 5: Report on Monitoring the Operation of an Eletrostatic Precipitator Filter on Reefton Chimneys

MONITORING THE OPERATION OF AN

ELECTROSTATIC PRECIPITATOR

FILTER ON

REEFTON CHIMNEYS

October 2014

Introduction

This report outlines the results of a trial monitoring the operation of an electrostatic precipitator (ESP) filter on two domestic burners in the Reefton Airshed. The particular ESP filter used is called the OekoTube which is designed to make PM_{10} particles adhere to chimney walls, thus reducing the amount of PM_{10} emissions discharged out the flue.

Background

Since October 2012 the Reefton Airshed Committee (RAC or the Committee) has been investigating options for reducing PM_{10} emissions from domestic burners in the Reefton Airshed, to improve air quality and meet the National Environmental Standard for Air Quality (NESAQ).

The NES requires that PM_{10} levels be no higher than 50 $\mu g/m^3$ averaged over a 24-hour period, with three permissible exceedances per year after September 2016, and only one per year after September 2020. Council's air quality monitoring in the Reefton Airshed shows multiple exceedances of the standard every year since 2006.

While the OekoTube appears to be a possible solution to reducing PM_{10} emissions in the Reefton Airshed, there is no information on it's performance on domestic coal fires. A laboratory trial was therefore undertaken in January 2014 to determine the percentage reduction of PM_{10} by the OekoTube on a coal, and coal and wood (50:50), fire. The results indicated a 90-97% reduction when the fire was operated at low burn setting, and approximately 58% reduction in total emissions across all the trialed burn cycles,[7] although the actual reduction could be higher in the colder Reefton air temperatures. The lab trial results give a positive indication that the ESP filter on domestic burners may be sufficient to achieve the NES for PM_{10} in Reefton, in tandem with other methods.

There is likewise no information on maintenance requirements of the ESP filter operating on a coal fire, specifically how quickly soot dust builds up on the flue wall and how often a chimney may need cleaning. The purpose of this trial is to identify how well the OekoTube runs mechanically in live conditions.

The trial

ESP filter

Two ESP filters were installed on a coal, and wood and coal, fire in the Reefton Airshed on 12th May 2014. The filters used are known as OekoTubes, consisting of a 1.5 metre long steel rod placed in the top inside of the chimney. A small electrical current is sent through the rod which causes PM_{10} and smaller particles to cluster together into larger particles and attach to the side of the chimney rather than discharging into the air. Further details about the OekoTube are shown in Appendix 1. While there may well be other ESP devices being developed overseas, the OekoTube is the only one Council is aware of that is currently accessible in New Zealand.

[7] Wilton, E. February 2014. Evaluation of the effectiveness of the OekoTube ESP in the management of PM_{10} in Reefton.

The OekoTube ESP filter

OekoTube circuit box on chimney

Light at bottom of circuit cover

Domestic burners

The flues on the two burners used in the trial were swept prior to the OekoTube being installed and operated, so there was no buildup of soot dust on the flue wall at the start of the trial.

The homeowners proceeded to operate their burners as they usually do during the colder Winter months (both burners are 25kW). The household burning coal and wood used Reddale coal, and to further replicate burning typically carried out in Reefton homes they burnt moderately wet, native wood. [8] The household burning only coal used Giles Creek coal. Bituminous coals were not used as the laboratory trial identified that bituminous coal soot, being very fine and powdery, clogs up the ESP filter so it stops functioning.

Both burners were operated 24 hours a day, seven days a week, and were only stopped for approximately 10-12 hours before each monitoring round to enable the flue to cool down enough for the contractor to view and measure the soot dust in the flue.

Monitoring

Levels of soot dust on both chimneys were measured four times during the Winter months, on 30 May, 27 June, 28 July, and 3 September. Daryl Topp of Topp Services Ltd in Greymouth was contracted to the West Coast Regional Council to do the monitoring, which involved climbing up on each roof, measuring the thickness of the soot dust layer at various places on the ESP filter and in the flue, recording measurements, and taking photos. Appendix 2 is a copy of the recording sheet.

[8] The moisture content of wood burnt in the Airshed is often more than 25% as the wood is not stored long enough to sufficiently dry out. Most wood is sourced from the local area and is native, which takes longer to dry out than exotic timber such as pine or eucalyptus.

Results of the trial

Note: No photos were available from the first round of monitoring due to a technical problem with the camera.

Table 1: Dust on insulator

The colour of the dust on the insulator of the OekoTube was ranked from "1" being all white to "10" being dark black. Dust thickness on the insulator was measured to give an indication of particulate matter coming out the chimney, which flows through the extension of the chimney and circulates under the circuit cover of the ESP filter.

