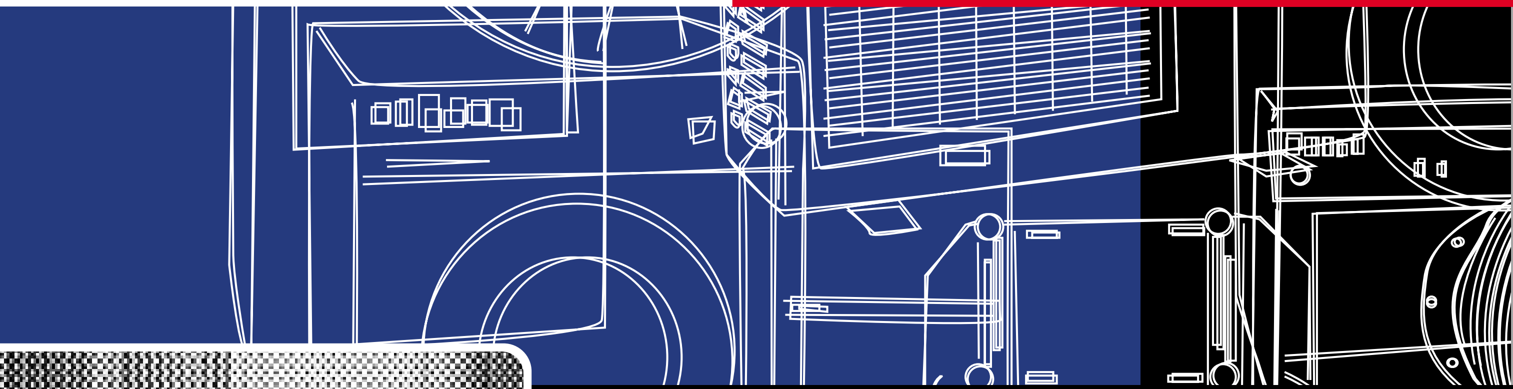
NATIONAL APPLIANCE AND EQUIPMENT ENERGY EFFICIENCY PROGRAM

VERIFICATION TESTING



A report on independent laboratory testing of

HOUSEHOLD ELECTRIC CLOTHES DRYERS

VERIFICATION TESTING

A report on independent laboratory testing of

DOMESTIC CLOTHES DRYERS

in Australia

March 2001

Published by

The National Appliance and Equipment Energy Efficiency Committee

with input from the
National Association of Testing Authorities

Verification Testing
Household Clothes Dryers in Australia

Introduction

This is the second report released by the National Appliance and Equipment Energy Efficiency Committee (NAEEEC) to report the outcome of an extensive independent testing program. This report details the results of testing two household clothes dryers. However, when considering these results, they need to be placed in the context of the wider testing program commissioned by NAEEEC to cover all appliances subject to mandatory labelling and minimum energy performance standards.

A report on refrigerators and freezers has been released at the same time as this report. NAEEEC will progressively release separate reports for domestic air conditioners and clothes washers later in 2001 from this round of testing. NAEEEC also expects to release reports relating to electric storage hot water units and dishwashers in 2002.

Who we are ?

NAEEEC comprises officials from government agencies with an interest in product energy efficiency drawn from all jurisdictions in Australia and in New Zealand. This committee is responsible for implementing the national greenhouse gas and energy efficiency programs on behalf of all Australian governments.

The National Association of Testing Authorities (NATA) in Australia is responsible for accrediting member laboratories to measure compliance to Australian Standards and, amongst other things, test the range of appliances subject to mandatory appliance labelling and minimum energy performance standards.

Why conduct verification testing ?

The national energy efficiency program is built on appliance labelling mandated by each state and territory under electrical safety regulation. For more than 10 years, NAEEEC members have tested appliances to verify manufacturer claims. NAEEEC and its predecessors have commissioned independent test laboratories who are accredited by NATA to undertake these tests to measure the energy use and performance of appliances and to confirm the accuracy of comparative efficiency labels attached to those appliances.

