

Emission Auditing of New Woodheaters in Australia and New Zealand

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This discussion continues the series in Clean Air and Environmental Quality dealing with residential firewood use in Australia and New Zealand, commencing in February 2008 (Vol. 42(1)). In this issue, the results of Australian and New Zealand emission audits of retail heater models are reviewed.

Testing of new woodheater models in accordance with the Australian and New Zealand Standards (AS/NZS4012 and AS/NZS4013) was intended to force the introduction of cleaner burning models (Todd 2008), thus contributing a technical fix to the on-going problem of urban winter wood-smoke. There are two potential flaws in this desirable approach to reducing air pollution: (i) the standard laboratory test method might not adequately reflect emissions when heaters are operated in people's homes (more on this question in later discussions); or (ii) the heater models sold are not the same as the heater models tested in the laboratory. In the past six years Australian and New Zealand governments have carried out several audits to check whether retail models meet the relevant standards and regulations.

The maximum allowable particulate emission limit for certified woodheaters in Australia is 4 g kg^{-1} . The New Zealand limit for new wood burners installed on properties less than 2 ha is 1.5 g kg^{-1} , and in Christchurch, NZ the limit is 1 g kg^{-1} . New Zealand also requires heaters to have an efficiency of 65% or better (no efficiency limit applies in Australia).

RESULTS OF AUSTRALIAN AUDITS

The first formal audit was carried out by the South Australian EPA in 2002. Six retail woodheater models were purchased and run through the standard laboratory test. Two of the six failed the test by a large margin. This alerted authorities to the possibility of significant non-compliance with the Standard in Australia.

In 2003, the Australian Government, working with the state governments of NSW, Victoria, Tasmania, WA and SA, and the Australian Home Heating Association, carried out an audit of retail woodheater models. The program involved selection of 47 popular models which underwent engineering design verification and labelling checks. The retail models were compared with the engineering drawings held by the laboratories when each model was originally tested. The design verification component of the audit focussed on features that might be expected to influence emissions, such as minimum combustion air settings, location of air

inlets, preheating chambers for combustion air, baffle materials and dimensions, and firebox dimensions. Labelling of each model was checked to see that it complied with requirements set out in the Standards. Twelve of the 47 models were also audited by carrying out full laboratory tests in accordance with the Standard test methods. The outcomes of the audit program are presented on the DEHWA website (DEH 2004a) and in a conference paper (Bagchi *et al.* 2003), but the identification of passing or failing models remains confidential.

The design verification and labelling checks showed:

- only five retail models (11%) matched engineering drawings and had correct labelling;
- nine retail models had incomplete or incorrect labelling but met the design specifications (this might be considered a minor problem from an air quality perspective, but is, nonetheless, unacceptable);
- 33 retail models (70%) had design differences which might increase emissions; of these 23 (47%) had reduced minimum combustion air and six (13%) had changes to the baffle; other changes identified in the audit included firebricks, convection

fans, water heating attachments and combustion chamber dimensions.

Thus, the design verification audit, which is relatively quick and inexpensive to do (provided original engineering drawings are available), showed that more than two-thirds of popular retail models differed from the tested model in ways that might increase emissions. It also showed widespread failure to comply with labelling requirements set out in the Standards.

The results from retail models that underwent a full audit (design verification plus laboratory testing) provide more quantitative data (Figure 1) for planning and policy development. The average emission factor based on the certification testing for all 12 models was 2.9 g kg^{-1} , but the average for the retail models was 6.5 g kg^{-1} . In other words, this sample of 12 popular heater models suggests that emissions from the heaters being sold are more than double what they should be if heater designs had not been changed. For heater models that failed the retesting, the retail heaters emit three times more particulates than their average certified emissions. The worst of the tested models emits almost 10 times more from the retail model than the certified model. It is prudent to remember that these emission factors are based on the Standard test method which assumes correct operation of the heater (i.e. emissions are minimised).