	Mace Street (coal)		Plaskett Street (coal and wood)	
Date	**Colour**	**Thickness**	**Colour**	**Thickness**
30 May	8	Under 1/10mm	4	Under 1/10mm (very little dust)
27 June	6	Under 1/10mm	7	Under 1/10mm
28 July	8	1mm	Not recorded	1mm
3 September	9	1mm	8	1mm

After nearly four months of burner operation layers of soot dust accumulating on the OekoTube's white insulator has obviously changed the appearance of the insulator to dark grey and black.

There is little difference between the colour and thickness of dust on both insulators, although the texture varied. Dust on the insulator of the coal fire tended to be dull, fine and powdery, compared to the dust from the coal-wood fire which had a shiny, varnished appearance due to the resin from the wood.

Insulator on coal fire, second monitoring Round, 27 June

Insulator on coal-wood fire, second monitoring round, 27 June

Insulator on coal fire, third monitoring round, 28 July. Note damage on top ring, discussed under 'Cleaning the firebox' on Page 8

Insulator on coal-wood fire, third monitoring round, 28 July

Table 2: Dust on electrode and flue wall

Dust thickness on the top of the electrode, and upper and lower flue wall were measured. The lower flue wall at the base of the electrode could not be physically measured so it was visually estimated relative to being a ¼, ⅓, or ½ of the distance between the flue wall and the electrode, which is a maximum distance of 75mm (see Question 6 of the record sheet in Appendix 1). These results are translated into millimetres.

	Mace Street (coal)			Plaskett Street (coal and wood)		
Date	Horizontal part of electrode	Flue wall near top of electrode	Flue wall at bottom of electrode	Horizontal part of electrode	Flue wall near top of electrode	Flue wall at bottom of electrode
30 May	Under 0.5mm	4mm	Under 19mm	Under 0.5mm	3-6mm	Under 19mm
27 June	0.1mm	1-4mm	Not recorded	Under 0.5mm	4-10mm	Under 19mm (approx. 4-5mm)
28 July	1mm	1mm	Not recorded	1-2mm	5-12mm	About 19mm
3 September	0.5mm	0.5mm	At least 37mm spikes	1.5mm	5-8mm	5-8mm

The results show a minor buildup of soot dust in both chimneys, to different extents for the coal, and wood-coal, fires.

Electrode

There is very little buildup of dust on the electrode from both fires, indicating that the OekoTube is working properly with the electrical current making particles attach to the flue wall rather than to the electrode, except for a typically very small amount attracted to the electrode due to it being in the gas stream and having a positive charge. This is a positive outcome as too much dust on the electrode will make it stop functioning. As expected, spikes on the lower flue wall have broken off before they became long enough to touch the electrode and cause a shortage.

Flue dust from coal fire

The contractor noted that with the coal fire there was only a small buildup of very fine, powdery soot dust on the flue wall, and this tended to be evenly spread throughout the flue for most of the trial period. By the fourth monitoring round further buildup had occurred on the flue wall at the bottom of the electrode, while the thickness at the flue top and on the electrode had slightly reduced. The latter may be due to reentrainment which is discussed later in this report.

The lesser buildup compared to the wood-coal fire can be attributed to the Giles Creek coal dust being very light, dispersing more readily, and not having wood resin to bind more of it to the flue wall.

The soot colour also changed from black at the earlier monitoring rounds to light grey at the fourth monitoring round. The latter colour indicates that the particles clustered on the flue wall are well burnt from a hot fire.

Black coal soot 1-4mm thick on upper flue wall, 0.1mm on electrode, 27 June

Coal dust 0.5mm thick on upper flue wall, 3 September

Lower flue wall, soot less than 19mm thick, 27 June

Lower flue wall, soot evenly spread, grey colour, 28 July

Flue dust from wood-coal fire

As mentioned above, the thicker soot dust on the upper flue wall of the coal-wood fire compared to the coal fire is due to the wood resin from burning wet wood. The higher the moisture content in the wood, the more tar is present in the particles, and the more particles adhere to surfaces. In the early stages of the trial the dust was flaky in appearance, with a black shine underneath from the wood. At the end of the trial drier wood was used, and so the soot changed to a powdery consistency.

The contractor noted at the second monitoring round a lot of soot flakes on the roof. The drop in soot thickness by the fourth monitoring round may be due to reentrainment.

As with the coal fire, after four months of burning the dust changed from a dark grey/black colour to light grey with white edges, indicating that the soot was well incinerated by a hot fire.