In 1999, NAEEEC and NATA agreed to conduct a major review of the independent laboratories' capacity to test appliances to the exacting Australian and New Zealand appliance performance Standards. NAEEEC took this decision to demonstrate the capacity of NATA laboratories to test compliance with the minimum efficiency levels specified for refrigerators, freezers and electric storage water heaters from late 1999 as well as for the new energy labelling requirements commencing in 2000.

In circumstances where governments are requiring suppliers to improve the energy efficiency of their products and consumers to pay potentially more for energy efficient products, NAEEEC wanted to transparently demonstrate the capacity of testing authorities to accurately measure compliance with the new regulatory requirements.

What was tested ?

NAEEEC agreed to fund NATA and its member laboratories to undertake a comprehensive testing program of all regulated appliance types in every independent NATA accredited laboratory in Australia. This program consisted of 13 products from 6 different product types being tested by 6 different laboratories resulting in 53 test reports. The main focus was to identify testing issues within each Standard that may require reconsideration by the relevant Standards Committees.

This "round robin" test program was undertaken with the assistance and expertise of the NATA who provided witnesses at each of the tests conducted in each laboratory. The initial round of testing was commenced in October 1999 with the final tests in this initial round completed in late March 2000. A program of follow-up tests is continuing in response to specific questions and queries raised by the original results for four of the six appliance types.

The round robin tested both the *repeatability* (the ability to obtain the same result on the same machine in the same laboratory) and *reproducibility* (the ability to obtain the same result on the same machine in a different laboratory) of the various test standards. The round robin sought to identify issues within each Standard that may require reconsideration by the relevant Standards Committee.

What will change ?

For appliances other than refrigerators and freezers, NAEEEC is proposing changes to some of the test standards as a result testing undertaken for the round robin. NAEEEC will share the results (subject to some confidentiality constraints) with other stakeholders as part of the process of continually improving public confidence in both appliance labelling and minimum energy performance standards. The results will be released progressively in 2001 and NAEEEC proposes to assist suppliers' laboratories by allowing tests to be undertaken on the same units used in the "round robin" in their own laboratories.

It remains imperative that inter-laboratory variability in testing is minimised to acceptable measured levels and those levels are documented so those regulators only act on those cases of truly inaccurate labelling and standards. Regulators also want to keep the public (and the industry) aware of these testing issues.

This report contains the comparative results for each product but identification of each participating laboratory has been removed and the results for each product mixed to further protect the identity of participants. This report contains general comments on the possible reasons for the differences in results (where these exist), and the subsequent tests that have been commissioned in order to improve the results (where applicable). Detailed comments are contained in a separate laboratory specific report, which was made available to the participating laboratory, and to NATA.

More detail of this testing program can be found within the "Administrative Guidelines for Labelling and MEPS" which can be down loaded from the Australian Greenhouse Office web site:

http://www.greenhouse.gov.au/energyefficiency/appliances/naeeec/program.html

What clothes dryers were tested ?

Two products were chosen for the "round robin"; a dryer that used a timer control and a dryer that used an autosensing control. The units represented were:

Timer Dryer – Eurotech MAD500
Autosensing Dryer – Asko T760

These units were purchased at random from a retail outlet.

What laboratories participated ?

NAEEEC accepted test reports from three laboratories that tested the domestic clothes dryers. All three laboratories are NATA accredited for clothes dryer testing and have at various times performed check testing for NAEEEC.

While the identity of NATA accredited laboratories is not confidential, at the request of NATA and some of its members, NAEEEC has decided not to disclose the three laboratories whose results are contained in this report. Possible unwarranted commercial advantage is the reason for not declaring the names of the participating laboratories.

What Standard was tested ?

The test were conducted as specified in AS/NZS 2442.1-1996 (including amendments 1 & 2). Mr John Greenham, an expert appointed by NATA, witnessed the tests of both products conducted in the three laboratories.