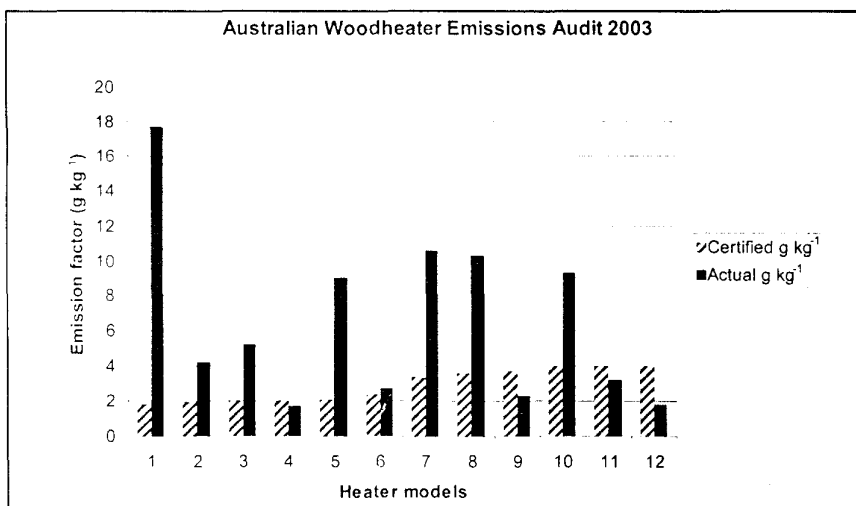


Figure 1. Results of laboratory testing of retail woodheaters. The striped columns are results from original certification testing and solid columns the results of the audit tests. Heaters are shown from cleanest certification value (on left) to less clean. Heaters 10 and 11 had no certification values available and are shown as the maximum allowable (4 g kg^{-1}).

EMISSION AUDITING OF NEW WOODHEATERS IN AUSTRALIA AND NEW ZEALAND

Following the Australian audit program, the government negotiated with the Australian Home Heating Association and they agreed to:

- improved procedures for certification (involving a check of a production model heater before certificates are issued) - this is a sensible change (AHHA 2006);
- a voluntary audit of retail models involving design verification (repeated if a model fails) and a laboratory emission test if the second design verification also indicates a failure (DEH 2004b). Being voluntary, no manufacturer with any doubts about passing the audit would be likely to participate, thus making the procedure ineffective.

The author was involved in a research program in 2005 that required purchase of four woodheaters. Laboratory tests showed that three of the four did not meet the emission standard. Thus, two years after the national audits there was still significant retail model non-compliance.

RESULTS OF NEW ZEALAND AUDITS

In 2007, New Zealand conducted design verification and laboratory test audits of wood burners (woodheaters). Perhaps benefiting from some of the problems encountered in the Australian audit, a well defined, government/industry agreed procedure was established, which included the public release of results for individual models audited (MfE 2007). The audit protocol specifies measurement/construction tolerances for various components and a grading for non-compliance: from undetermined, through minor, moderate, serious to very serious.

The design verification audit (Stage 1) covered 35 models randomly selected from 90 authorised or tested wood burning heaters (MfE 2007). The audit found:

- 13 models (37%) 'passed' the audit;
- three models (9%) were undetermined (i.e. it was not possible to precisely confirm or reject whether retail models were identical to the tested model); and
- 19 models (54%) 'failed' the audit. Failures were classified as minor (11 models), moderate (two models) or serious (six models).

The outcomes of the New Zealand design verification audit were marginally better than the Australian audit carried out four years earlier, but still showed widespread non-compliance.