Black wood-coal soot, 4-10mm thick on upper flue wall, under 0.5mm on electrode, 27 June

Light grey dust, 5-8mm thick on upper flue wall, 3 September

Wood-coal soot, less than ¼ the distance between the lower flue wall and the bottom of the electrode, grey/black colour, 27 June

Light grey dust, approx. 5-8mm evenly spread on lower flue wall, 3 September

Reentrainment

Reentrainment is where soot dust particles cluster together into flakes or spikes on the flue wall, and when large enough break off and either drop down into the firebox to be re-burnt, or are discharged out the chimney when the burner vents are fully opened. Flakes generally land on the roof around the chimney base or on the ground, depending on weather conditions. Reentrainment discharged out the chimney is significantly larger than the PM_{10} size, much less likely to enter human airways, and is easily washed away by rain.

It was observed in this trial that a smaller amount of reentrainment from the coal fire settled on the roof, compared to reentrainment from the wood-coal fire. Notwithstanding weather conditions and volume of fuel burnt, this may be due to wood resin making the wood-coal particulate heavier and stickier.

Reentrainment particles at the chimney base of the coal fire

Particles on the roof from the wood-coal fire

Wood-coal reentrainment on a plastic chair

The phenomenon of reentrainment makes it difficult to obtain precise measurements of the amount of soot dust buildup on the flue wall, however it is not the purpose of this trial to measure the total amount of dust retained.

Findings

The ESP filter has clearly retained soot dust containing PM_{10} within the flue almost continually over Winter without any major malfunctions, confirming that it does operate well in real life conditions on coal and coal-wood fires. The minor buildup of soot dust on the flue wall did not interfere with the safe operation of the burners.

Maintenance findings

On-site testing has proved to be very valuable in identifying some minor maintenance and operational matters that will improve use of the ESP device.

Chimney cleaning

The small amount of soot buildup on the flue wall indicates that with the ESP filter operating full time over the four-month Winter period, cleaning the flue and electrode once a year should be sufficient to ensure the flue functions safely and efficiently. The buildup of soot dust over the trial period was not enough to require the chimneys to be cleaned during the trial period. The reentrainment process created by the ESP device is self-cleaning to a large extent, and fully opening the vents helps to remove spikes and flakes.

Minor modification to flue

A minor modification may need to be made to the flue cap to avoid smoke potentially shorting out the insulator. The chimney cap fitted on most chimneys to stop rain infiltration partially restricts the flow of smoke out the chimney, resulting in some smoke flowing through the ESP circuit box. Too much smoke entering the circuit box

can lead to a heavier buildup of dust on the insulator which in turn causes the device to short out. The problem can be alleviated by extending the height of the cap legs to give greater clearance. If smoke still flows through the circuit box under heavy discharge, a second option is to make a 50mm diameter hole in the flue cap allowing more smoke and tar to escape directly out the flue, and reducing the amount going through the circuit box. A 50mm hole will not allow volumes of rain in which will extinguish the fire. As there will still be some smoke that flows through the circuit box the insulator and circuit unit needs to be checked and cleaned once a year.

Routine checks

It is helpful if occupants regularly check that the ESP filter is operating properly. This can be done by checking what colour the light is at the bottom of the circuit cover (on the outside of the filter device at the top of the chimney):

Red:	means there is a problem with the OekoTube. A common problem is an electrical shortage. If soot builds up on the flue wall at the bottom of the electrode and gets too close to the electrode, or builds up on the insulator, or the electrode is off-centre, this can make the OekoTube cut out. It could also be caused by a faulty security magnet built into the OekoTube cover for safety reasons, which can easily be replaced.
Green flashing:	means the fire is not on and the OekoTube is on standby. There is 10 seconds between each flash so allow enough time to ensure the green light is flashing. During warmer months when fires are not used, the OekoTube can be switched off.
Green	means the OekoTube is working and the fire is going.
No light	means the OekoTube is switched off.