The energy consumption test only was conducted on each of the test units in all three laboratories.

What did the NATA Observer find ?

Laboratory Facilities – Generally

Two of the laboratories' facilities were adequate to carry out clothes dryer tests. These facilities include factors such as ambient control, test room conditioning equipment, and recording raw data. The third laboratory was required by NATA to upgrade controls on environmental conditions before re-tests were carried out.

Environmental Conditions

Two laboratories were able to maintain the environmental conditions as required by the Standard. The third laboratory as noted above was required to upgrade environmental controls.

Instrumentation and Calibration

All laboratories instrumentation such as balance scales, power meters and temperature sensors were adequate to meet the requirements of the Standard and were within the period of re-calibration.

Compliance by laboratories to Standards

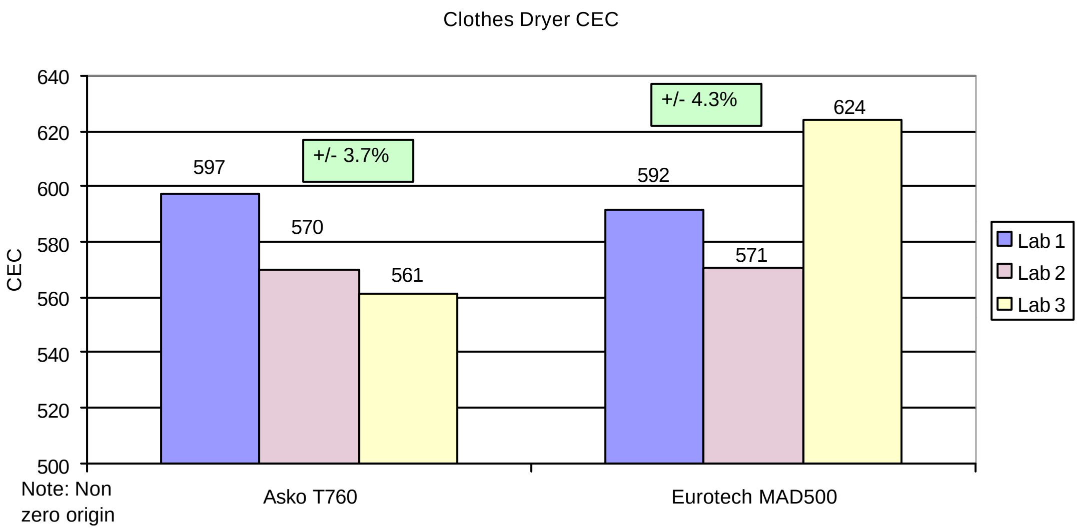
All laboratories complied with the requirements of the current standard as written.

What were the test results ?

Results

The following chart detail the results from the initial round robin tests conducted on the selected clothes dryer units:

Figure 1: Initial round of tests



Note: Labs 1 to 3 for the Asko unit do not correspond to Lab 1 to 3 for the Eurotech unit.
Note non zero Y axis for energy.

Analysis of Results

Energy Consumption tests demonstrated a reasonable level of reproducibility between laboratories. Uncorrected variations ranged from ±3% to ±5%. However, on advice, NAEEEC attempted to identify the issues that created this variation because it felt that there was still room for further improvement in terms of reproducibility.

Analysis of the results suggested a number of possible causes for the observed discrepancies between the laboratories. These possible causes were investigated in a series of follow up tests that are detailed in the following sections.

Timer Dryer: Follow-Up Tests

Following the initial round robin tests a series of further tests were conducted at one of the test laboratories to try to determine the cause of the observed discrepancies in the timer dryer results. The results of these follow-up tests were presented at a Standards' meeting in May 2000.