An additional 10 wood burners underwent a full audit in New Zealand including design verification and laboratory testing (MfE 2008). Figures 2 and 3 show the results for emissions auditing and efficiency auditing. The average emission factor for the certified/authorised models

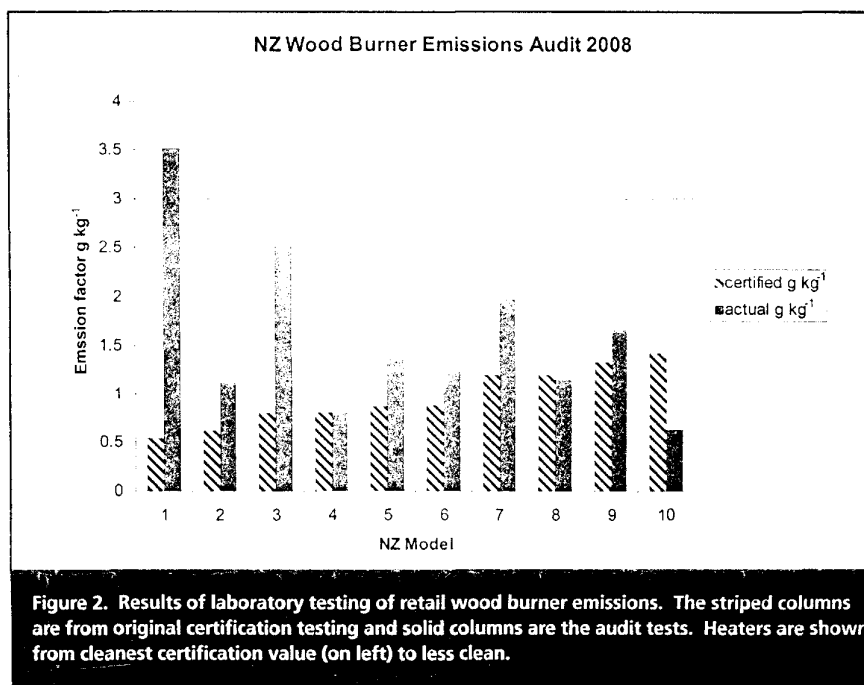


Figure 2. Results of laboratory testing of retail wood burner emissions. The striped columns are from original certification testing and solid columns are the audit tests. Heaters are shown from cleanest certification value (on left) to less clean.

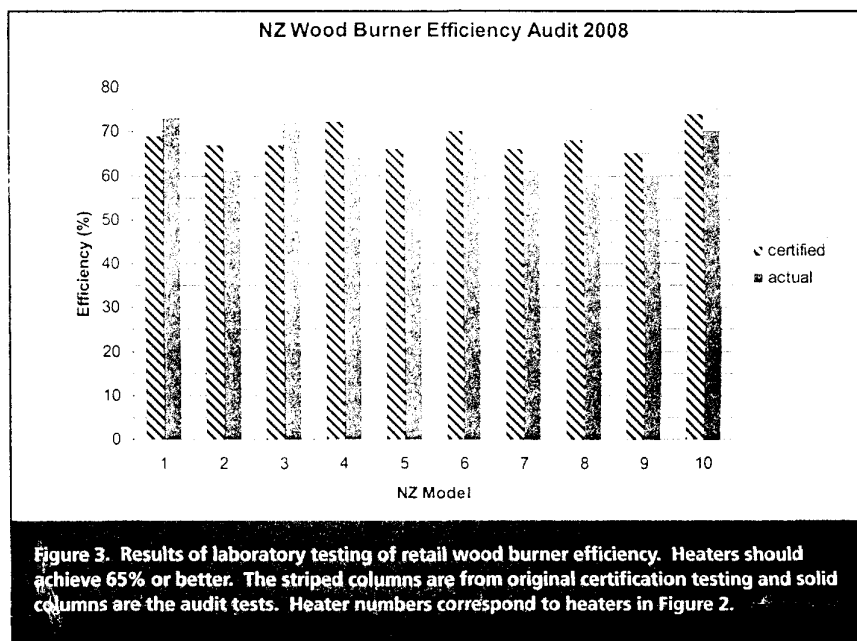


Figure 3. Results of laboratory testing of retail wood burner efficiency. Heaters should achieve 65% or better. The striped columns are from original certification testing and solid columns are the audit tests. Heater numbers correspond to heaters in Figure 2.

was 0.96 g kg^{-1} while the measured retail models averaged 1.6 g kg^{-1} . This is a 67% increase (compared to a 124% increase for the Australian audit).