Cleaning the firebox

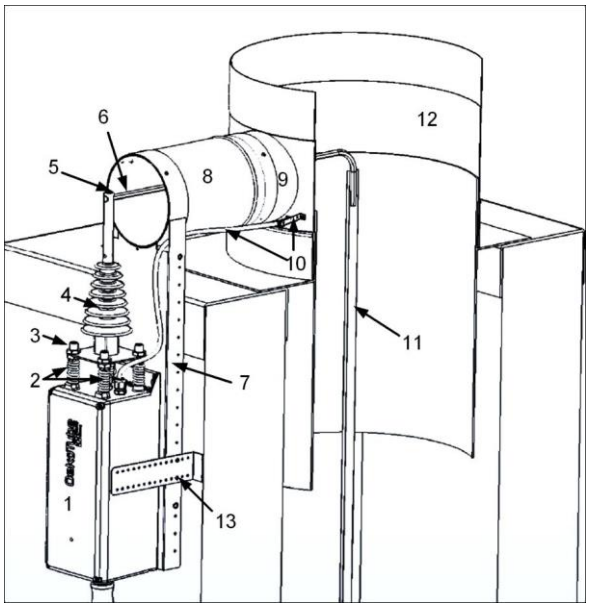
Clearing ash from the grate too quickly or vigorously can damage the insulator, causing the ESP filter to stop working. A cloud of ash going up the flue will settle on the insulator, and can short out the unit. The photo on the right shows damage to the top ring of the insulator where the electricity current has arked across the ash buildup, cracking the ring and causing chips to come away around the edge. Shorting out will stop the OekoTube working for around 10-15 minutes until the ash cloud has cleared. This should be avoided as it means that additional PM_{10} is discharged out the chimney while the OekoTube is not working. The grate needs to be cleaned slowly and gently to avoid stirring up too much ash.

Conclusions

This trial has established that an ESP filter can work effectively on domestic coal and coal-wood fires in the Reefton Airshed during Winter months. Monthly monitoring of the OekoTube on two domestic fires in Reefton between May and September showed that soot dust containing PM_{10} was retained on the flue wall and parts of the ESP device, with an overall increase in the thickness of soot between the start and finish of the trial. No major malfunctions occurred with the OekoTube when the device and burner were operated properly. The minor maintenance and operational matters identified in the course of the trial can be adequately dealt with by households to ensure that an ESP filter functions to its optimal capacity.

APPENDIX 1: DIAGRAM OF THE OEKOTUBE ELECTROSTATIC PRECIPITATION FILTER

15. Electronic box
16. Springs
17. Adjusting nuts
18. Insulator
19. Grub screw to fix the hexagonal electrode
20. Holder (6)
21. Hexagonal electrode holder (steel rod)
22. Electronic box mounting bracket
23. Extension pipe
24. T-piece connecting piece
25. Temperature sensor and cable holder
26. Flexible electrode
27. T-piece
28. Mounting bracket



APPENDIX 2 TRIAL RECORDING SHEET

THE WEST COAST
REGIONAL COUNCIL

Recording Sheet for OekoTube Dust Monitoring – Winter 2014

Physical address : ……

Date : ……

Time : ……

Contractor doing monitoring : ……

Note if any re-entrainment (larger soot flakes) are present in the air or on the ground

(Include approx. date)

……

……

……

1. Control light on circuit cover (tick the relevant circle)

   All Red O

   Green flashing O

   All green O

   No lights O

2. Dust colour on the insulator: rank from ‘1’ being all white to ‘10’ being dark black

   Score: ……

3. Thickness of dust on the insulator (tick relevant circle)

   Very thin layer (under 1/10 mm) O

   Under 0.5 mm dust layer O

   About 1.0 mm dust layer O

   Over 1.0 mm dust layer O Thickness (mm): ……..

   Photo No:……

   Remarks to Nos 2 and 3: ……..

4. Dust on horizontal part of the electrode

   Very thin layer (1/10 mm) O

   Under 0.5 mm dust layer O

   About 1.0 mm dust layer O

   Over 1.0 mm dust layer (evenly spread) O Thickness (mm): …….

   Description of the dust: ……

   Photo No: ……

   Remarks: ……..

5. Dust on flue wall near horizontal part of the electrode

Distribution: even thickness around the wall O mm: ……

uneven thickness around the wall O

thickest measurement: mm: ……..

thinnest measurement: mm: ……..

If the dust is unevenly spread, describe where most and least dust occurs, using a clock face description, with 6 o'clock being at the point where the horizontal rod touches the flue wall.

Most dust located: ……. o'clock Least dust located: ……. o'clock

Description of the dust: ……

Remarks: ……..

Photo No of the flue wall: ……

Photo No of the ruler: …….

6. Dust on flue wall at the bottom of the electrode, estimated in relation to distance between the wall and the electrode (max 75 mm):

Less than ¼ of the distance O

About ¼ of the distance O

About ⅓ of the distance O

About ½ of the distance O

More than ½ of the distance O

Description of the dust 'spikes':

……...

Photo No of flue wall at bottom of electrode: ……

General comments about the monitoring:………………………………………………………………….

………

………