The main finding of these tests was that balance readings were likely to be significantly affected by two factors:

1. The accumulation of condensed water within both internal and external ducting associated with the dryer.

2. The buoyancy effect caused by hot air accumulating in the dryer.

To overcome these problems, the Standards Committee is formulating a revision to the current test method based on conclusions from the round robin results. The revised test method (see appendix A) still relies on taking the results of the interpolation using the platform scales. However, these results are then adjusted by a correction factor equal to the difference between the final mass (m_{c2}) as measured on the platform scales and the final mass (m_f) as measured by removing the load from the dryer and measuring its mass separately.

The revised test method was trialed on the timer dryer at the first laboratory. The same unit was then shipped to the two other laboratories and tested using the revised test method.

The results from the three participating laboratories are presented below.

Table 1: Results of Dryer Retesting

	Reading	Lab 1	Lab 2	Lab 3
M_{bd}	Bone dry mass	4.19	4.16	4.15
E1	Energy consumption at reading 6-7%	3.79	3.75	3.77
M_{c1}	Mass of load measured in dryer at 6-7%	4.46	4.44	4.39
M_f	Final mass of load measured out of the dryer	4.40	4.42	4.58
M_{c2}	Final mass measured in dryer (ie at 5-6%)	4.40	4.41	4.36
$M_{c6\%}$	Target mass at 6%	4.44	4.41	4.40
E2	Energy at reading 5-6% ie final energy	3.88	3.77	3.82
AF	Adjustment Factor	-0.01	0.01	0.22
E6%	Energy Consumption at 6% moisture content	3.80	3.76	3.81
CEC	**(old standard)**	**628**	**621**	**629**

As can be seen the results from each laboratory are very close. The maximum difference in the energy consumption is 1.4% (± 0.7%).

Conclusions From Results Of Timer Dryer Follow up Tests

The results obtained using the proposed revised method represent a significant improvement in reproducibility. Using the revised method, clothes dryer energy consumption tests can be reproduced with a maximum variation of approximately 1.5%.

Auto Sensing Dryer Follow-Up Tests

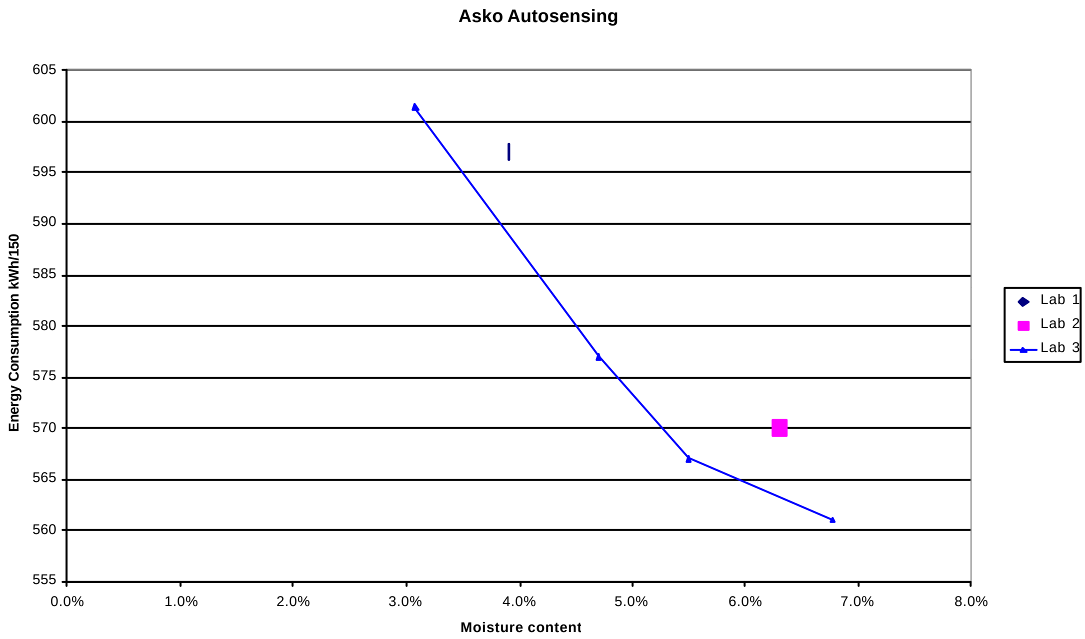
The auto sensing test method is straight forward as the dryer is operated until the commencement of cool down then the load mass, moisture content and energy consumption are determined at that point for the selected program.