The wood burner efficiency audit results (Figure 3) show 60% of models failed to meet the 65% efficiency requirement (although efficiencies in the 60 to 65% range are considered 'undetermined' because of experimental uncertainty in the testing, so only two models formally failed the efficiency audit).

DISCUSSION

Design verification audits and full laboratory emission test audits in Australia and New Zealand show serious differences between

the 'representative' models tested for certification purposes and the models appearing on the retail floor.

The Australian audit in 2003 suggests that consumers wanting to buy low emission woodheaters have no way of deciding which model suits their needs. In fact, for the 12 models undergoing laboratory audit tests the one with the lowest stated emission factor was the worst as far as retail model emissions were concerned (Figure 1). Interestingly, the New Zealand model with the lowest certified emission factor (Figure 2) also had the highest emission factor for the retail model (an increase by a factor of 6.5). This poor audit outcome for the two models with the lowest certified emission factors appears purely coincidental because analysis

of the full data set shows no correlation between lower certified emission factors and higher retail model emission factors. While some auditing has taken place since 2003 in Australia the results remain confidential, so Australian consumers have no independent confirmation that the situation now is better or worse than it was five years ago. In New Zealand consumers can easily identify models that passed the audit or, if they failed the audit, what the manufacturer is doing to remedy the problem.

The audits have shown that similar compliance problems occur in Australia and New Zealand. However, the results show a stark difference between the emission factors in the two countries (Figure 4). The much lower certified and retail emission factors in New Zealand reflect tougher emission limits, with laboratory testing showing heaters emit one-quarter to one-third the particulates compared to Australian heaters. These Australia/New Zealand differences will be covered in more detail in coming discussions.

Both Australia and New Zealand require additional independent auditing of retail woodheater models, with appropriate penalties for non-compliance, in order to improve quality control in the industry and reassure consumers that they are purchasing appliances that match the advertised performance specifications.

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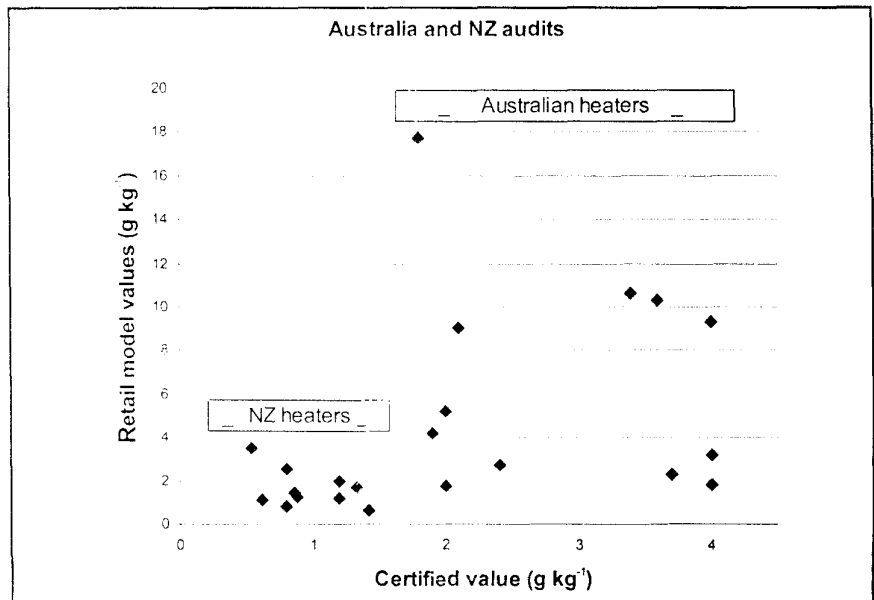


Figure 4. Results of Australian and New Zealand laboratory audits of heaters showing measured emissions from retail models plotted against each heater's certified/authorised emission factor.

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