Tests were commissioned to examine the impact of exhaust placements and humidity control on the operation of the dryer. The results showed that small changes in the ambient conditions have little impact on the overall dryer energy efficiency. Analysis of this test data also revealed that the ASKO dryer termination moisture content was variable, and seemed to be independent of ambient humidity control and venting arrangements. Final moisture content varied from 3% to nearly 7% using the same program and this appeared to be largely random in nature (the standard requires a maximum final moisture content of 6% at the start of the cool down period).

By plotting the data of moisture content versus energy consumption for each laboratory, it can be seen that the variation between labs is extremely small. Two Laboratories lie within

7 kWh (about 1% of energy) of the energy-performance curve of the other laboratory for the same moisture content for the ASKO dryer. This suggests that if the dryer could have been terminated at the same moisture each time, energy reproducibility would be of the order of 1%.

Figure 2: Energy Performance Curve - Asko autosensing



It should be noted that the energy performance curve is rather steep at the point of termination, with a change of about 2.5% in energy for each 1% change in moisture content. So the variation in final moisture content which appears in the original round robin energy graph for the ASKO machine (Figure 1) is mostly due to the variable behaviour of the machine under test rather than a problem with the test method as such.

Outcomes

The findings of this study were presented to the joint Australian/New Zealand Standards Committee that deals with clothes dryers (EL 15/4) in February 2001. The Standards committee agreed to the following alterations

1. The Standard should mandate that the clothes load should be weighed separately at the end of the program (start of cool down) to allow for any accumulated moisture and buoyancy to be accounted for in the test method. (see proposed revisions to the standard detailed in Appendix A).

2. That the only acceptable method for determining the final moisture content for autosensing type dryers should be based upon the mass of the load weighed separately at the end of the autosensing program as detailed in Appendix A (use of the balance to determine the clothes mass is not acceptable).

3. That the method for determining energy consumption for manual and timer type dryers be modified in accordance with Appendix A so as to account for accumulated moisture and buoyancy.

4. For the purpose of verification testing of autosensing dryers, the taking of a single reading will be acceptable only if the final moisture content is *equivalent* to the initial claim used to determine the label energy consumption. Where this is not the case two runs may be required. Where the mass of the load is tracked using a balance and the final moisture content of the verification run is lower than the original claim, interpolation back to the claimed termination moisture content can be undertaken using the method develop for timer dryers (but replacing a 6% target moisture content with the claimed moisture content – note that many autosensing dryers cannot be stopped to take mass measurements on a balance so a method of continuous mass measurement may be required). If not, then one additional run must be undertaken to return a final moisture content such that one run is above the claimed final moisture and one run is below the claimed final moisture (using a different program setting as necessary). Using interpolation between the energy consumption results of each run, the predicted energy consumption at the moisture content of the initial claim can then be determined.

NAEEEC believes the results of the additional testing vindicate its decision to commission tests that further analyse the reasons for the variations reported in the initial round of testing in 2000. The fact that the relevant Standard Committee is working to amend the standard is evidence of that conclusion. The level of confidence in the reproducibility of results between laboratories has been enhanced through this process.

APPENDIX A

Proposed Revision to the Clothes Dryer Test Standard AS/NZS 2442.1:1996

1. Autosensing Dryers

The method for determining the moisture removal and energy consumption (Appendix B) shall remain as is except that the "performance target" (total mass = 106% of bone dry mass) as noted in B3.2.1 (c) shall be measured (at the point immediately prior to the cool down period) by removing the load from the dryer and measuring the load alone on a scale. The revised clause would be clause B3.2.1 (g) that would read as follows:

(g) Monitor the dryer as it progresses through the program. When the heater switches off for the final time, i.e. immediately before the cool-down period begins, (refer to Paragraph B3.3 for methods of determining cool-down) stop the dryer, remove the load and immediately transfer the load to a balance or scale and record the final mass (m_f). If the final mass m_f is greater than the performance target $m_{6\%}$ the test shall be invalid and a new run (possibly with a different drying program setting) shall be conducted.

A new section on the verification of auto-sensing dryer energy consumption will include a requirement to interpolate the result to the claimed final moisture content when assessing the original claim (either using the timer dryer correction approach with a balance or undertaking separate test runs to allow interpolation).

2. Manual and Timer Dryers

The method for determining the moisture removal and energy consumption (Appendix A) shall remain as is except that:

- The interpolation method shall be the only method used; and
- The results of the interpolation using the platform scales shall be adjusted by a factor equal to the difference between the final mass (m_{c2}) as measured on the platform scales and the final mass (m_f) as measured by removing the load from the dryer and measuring its mass separately.

The revised clauses would be as follows:

A3.1 Delete the NOTE at the end of this clause.

A3.2 Delete entirely.

A3.3 (h) Add the following to the end of this clause

Immediately following the final reading on the platform scales stop the dryer, remove the load and immediately transfer the load to a separate balance or scale and record the final mass (m_f). If the final mass m_f is greater than the performance target $m_{6\%}$ the test shall be invalid and a new run (with a longer drying time) shall be conducted.

Using the final mass m_f and the mc_2 figures calculate the adjustment factor (AF) as follows : $AF = m_f - m_{c2}$

A3.3 (i) Alter as follows:

Using the two values of energy, perform a linear interpolation (adjusted using the adjustment factor (AF)) to obtain the test value of input electrical energy for a moisture content of 6% exactly.

A suitable equation for this is as follows:

$$E_{6\%} = E_1 + \left[\frac{(m_{c1} + AF - mc_{6\%})x(E_2 - E_1)}{(m_{c1} + AF - m_{c2})} \right]$$

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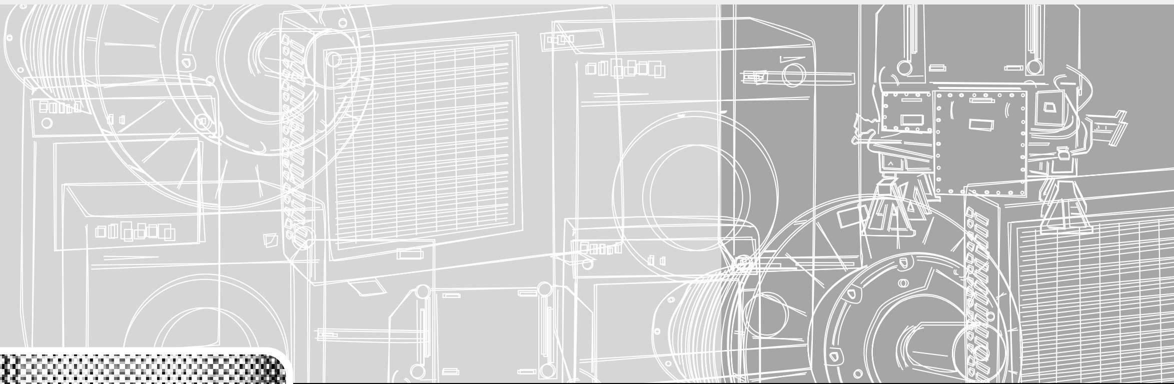

For more information contact:

Energy Efficiency Team
Australian Greenhouse Office
GPO Box 621
CANBERRA ACT 2601

Facsimile: (02) 6274 1884
Email: energy.efficiency@greenhouse.gov.au

or any member organisation working
on the National Appliance and Equipment
Efficiency Program.